**Autonomous Program Structure of**

**Third and Final Year B. Tech.**
**Academic Year: 2022-2023 Onwards**

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Oral | Practical | | |
| 20OEHS 501 | Open HS Elective –I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 601 | Open Elective-II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 801 | Open Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 802 | Open Elective-IV* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |

* **Inter-disciplinary Course**

20OEHS 501 Open Elective I (Humanities)

| **Sr. No.** | **Course Code** | **Course Title** |
|---|---|---|
| 1 | 20OEHS501A | Entrepreneurship Development |
| 2 | 20OEHS501B | Intellectual Property Rights |
| 3 | 20OEHS501C | Introduction to Digital Marketing |
| 4 | 20OEHS501D | Law for Engineers |
| 5 | 20OEHS501E | Organizational Behaviour |
| 6 | 20OEHS501F | Project Management |

20OE601 Open Elective-II

| **20OE601 Open Elective-II** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE601A | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601B | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601C | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601D | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601E | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601F | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601G | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601H | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601I | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601J | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601K | Multimedia Systems | Y | Y | Y | N | Y |

20OE801 Open Elective-III

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

20OE802 Open Elective-IV

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

## 20OEHS501A ENTREPRENEURSHIP DEVELOPMENT

**Teaching Scheme** | **Examination scheme:**

**Lectures:** 3 Hours / Week

**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Prerequisite:** NA

**Course Objectives:**

1. Understand the fit between individual entrepreneurial ambitions
2. Select a problem worth solving
3. Identify customers
4. Develop a solution for your customers' problems and problem solution
5. Build and demonstrate an MVP (Minimum Viable product)
6. Structure a business model around the problem, customer, and solution and present Business Model Canvas

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe what it takes to be an entrepreneur
CO2 Analyze business opportunities and the basics to create, launch and manage new businesses
CO3 Develop Business Model for their Idea/Problem
CO4 Create MVP (Minimum Viable Product)

**Module 1: Introduction (03)**

Discover yourself, Principles of Effectuation, Identify your entrepreneurial style

**Module 2: Problem Identification and Idea generation (04)**

Identify Problems worth Solving, Introduction to Design Thinking, Generate ideas that are potential solutions to the problem identified

**Module 3: Customer Segmentation (07)**

Customer identification, Market, Creative solution, Unique Value proposition

**Module 4: Business Model Canvas (04)**

Types of business models, Business Plan documentation, Risk identification

**Module 5: Validation (09)**
Identification of MVP, Solution development, Building products/services, Build-measure-learn loop for development, Market fit of solution

**Module 6: Money (05)**
Revenue streams, Pricing and cost, Venture financing, Investor expectations

**Module 7: Team building (03)**
Shared leadership, role of good team, Collaboration tools and techniques

**Module 8: Marketing and sales (03)**
Positioning, Channels and strategies, Sales planning

**Module 9: Support (04)**
Project management, Planning and tracking, Business Regulation

**Text Books:**

1. Course contents available at: https://staging.learnwise.org/ - Through a Cloud Technology Platform – WF Learn Wise Platform
2. PDF documents can be downloaded from the website for the distribution to students.

**Sample References:**

1. Effectuation: https://necrophone.com/2014/01/20/effectuation-the-best-theory-ofentrepreneurship-you-actually-follow-whethe
2. Value Proposition: https://www.youtube.com/watch?v=jZN6CUieuOQ&list=PLw540Wq5kay866m6A6xI7KOwE_Ah7is4m
3. The Lean BMC: https://www.youtube.com/watch?v=FjB_e7UO1hc
4. Define your MVP: https://startups.fb.com/en-in/categories/development/
5. Designing Experiments: https://www.youtube.com/watch?v=WiMZWCg1Hu8&t=111s
6. Beating the Competition: https://www.youtube.com/watch?v=46uP6vOj5G
7. Google : Think branding: https://www.youtube.com/watch?v=1l2CUjkg0ug

## 20OEHS501B Intellectual Property Rights

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| **Lectures:** 3 Hours / Week | **ISE:** 50 Marks |
| | **ESE:** 50 Marks |
| | **Credits: 3** |

**Prerequisite: No pre-requisite**

**Course Objectives:**
**To facilitate learners to,**

1 Overview of Intellectual Properties (IP) regime in India and International arrangements
2 Introduce the types of IP as Patents, Copyrights, Trade Secrets etc.
3 Understand the process and steps involved in filing Intellectual Properties
4 Understand intricacies involved in drafting patent applications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Demonstrate the concepts of Intellectual Property Rights, patents and other forms of IP |
| CO2 | Apply appropriate type of IP for the Intellectual property |
| CO3 | Analyze the patentability of inventive step by searching patents |
| CO4 | Construct patent drafts for given Patent specification |
| CO5 | Understand the advances in patent law, in national and international scenario |

**Unit 1: Introduction (06)**

Intellectual Property (IP) Vs. Physical property, History of IP in India, Importance of IP, Patentable inventions / art, types of IPR-Patents, Copyright, Industrial Design, Trade Marks etc., Basic principles of IPR, Economic Importance of Intellectual Property Rights, IPR-ownership, morality, public order, traditional knowledge

**Unit II: Patents (08)**

Introduction to Patents, Patentable Inventions as per the Indian Patent Act, Patent searching, types of Patent applications, Procedure for filing application (National and International), Patents offices, Register of Patents, Rights and obligations of patentee, Term of patent, Patent of Addition

**Unit III: Drafting of patent applications (08)**

Fundamentals of drafting, structure of the patent specification-Field of invention, prior art, patent classifiations, technical advance, Invention Disclosure Form, problem solution statement, claims, preamble, body, summary

**Unit IV: Transfer and Infringement of Patent Rights (06)**

Working of patents, compulsory licensing, Revocation of patents, Transfer of Patent Rights- Assignment, License; Concept of infringement, Infringement of Patents Rights, Infringement of Patents rights

**Unit V: Introduction to other types of IPs (08)**

Copyright, Trade Marks, Geographical Indications, Industrial Designs, Trade Secrets, Layout designs of Integrated Circuits : Introduction, Work protected by, ownership and infringement, Application process

**Unit VI : Advances in IPR (06)**

International Patenting, Patent Co-operation Treaty (PCT), Commercialization of Patents, Advances in IPR

**Text Books:**

1 Niraja Pandey, Khushdeep Dharni, "Intellectual Property Rights", PHI
2 N. S. Rathore, "Intellectual Propoerty Rights: Drafting,Interpretation of Patents Specification and Claims" , New India Publishing Agency

**Reference Books:**

1 Venkataraman M., "An introduction to Intellectual property Rights", Venkataraman M.
2 Mishra, "An introduction to Intellectual property Rights", Central Law Publications
3 R Anita, V. Bhanoji Rao, "Intellectual property Rights, - A Primer", Eastern book Company
4 R Puri, "Practical approach to intellectual propert Rights"
5 P Ganguly, "IPR unlisting the knowlege economy"

**Online Resources:**

1 NPTEL course material on "Patent Drafting for Biginners" - https://onlinecourses.nptel.ac.in/noc18_hs17/preview
2 IP India : www.ipindia.nic.in/
3 WIPO, World Intellectual property Organization - www.wipo.int/
4 Intellectual Property (IP) Policy | USPTO - https://www.uspto.gov/intellectualproperty-ip-policy

## 20OEHS501C Introduction to Digital Marketing

**Teaching Scheme**
**Lectures:** 3

**Examination scheme:**
In Semester: 50 marks
End Semester: 50 marks
**Credits: 3**

**Prerequisite:**

**Course Objectives:**

1 Interpret Digital marketing campaign strategy
2 Explain social media and its role in marketing strategy through various channels which it operates
3 Explore search engine optimization
4 Explain concepts related to mobile marketing

**Course Outcomes:**
After successfully completing the course students will be able to
1 Explore methods to illustrate website and webhosting concepts
2 Develop a marketing plan for product or service by integrating social media platforms to generate leads
3 Examine mobile marketing strategies to connect with customers
4 Demonstrate importance of organic ranking through SEO

**Unit I: Overview of Digital Marketing (08)**
Introduction to Digital Marketing,Understand customer needs, Benefits of Digital marketing, Digital marketing platforms and Strategies, Comparing Digital with Traditional Marketing,Latest Digital marketing trends, What is Domain Name, Types of Domain, Web Hosting Concepts, Domain/Hosting Business,introduction to wordpress

**Unit II: Digital Advertising with Google AdWords (08)**
Introduction to Paid Marketing, Google Account setup, Account Structure, Campaigns settings, AdGroup setup, Keyword Match Types, Keyword Research Tools, Understanding Ad Auction, What is Quality Score, My Client Centre, Google AdWords Editor Tool,
Interface Tour and BillingSettings

**Unit III: Social Media Marketing (08)**
Introduction to Social Media, Integrating Social Media with Other Disciplines, Facebook Marketing, Facebook account setup, Personal account properties, Facebook marketing strategy, Facebook business page setup, Types of Business pages, Cover photo designing, Page management options, twitter and Instagram marketing

**Unit IV: Mobile Marketing (06)**

Introduction to Mobile Marketing and m-commerce, create mobile app,case study:market potential of mobile commerce.

**Unit V: Search Engine Optimization (06)**

**I**ntroduction to Search Engines, On-Page Optimization, Off-Site Optimization, Social media monitoring Tool

**Unit VI : Case study and Future Trends in Digital marketing (06)**

Digital marketing Scenario in india and world, Digital Strategies Influence r marketing, AI in Digital Marketing

**Text Books:**

1 Seema Gupta, **"Digital Marketing**", *McGraw-Hill Publication*, (1st Edition), (2018).
2 Benjamin Mangold, **"Google Adwords and Google Analytics"**, *loves data* , (1st Edition), (2018).
3 Richard stokes, **"Pay per click",** *Entrepreneur Press*,(2nd Edition), (2014).
4 Suraj Bandyopadhyay **"Models for Social Networks with Statistical Applications"**, *Sage Publications*, (1st Edition), (2011).

**Reference Books:**

1 Ian Dodson, "**The Art of Digital Marketing",** *Wiley*, (1st Edition), (2016).
2 Sira. R Bowden , "**Beginners Guide Digital Marketing Part 2:** *Mobile Marketing", BookRix,* (1st Edition), (2016).

**Online Resources:**

NPTEL:Marketing Management: *https://nptel.ac.in/courses/110/104/110104070/*

**websites:**

1 https://www.searchenginejournal.com/seo-guide/panda-penguin-hummingbird/
2 https://www.lynda.com/Analytics-tutorials/Online-Marketing-Fundamentals/188429-2.html

## 20HS501D - LAW FOR ENGINEERS

**Teaching Scheme** | **Examination scheme:**

**Lectures:** 3 Hours / Week

**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Course Objectives:**

1 To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it
2 To make students aware of the theoretical and functional aspects of the Indian Parliamentary System
3 To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers
4 To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework
5 To make students learn about role of engineering in business organizations and e- governance

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify and explore the basic features and modalities about Indian constitution |
| CO2 | Differentiate and relate the functioning of Indian parliamentary system at the center and state level |
| CO3 | Differentiate different aspects of Indian Legal System and its related bodies |
| CO4 | Correlate and apply different laws and regulations related to engineering practices |
| CO5 | Correlate role of engineers with different organizations and governance models |

**Unit 1: Legal Structure and Constitutional Law (06)**

Legal Structure **:** Court System in India (District court, District Consumer court, Tribunals, High courts, Supreme Court), Arbitration, Constitutional Law: The Preamble, Fundamental Rights, Fundamental Duties, Emergency provisions: Kinds, Legal requirements and Legal effects.

**Unit II: RTI and Contract Law (06)**

Right to Information Act, 2005: Evolution and concept, Practice and procedures, Contract Law : General Principles of Contract under Indian Contract Act, Kinds of government contracts and dispute settlement, Standard form contracts : Nature, Advantages, Unilateral character, Principles of protection against possibility of exploitation, Clash between two standard forms contract.

**Unit III: Sale of Goods Law and Consumer Protection Act (06)**
Sale of Goods Law **:** Goods- movable property, Warranty, Guarantee, Consumer Protection Act **:** Consumer Rights and Legislative framework on Consumer protection.

**Unit IV: Environment Law and Labour Laws (08)**
Environment Law**:** Laws relating to industrial pollution, environmental protection, Labour Laws**:** Industrial Disputes Act, Collective bargaining; Industrial Employment, Health and safety at work, Accidents, PoSH Act 2013 **:** Laws relating to Equality and Empowerment of Women, The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013

**Unit V: Patent and Cyber Law (08)**
Law relating to Patents : Patents Act, 1970, Law relating to Intellectual property, Law relating to Copyright, Law relating to Trademarks, Cyber law Act 2000 : The Information Technology Act, 2000 (also known as ITA-2000, or the IT Act) - dealing with cybercrime and electronic commerce.

**Unit VI : Corporate Law and Land Law (08)**
**Corporate** Law**:** Meaning of corporation; Law relating to companies, public and private (Companies Act, 1956) general provisions, Corporate liability, civil and criminal, Code of Business Conduct (COBC) provides the ethical guidelines and expectations for conducting business, Land Law: Transfer of Property Act, Land disputes.

**Text Books:**
1 D.D. Basu, "**Shorter Constitution of India"**, Prentice Hall of India, December 2017
2 S.K. Awasthi & R.P. Kataria, "**Law relating to Protection of Human Rights"**, Orient Publishing, 2000
3 Wadhera , "**Intellectual Property Rights"**, Universal Law Publishing Co, 5th edition
4 O.P. Malhotra, "**Law of Industrial Disputes"**, N.M. Tripathi Publishers, 1968

**Reference Books:**
1 M.P. Jain, "**Indian Constitutional Law"**, Wadhwa & Co., 2018
2 S.K. Kapur, "**Human Rights under International Law and Indian Law"**, Central Law Agency, 7th edition
3 Avtarsingh, "**Law of Contract"**, Eastern Book Co, 2020
4 T. Ramappa, "**Intellectual Property Rights Law in India"**, Asia Law House, 2016

**Online Resources:**
1 **Companies Act, 2013 Key highlights and analysis by PWC.**
https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlightsandanalysis.pdf

**20OEHS501E ORGANIZATIONAL BEHAVIOR**

**Teaching Scheme** | **Examination scheme:**
Lectures: 3 Hours / Week
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**
To facilitate the learner to
1 Develop familiarity with the concepts related to organizational behavior.
2 Gain knowledge about personality traits and individual behavior.
3 Study group dynamics.
4 Get exposure to the recent trends in Organizational behavior.

**Course Outcomes:**
After completion of the course, students will be able to
1 Explain concepts of organizational behavior, its importance and culture.
2 Outline meaning of personality and how individual behavior impact organization.
3 Relate with ideas of group dynamics and influence of groups in work place.
4 Recall latest trends in Organizational behavior.

**Unit 1: Introduction (07)**
Management and Organizational Behavior (OB), Organizational behavior in historical perspective, Developing an OB model, Challenges and Opportunities for OB, Foundation of individual behavior.

**Unit II: Individual (08)**
Personality, personality frameworks, big five model, perception, individual decision making, attitudes, components of attitudes, attitudes and behavior, Job attitudes, values

**Unit III: Diversity and Ethics (06)**
Environmental context : diversity and ethics, Communication, Case studies

**Unit IV: Trends (07)**
International organizational behavior, emotional intelligence, strategic organizational behavior, Intra-preneurship, flat organization,Gig economy

**Unit V: Group Dynamics (08)**
Foundation of group behavior, stages of group development, group decision making, team building, organizational conflicts and negotiation, power and politics,employee engagement

**Unit VI : Dynamic Environment and Culture (06)**

Information technology and globalization, Human resource policies and practices, OKR (Objective and Key results )framework, Learning

**Text Books:**

1 Stephen P. Robbins, Timothi A.Judge, **'Organisational Behavior'**, 18th Global Edition, Pearson Education(2017),ISBN: 978-0-13-410398-3
2 Dr. S. S. Khanka, **'Organisational Behaviour (Text and Cases)',** S.Chand & Company Pvt.Ltd. (2018), ISBN 978-81-219-2014-8
3 Fred Luthans, **'Organizational Behavior '**, 12th Edition, McGraw Hill Publication (2017), ISBN-978-1-25-909743-0

**Reference Books:**

1 Moorhead, Griffin, 'Introduction to Organizational Behavior', India Edition (2010), Cengage Learning, ISBN: 978-81-315-1242-5
2 P. Subba Rao, 'Organisational Behaviour (Text , Cases and Games)' Himalaya Publishing House (2017), ISBN 978-93-5024-673-3
3 K. Aswathappa, 'Organisational Behavior : Text, Cases & Games', 12th Revised Edition,Himalaya Publishing House(2017), ISBN 978-93-5051-588-4

**Online Resources:**

1 NPTEL on "Organizational Behavior": https://nptel.ac.in/downloads/110105034/#

## 20OEHS501F PROJECT MANAGEMENT

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| Tutorial : 1 Hour/ Week | ESE**:** 50 Marks |
| | Credits: 3 |

**Course Objectives:**

1 To introduce concepts of Project management
2 To discuss life cycle of real life projects and activities involved in projects
3 To understand risks involved in a project

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify scope of a project and lifecycle of a project |
| CO2 | Develop a plan for a project |
| CO3 | Determine schedule of a project |
| CO4 | Assess risks involved in a project |
| CO5 | Estimate budget of a project |
| CO6 | Adapt project management tools and techniques |

**Unit 1: Introduction (07)**

Definition of project, Objectives of Project Management, Classification of projects, Life cycle phases of the project. Project management and Project manager, Role and responsibilities of the project manager, Stakeholder Identification, team building

**Unit II: Project Planning (07)**

Project Planning: Introduction and basic requirements, establishing project objectives, Statement of work (SOW), project specifications, Work Breakdown structure (WBS).

**Unit III: Project Scheduling (07)**

Project scheduling: Introduction and basic requirements, milestone scheduling, Network Scheduling techniques: PERT(Program Evaluation Review Technique), CPM(Critical Path Method), GANNT chart, Schedule control

**Unit IV: Risk Assessment and Management: (07)**

Risk Management Planning, Risk identification, Qualitative Risk analysis, Quantitative Risk analysis, Risk response planning, Risk monitoring and controlling

**Unit V: Project Cost Estimation (07)**

Resource Planning, Cost Estimating, Cost Budgeting, Budget control, Earned Value Analysis, Project Audits, Project closure

**Unit VI : Tools and Techniques for Project Management (07)**

Project Management tools, International Project Management, Collaborative development, Planning Quality Management, Quality metrics, Techniques for Quality Control (statistical control, six sigma, ISO)

**Text Books:**

1 1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), PMI.
2 PROJECT MANAGEMENT A Managerial Approach, Jack R. Meredith, John Wiley & Sons

**Reference Books:**

1 Morris, P. W. G., Pinto, J. K., The Wiley Guide to Managing Projects, 2004, John Wiley & Sons
2 Phillips, J.PMP Project Management Professional Study Guide, McGraw-Hill, 2003.

**Online Resources:**

1 http://www.pmi.org
2 https://www.ipma.world

**20OEHS601A Automation and Control Engineering [ACE – OE-II]**

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| | ESE**:** 50 Marks |
| | Credits: 3 |

**Pre-requisite:** Engineering Mechanics, Fluid Mechanics, Basic Mathematics

**Course Objectives:**

**Course prepares students to**

1 To familiarize with the basic concepts of Industrial Automation
2 To acquaint with the concept of low cost automation with Hydraulic and Pneumatic systems.
3 To acquaint with the basic concepts of the Industrial Fluid Power and Factory Automation.
4 To familiarize with the working of different types of controllers and control actions.

**Course Outcomes:**

**Students will be able to**

1 Identify the elements of automation systems, levels of automation and types of automation.
2 Describe assembly line automation, Transfer system, and its components.
3 Analyze different hydraulics and pneumatics circuits for Industrial applications.
4 Study of control system and its types.
5 Develop the basic ladder logic using PLC for different industrial applications.

**Unit/Module: 1 Introduction to Automation 4 hours CO: 1**

Definition, Automation in Production system, Need of automation, Societal issues of automation, Automation strategies, levels of automation, types of automation, Architecture of an Industrial automation system.

**Unit/Module: 2 Hydraulics and Pneumatics devices 6 hours CO: 2**

Different types of Hydraulics and Pneumatics devices,

DCV: All possible configuration and valve designation for Single acting and double acting actuators

FCV, PCV, Actuator and auxiliary elements in hydraulic and pneumatic system, Industrial applications and Case studies.

**Unit/Module: 3 Hydraulic Systems 8 hours CO: 3**

ISO symbols for Hydraulics, Basics of Hydraulic system, Hydraulic Power Pack, Actuators, Circuits using Sequencing and cascading method, Design of Electro-Hydraulic circuits, Case studies and Industrial Applications. Digital and Servo hydraulic control circuits.

**Unit/Module: 4 Pneumatic Systems 6 hours CO: 4**

ISO symbols for Pneumatics, Basic circuits using linear and rotary pneumatic actuators, Circuits using Cascade method and shift register method, Design of Electro-pneumatic circuits using solenoids to operate single acting and double acting actuators.

**Unit/Module: 5 Assembly line Automation and control 6 hours CO: 5**

Automated Material handling systems, automated inspection, transfer lines, part placing and part escapement, AGV's and conveyors

Control System: Open loop, Close Loop, Mathematical Modelling of basic systems :Hydraulic, Pneumatic, Thermal and Fluid systems, Case Studies

**Unit/Module: 6 Controllers 6 hours CO: 6**

Programmable Logic Controller: Basics of PLC, PLC operating cycle, Architecture of PLC, PLC Ladder Programming, Logic Gates, Timers, Counters, Concept of Latching and Interlocking, Selection of PLC for different industrial applications.

Control Actions: On-Off controller, Proportional controller (P),Integral Controller(I) ,Derivative Controller(D),Compound Controller actions: PI,PD,PID

**Total Lecture hours: 36 hours**

**Text Books:**

1 Anthony Esposito, "Fluid Power with Applications",7th Edition, 2008,PHI Publication.
2 M.P.Groover, "Automation, Production System and Computer Aided Manufacturing",3rd Edition,PHI Publication,New Delhi.
3 M.P.Groover, "Industrial Robotics: Technology, Programming and Applications
4 Ogata, "Modern Control Engineering"
5 Nagrath and Gopal "Mathematical Modelling, Simulation and Analysis", MGH Pub
6 Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
7 Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons.

**Reference Books:**

1 C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi. ISBN: 8120309871
2 Vickers "Industrial Hydraulics" Manual, 3rd Edition, Vickers Inc.

## 20OE601B AUTOMOTIVE ELECTRONICS

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1 To explain the operation of basic automotive System components
2 To discuss sensors and actuators in automotive applications
3 To describe the system view of automotive control systems and In-vehicle Communication Protocols
4 To introduce diagnostic methodologies and safety aspects in automotive system

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain the functioning of automotive systems |
| CO2 | Identify key components of automotive control systems and represent in terms of block diagram |
| CO3 | Develop a model for simple systems using model based development. |
| CO4 | Compare communication protocols, safety systems and diagnostic systems Estimate |

**Unit 1: Fundamentals of Automotive Systems (10)**

Overview of an Automotive System, Basics of Spark Ignition, Compression Ignition Engines, Need of Electronics in Automobiles, Ignition systems, Transmission systems, Suspension system, Braking system, Steering system, Fuel Delivery system, Alternator and battery charging circuit, Basics of Hybrid Electric Vehicles.

**Unit II: Automotive Sensors, Actuators, Control Systems (08)**

Systems approach to Control and Instrumentation: Concept of a system, Analog and Digital system, Basic Measurement system, Types of Control Systems, Sensor Characteristics, In-vehicle Sensors: Air flow sensing, Crankshaft Angular Position sensing, Throttle angle sensing, Temperature sensing, EGO sensor, Vibration sensing (in Air Bags), Actuators: Fuel injector, EGR actuator, Ignition system, Variable Valve Timing (VVT), BLDC motor, Electronic Engine Control, Engine Management System strategies for improving engine performance and efficiency.

**Unit III: Microcontrollers / Microprocessors in Automotive Domain, Model Based Development (09)**

Critical review of Microcontroller / Microprocessor (Architecture of 8-bit /16-bit Microcontrollers with emphasis on Ports, Timers/Counters, Interrupts, Watchdog Timer and PWM ), Criteria to choose the appropriate microcontroller for automotive applications, Automotive grade processors, Fuel Maps and Ignition Maps, Introduction to Model Based Development.

**Unit IV: Automotive Communication Protocols (07)**

Overview of Automotive Communication Protocols, CAN, LIN, FLEXRAY, MOST, Communication Interface with ECUs, Interfacing with infotainment gadgets, Application of telematics in automotive domain: GPS and GPRS, Relevance of Protocols such as TCP/IP, Bluetooth, IEEE 802.11x standard, in automotive applications.

**Unit V: Safety Systems in Automobiles, Diagnostics, Standards (08)**

Active Safety Systems: Anti-lock Braking System (ABS), Traction Control System, Electronic Stability Program, Passive Safety systems: Airbag System, Advanced Driver Assistance System (ADAS), Anti-theft systems, Fundamentals of Diagnostics, Self Diagnostic System, On-Board Diagnostics and Off-Board Diagnostics, Importance of Reliability in Automotive Electronics, Reliability Testing with example, Environmental and EMC Testing for Automotive Electronic Components, ISO, IEC and SAE Standards.

**Text Books:**

1 Williams B. Ribbens, **"Understanding Automotive Electronics**", *Newnes*, (7th Edition), (2003).
2 Robert Bosch, **"Automotive Electronics Handbook"**, *John Wiley and Sons*, (1st Edition), (2004).

**Reference Books:**

1 Ronald K Jurgen, **"Automotive Electronics Handbook",** *McGraw-Hill*, (2nd Edition), (1999).
2 James D Halderman, **"Automotive Electricity and Electronics",** *PHI Publication* , (1st Edition), (2005).
3 Tom Denton, **"Automobile Electrical & Electronic Systems",** *Routledge*, (4th Edition), (2002).
4 Tom Denton, **"Advanced Automotive Diagnosis",** *Elsevier*,(2"d Edition), (2006).
5 V.A.W. Hillier, **"Fundamentals Automotive Electronics",** *Oxford University Press*, (6th Edition), (2014).
6 Mehrdad Ehsani, Ali Emadi, Yimin Gao, **"Modern Electronic, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press*, (2nd Edition), (2009).
7 Terence Rybak, Mark Steffka, **"Automotive Electromagnetic Compatibility (EMC)"**, *Springer*, (2004).

**Online Resources:**

1 **NPTEL Course "Fundamentals of Automotive Systems"** https://onlinecourses.nptel.ac.in › noc20_de06 › preview

## 20OE601C Avionics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Control Systems, Basics of Communication System

**Course Objectives:**
1 To integrate the digital electronics with cockpit equipment
2 To understand the various principles in flight desk and cockpit panels.
3 To understand the communication techniques used in aircraft.
4 To explain the modern era of flight control system

**Course Outcomes:** The student will be able to
1 Identify the mechanical and electronic hardware required for aircraft.
2 Compare the communication and navigation techniques used in aircrafts.
3 Disseminate the autopilot and cockpit display related concepts.
4 Compare and identify different actuators in avionics.

**Unit 1: Introduction to Avionics (08)**
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

**Unit 2: Digital Avionics Bus Architecture (07)**
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies.

**Unit 3: Flight Deck and Cockpit (07)**
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

**Unit 4: Avionics Systems (06)**
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals- Certification-Military and civil aircrafts.

**Unit 5: On Board Navigation Systems (07)**
Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.

**Unit 6: Basics of Final Control Element (06)**

Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

**Text Books:**

1 R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.

2 N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

**Reference Books:**

1 Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2 Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3 Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4 Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

## 20OE601D Bioinformatics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2 To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3 To understand the concepts and types of Phylogeny.

**Course Outcomes:** Students will be able

1 Apply basic concepts of bioinformatics to biological data analysis.
2 Classify different types of biological databases.
3 Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4 Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

**Unit 1: Introduction to Bioinformatics (06)**

Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

**Unit 2: Bioinformatics Databases (08)**

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

**Unit 3: Algorithms for bioinformatics (08)**

Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

**Unit 4: Sequence Analysis (08)**

Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms

**Unit 5: Sequence Alignment (06)**

Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

**Unit 6: Phylogeny (06)**

Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

**Text Books/Reference Books:**

1 Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2 Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3 N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4 Bioinformatics: Databases and Systems, by Stanley I. Letovsky
5 Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6 Mathematical Biology & Medicine), by SorinDraghici
7 Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8 Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

## 20OE601E COMPUTER VISION

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite:**20EC501 Digital Signal Processing

**Course Objectives:**

1 To introduce major ideas, methods and techniques of Computer Vision algorithms
2 To introduce fundamentals of Image formation
3 To explain concepts of Camera Calibration and Stereo Imaging
4 To explain different Background Subtraction techniques and Motion tracking algorithms

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the fundamentals of Image formation, Camera calibration parameters and Stereo Imaging |
| CO2 | Apply camera calibration concepts to calculate intrinsic and extrinsic parameters of camera |
| CO3 | Explain different Background Subtraction techniques and Calculate the Performance measures of it. |
| CO4 | Select the appropriate feature extraction techniques according to the requirement of the applications |
| CO5 | Analyze the appropriate Background Subtraction techniques and Object tracking algorithms according to the requirement of the applications |

**Unit I: Camera Calibration (07)**

Geometrical primitives and transformations, 3D to 2D projections, Image Formation, Capture and Representation, Camera Calibration and parameters, Digital camera.

**Unit II: Stereo Imaging (08)**

Stereo Vision: Epipolar geometry, Rectification, Correspondence, triangulation, RANSAC algorithm, Dynamic programming.

**Unit III: Visual Features and Representations (09)**

Edge, Blobs, Corner Detection, SIFT, SURF, HoG.

**Unit IV: Background Subtraction Techniques for Moving Object Detection (09)**

Frame differencing, Mean and Median filtering, Gaussian Mixture Model (GMM), Kernel density estimation, Applications.

**Unit V: Motion Tracking (09)**

Motion tracking using Optical flow, blob tracking, Colour feature based mean shift, Kalman tracking, Applications.

**Text Books:**

1 D. Forsyth, J. Ponce, **"Computer Vision, A Modern Approach"**, *Prentice Hall*, (2nd Edition), (2003).
2 R. Szeliski, **"Computer vision algorithms and applications",** *Springer-Verlag*, (2nd Edition), (2010).

**Reference Books:**

1 L. G. Shapiro, George C. Stockman**, "Computer Vision"**, *Prentice Hall*, (1st Edition), (2001
2 E. Trucco, A. Verri, **"Introductory Techniques for 3-D Computer Vision"**, *Prentice Hall*, (1st Edition), (1998)
3 D. H. Ballard, C. M. Brown, **"Computer Vision"**, Prentice Hall, (1st Edition), (1982).
4 M. Sonka, V. Hlavac, R. Boyle, **"Image Processing, Analysis, and Machine Vision",** *Thomson Press*, (3rd Edition), (2011).

**Online Resources:**

NPTEL Course **"Computer Vision"**

1 https://nptel.ac.in/courses/106/105/106105216/
2 http://www.ai.mit.edu/projects/vsam/Publications/stauffer_cvpr98_track.pdf
3 https://people.cs.rutgers.edu/~elgammal/pub/ieeeproc-paper-final.pdf
4 http://www.cs.cmu.edu/~16385/s15/lectures/Lecture24.pdf

## 20OE 601F Design Thinking

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| Tutorial: - | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:**

**Course Objectives:**

Familiarize students with

1 Design thinking process
2 User centric approach for designing a solution
3 Problem analysis with various methods
4 Applications of Design Thinking

**Course Outcomes:**

Students should be able to

1 Analyze problems with various methods
2 Recommend a solution based on empathy, ideation, prototyping, and playful testing
3 Apply design thinking methods to generate innovative and user centric solutions
4 Test designed prototypes to reduce risks and accelerate organizational learning

**Unit I: Design and Design Problems — 8 Hours**

What is Design? The components of design problems; measurement, criteria and judgement in design

A model of design problems – Defining problems: Selecting goals and diverse teams, creating a unified vision and scope, mapping stakeholders and personas; Analysing design problems, generators of design problems, roles of generators, design constraints

**Unit II: Design Solutions — 8 Hours**

Solutions to Design Problems: Designer's response: procrastination, non-committal design and throw away design, design problems and solutions

Design Process: define, search, ideate, prototype, select, implement, learn, Refresher and restate the challenge, getting inspiration, understanding innovation ambition, Solution ideation, Narrowing solution choice, Solution evaluation, Road map

**Unit III: Design Thinking — 9 Hours**

Types and Styles of Thinking – theories of design, types of thinking; creative thinking - what is creativity? creativity in design, Principles of design thinking

**Unit IV: Design Philosophies and Strategies 9 Hours**

Theory and practice, three early phases of working on the same problem

Prototype Creation: Choosing a prototype approach, user interface prototypes, applications vs custom build, reference architectures, prototype and solution evaluation

**Unit V: Design Tactics and Traps 8 Hours**

Methods and Tactics, understanding the problem, the model of problems, One or many solutions? Common traps and ways of avoiding them

**Text Books:**

1 Bryan Lawson, "How designers think: The design process demystified", 2nd Edition, Butterworth Architecture
2 Nigel Cross, "Design Thinking", Berg Publishers - 2011

**Reference Books:**

1 Ben Crothers, "Design Thinking Fundamentals", O'Reily
2 Tim Brown, "Change by Design: How Design Thinking Transforms Organizations", HarperCollins – 2009
3 Susan Weins Chenk, "Hundred things every designer needs to know about people", New Riders Publication
4 Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley Publication
5 Roger L. Martin, "Design of Business: Why Design Thinking is the Next Competitive Advantage" Harvard Business Press
6 Karl Ulrich, "Design: Creation of Artifacts in Society" - 2011
7 Bala Ramadurai, "Karmic Design Thinking"
8 T. Amabile, "How to kill creativity", SAGE Publication - 2006
9 William Lidwell, Kritina Holden, Jill Butler, "Universal principles of Design ", Rockport Publishers
10 Bella Martin, Bruce Hanignton, Bruce M Hanington "Universal methods of design", Rockport Publishers - 2012
11 Roman Kizanie, "Empathy: Why it matters, how to get it", TarcherPerigee Publishers
12 Karla McLaren, "The Art of Empathy: A complete Guide to life's most essential skill", Sounds True Publishers

## 20OE601G e-Business

**Teaching Scheme**
**Lectures:** 3 Hours / Week

**Examination scheme:**
In Semester**:** 50 Marks
End Semester**:** 50 Marks
Credits: 3

**Prerequisite:** No Prerequisites

**Course Objectives:**

To facilitate the learners to-

1. Understand the technological, economic and social phenomena behind rapid changes in the e-businesses.
2. Have a good working knowledge of e-business concepts, applications and technologies.
3. Understand the e-business models and infrastructure.
4. Learn how e-business concepts are applied to different fields, such as: education, banking, tourism and so on.
5. Inspire with online business ideas and motivate them to apply in the real life.
6. Study the new trends in e-business, e-commerce

**Course Outcomes:**

By the end of this course, students will be able to

CO1 Explain the concepts of e-business and e-business models
CO2 Apply suitable principles and practices of designing and developing e-business website
CO3 Apply necessary back end system components required for successful e-business implementations
CO4 Outline the meaning of e-business security and how it impacts the business
CO5 Relate e-business, BI and KM to fulfil modern e-business trends

**Unit I: Introduction (07)**

E-commerce and e-business, advantages of e-business in growth of a business, Transition from traditional business to e-business, features of e-business technology, e-business models, IT Infrastructure requirements of e-business Case Study : Various e-business models

**Unit II: Building e-business Websites (07)**

Issues involved in designing a website, designing in-house websites, steps involved in website development, e-business and website development solutions, Advantages of using an e-business solution, selection of a suitable e-business solution, security issues involved in websites, tracking and analysing website traffic data. Digital Marketing Case Study

**Unit III: e-Business Infrastruture / Back end Systems (07)**

Back end system support requirements - security, scalability, availability, adaptability, manageability, maintainability, assurance, interoperability, load balancing; internet technology, World Wide Web, Internet software; Content management, Case Study

**Unit IV: e-security & online payment systems (07)**

e-Business security policy, risks and risk assessment, practice guidelines to e-security, legal framework and enforcement, ethical, social and political issues in e-business

Performance characteristics of online payment systems, online payment methods, security and risk handling in online payments, fraud detection in online payments, IT Act 2000, digital signatures, digital certificates, and PKI; Case Study

**Unit V: Knowledge management & BI for strategic e-business (08)**

From information processing to knowledge world, aligning knowledge with business, knowledge management platforms, state of knowledge and measuring parameters; knowledge industry, knowledge strategy, and knowledge workers

Business and Intelligence - applications and importance of business intelligence, implementation of intelligence, building BI systems, selecting BI tools, integrating BI and KM, decision-making and BI, Case Study

**Unit V: Launching an e-Business and e-business trends (06)**

Launching a successful e-business – requirement analysis, managing Web site development, search engine optimization, Evaluate Web sites on design criteria.

Future and next generation of enterprise e-business, challenges and new trends, ethical and regulatory issues

**Text Books:**

1. Papazoglou, Michael and Pieter Ribbers, "E-Business : Organizational and Technical Foundations", John Wiley, 2nd Edition (Sept 2011).
2. Parag Kulkarni, Sunita Jahirabadkar, Pradeep Chande, "E-Business", Oxford University Press (May 2012)

**Reference Book:**

1. Daniel Amor, "The E-business (R)evolution", Prentice Hall PTR (2000)
2. Kenneth Laudon, Carol Guercio, "E-commerce : Business, Technology, Society", Prentice Hall, 4th Edition (January 2008).
3. Kalakota Ravi, Marcia Robinson, "E-Business 2.0 – Roadmap for Success", Pearson Education, 2nd Edition (2004).

## 20OE601H - Electric Vehicles

**Teaching Scheme**
Lectures**:** 3 Hours / Week
Tutorial: -

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**

1 Understand and identify and integrate EV subsystems
2 Learn and find energy storage requirements for vehicle application
3 Comprehend design of battery thermal management system
4 Undestand calculations of motor power ratings for an EV application
5 Study suitable type of sensors for EV applications
6 Study appropriate control strategy for EV

**Course Outcomes:**
Students should be able to
1 To identify and integrate EV subsystems
2 To calculate energy storage requirements for vehicle application
3 To select and design battery thermal management system
4 To calculate motor power ratings for an EV application
5 To select a suitable type of sensors for EV applications
6 To select appropriate control strategy for EV

**Unit 1: Introduction to hybrid and electric vehicles:** (6)
Engineering case, legislative push, incentives, market pull. EV : micro to mild to PHEV to HEV to REEV to EV - Hybrid-Electric Vehicle Power trains, Vehicle Energy Storage System Design, System and sub-systems, Modelling and design of EVs as a system, Motors & motive power spilting concepts, and interface within power train system

**Unit 2: Power train architecture:** (6)
Parallel, Series and Combined, Types of EVs, Vehicle layout and packaging options, Duty Cycles in Indian cities; performance, Components of Power Train**,** Auxiliary Inverter, HV-LV DC-DC converter, Traction Inverter, Gear Trains, Integration of power train components, regenerative brakes

**Unit 3: Introduction to Energy Storage** (6)
Energy storage requirements for vehicle applications, Storage technologies and metrics for comparison, Distribution of Energy, Storage Form of Energy, Intermediary Conversion, Control and Diagnostic, Ragone Chart, Theory of Ragone Plots. Ragone Plot of a Battery

**Unit 4: BMS, Packing and Charging:** (6)

Battery Management Systems (BMS), Lithium-Ion Batteries Aging Effects. Battery characterization and testing systems, Thermal management & Battery life cycle, Modular battery packs, packaging, thermal control, Changing Systems and Infrastructure

**Unit 5: Electric Drives** (6)

DC motors, induction motors and synchronous motors, permanent magnet motors, BLDC, switched reluctance motors, Switched Reluctance Motors (SRM),Permanent Magnet Synchronous Motor (PMSM)

**Unit 6: Sensors in Electric Vehicles:** (6)

MEMS Sensors for Engine Management, Battery Monitoring Sensors, State of the Charge Sensing, Sensors for Passenger Safety, Sensors for Skidding and Rollover Detection, Tire Pressure Sensors, Electronic Stability Control of Vehicles, Sensors for Antitheft, Vehicle Navigation Sensors. EV sensors of Texas Instruments, STM, NXP, etc.

**Books:**

1 Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Celll vehicles-Fundamentals - Theory and Design", CRC Press
2 Energy Storage by Robert A. Huggins, Springer Publication
3 Chang Liang Xia,Permanent Magnet Brushless Dc Motor Drives and Controls, Wiley 2012.
4 Katsuhiko Ogata, "Modern Control Engineering" 5th edition, Prentice Hall of India Private Ltd., New Delhi, 2010.
5 Cooper W.D & Hlefrick A.D., Electronic Instrumentation Measurement Technique, III Edition, Prentice Hall of India – 1999

## 20OE 601I Gamification

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 To develop problem solving abilities using gamification.
2 To identify the various methods of gamification.
3 To apply gamification mechanics to solve a problem.
4 To make use of gamification tools to solve a problem.

**Course Outcomes:**
After completion of the course, students will be able to
1 To apply steps of problem solving using gamification.
2 To analyze player motivation and counter gamification.
3 To develop game using game mechanics.
4 To apply tools of gamification to real life applications.

Gamification is about applying game concepts, driving engagement into non game environments/contexts like a website designing, online community for interactive discussion, a fun way of learning management system for engagement of stakeholders etc.

Gamification is NOT about designing fancy games, video games, virtual reality games etc. Therefore this course does NOT cover games and game design aspects. Course will also discuss the negative impact and influence of games (when played in excess) on young minds like addiction to video games, over spending time for games.

**Unit I: Gaming Foundations (6)**
Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

**Unit II: Player Motivation (7)**
Powerful Human Motivators, Why People Play, Player types, Social Games, Intrinsic verses Extrinsic Motivation, Progression to Mastery, Case studies for Thinking: Tower of Hanoi,Concepts Applied to Video games and Gamification.

**Unit III: Counter Moves in Gamification (8)**
Reclaiming Opposition: Counter gamification, Gamed Agencies: Affectively Modulating Our Screen-and App-Based Digital Futures, Remodeling design, Designing for Engagement, Case study of Maze Problem.

**Unit IV: Game Design (8)**

Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, Putting it together, Case study of 8 queens problem.

**Unit V: Game Mechanics and Applications (7)**

Gamification case Studies, Coding basic game Mechanics,Gamification Applications : Education,Healthcare,Marketing,Gamification for Machine Learning.

**Unit VI: Gamification Platforms (6)**

Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server
(ref: https://github.com/ngageoint/gamification-server).

**Text Books:**

1 Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press,2014, ISBN: 978-3-95796-000.
2 Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly,August 2015, ISBN: 978-1-449-397678.

**Reference Books:**

1 B. Burke, Gamify: How Gamification Motivates People to Do Extraordinary Things, Gartner 2014,ISBN:1937134857.
2 **Stieglitz**, S.**Lattemann**, C.**Robra-Bissantz**, S.**Zarnekow**, R.**Brockmann**,Gamification :Using Game Elements in Serious Contexts,2016,ISBN: 978-3-319-45557.

## 20OE 601J Geographical Information Systems

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Learn basics of GIS
2 Understand representation of GIS models
3 Relate GIS and DBMS for various applications, analyze and visualize the spatial data
4 apply GIS to supply chain management

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basics of GIS to database design
2 Make use of various data models to given data
3 Apply data editing techniques to spatial data
4 Apply spatial data analysis to GIS data
5 Create maps using ArcGIS
6 Apply GIS in supply chain management

**Unit I: Introduction to GIS (05)**
Define GIS, GISystems, GIScience, Spatial and Geoinformation, Components of GIS, Recent trends and applications of GIS; Data structure and formats, Spatial data models – Raster and vector, Database design- editing and topology creation in GIS, Linkage between spatial and non-spatial data, Data inputting in GIS. Rectification, Transformation Methods; Root Mean Square (RMS) Error

**Unit II: Data Types and data models (05)**
Data Types; Spatial Data; Non-Spatial Data, Data Input; Existing GIS Data, Metadata; Conversion of Existing Data, Creating New Data, Data Models; Vector Data Model; Raster Data Model; Integration and Comparison of Vector and Raster Data Models.

**Unit III: Data Exploration and spatial data editing (08)**
Attribute Data in GIS, Attribute Data Entry, Manipulation of Fields and Attribute Data, Data Exploration; Attribute Data Query, Raster Data Query, Map- Based Data Manipulation, Types of of Digitizing Errors, Causes for Digitizing Errors; Topological Editing and Non-topological Editing; Other Editing Operations; Editing Using Topological Rules.

**Unit IV: Spatial data Analysis (08)**

Spatial Data: Definition, Analysis, Processes & Steps, Software and Tools, Geodatabase Model, Role of Databases in GIS, Creating, Editing and Managing, Classification scheme of Vector-Based and Raster- Based GIS Operation Raster- Based Techniques: Methods of reclassification, overlay analysis, Digital Terrain Analysis and Modeling- TIN and DEM, Surface representation and analysis, Slope and Aspect, Geographic Visualization Data Classification

**Unit V: ArcGIS (08)**

Introduction, Geographical terms, ArcMap main window, Coordinate system, Georeferencing, Generation of vector referencing, Table administration, Geoprocessing tools, spatial analysis, Design and publication, API for ArcGIS

**Unit VI: Trends and applications (08)**

Need for GIS network analysis in SCM, data for GIS logistic service, understanding logistic management, types of GIS services, supply chain audit, ISRO-Bhuvan, Web GIS

**Text Books:**

1 "Fundamentals of GIS", Franz Pucha et al, 2018
2 "Principles of Geographic Information Systems",Kang-tsung chang, 2017

**Reference Books:**

1 "Essentials of Geographic Information Systems",Jonathan E. Campbell Michael Shin, 2018
2 "Introduction to GIS",Víctor Olaya

## 20OE601K MULTIMEDIA SYSTEMS

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**20EC402 Analog and Digital Communication

**Course Objectives:**

1 To introduce basic concepts and design of Colour TV and Digital TV
2 To explain advanced TV technologies like HDTV, CATV, CCTV, DTH, CAS and case study for live telecast
3 To introduce multimedia compression techniques, standards and multimedia over the internet
4 To familiarize the students with digital recording and playback systems, acoustic design, microphones and loudspeakers

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the concepts of colour TV design, systems and Digital TV |
| CO2 | Discuss and compare advanced TV systems like CATV, CCTV, DTH, HDTV, CAS, Wi-fi TV, 3DTV and different display technologies |
| CO3 | Apply and analyze multimedia compression standards for text, audio, image and video and explain multimedia over the internet |
| CO4 | Compare optical recording techniques, microphones and loudspeakers |
| CO5 | Design acoustics and PA system for auditorium, public meeting, debating hall, football stadium and college classrooms |

**Unit I: Colour and Digital TV (11)**

Resolution, interlaced scanning, BW, CVS, Color TV systems, frequency interleaving, colour difference signals, colour TV receiver, NTSC, PAL, SECAM encoders and decoders, Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters and receivers.

**Unit II: Advanced TV Systems (10)**

HDTV standards and systems, HDTV transmitter and receiver, CCTV, CATV, Direct to Home TV (DTH), Set top box, Conditional Access System (CAS), 3D TV systems, Case study (Cricket match, Marathon, Football match), Wi-Fi TV, Video door phone systems, Display devices: LED, LCD, Plasma.

**Unit III: Multimedia Compression and Multimedia over Internet (11)**

Introduction, Overview, Concept of Multimedia, Multimedia Applications, Text: Types, Compression, Hypertext, Image Compression techniques: JPEG, Multimedia Audio: MIDI, MP3, Video: MPEG, Animation: Introduction, types, 3D animation, Virtual reality, Multimedia over Internet**:** Introduction to Multimedia Services, Transmission of Multimedia over the Internet, IP Multicasting, Explaining VOIP

**Unit IV: Acoustics and Digital Audio Video (10)**

Optical recording, noise, CD, DVD, dual layer DVD, rewritable DVD, Blu Ray DVD, Studio acoustics and reverberation, acoustic chambers, PA system for : auditorium, public meeting, debating hall, football stadium, college hall, Advanced PA systems, Different types of speakers and microphones.

**Text Books:**

1 R. R. Gulati, **"Modern Television Practice",** *New Age International*, (5$^{th}$ Edition), (2015).
2 Ralf Steinmetz, Klara Nahrstedt, **"Multimedia: Computing, Communication and Applications"**, *Pearson Publication*, (8$^{th}$ Edition), (2011).
3 R.G. Gupta, **"Audio and Video Systems"**, *Tata Mcgraw Hills*, (2$^{nd}$ Edition), (2020).
4 Robert D. Finch, **"Introduction To Acoustics",** *PHI*, (2nd Edition), (2007).
5 Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, "**Advance Computer Network"**, *Wiley*, (2$^{nd}$ Edition), (2014).

**Reference Books:**

1 A. M. Dhake, "**Television and Video Engineering**", *Tata Mcgraw Hills*, (2$^{nd}$ Edition), (2003).
2 Ranjan Parekh, **"Principles of Multimedia**", *Tata Mcgraw Hills*, (2nd Edition), (2013).
3 Alec Nisbett , "**The Sound Studio**", *Focal Press,* (5$^{th}$ Edition) , (1993).

**Online Resources:**

**NPTEL Course " Multimedia Systems"**

1 https://nptel.ac.in/courses/117/105/117105083/

## 20OE 801A Big Data And Analytics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Understand the concepts, challenges and techniques of Big data and Big data analytics
2 Understand the concepts of Hadoop, Map Reduce framework , Spark for Big data analytics
3 Apply skills and tools to manage and analyze the big data
4 Understand latest big data trends and applications.

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basic concepts of big data for the various applications.
2 Apply data analytics life cycle to real-world big data applications
3 Choose Hadoop ecosystem components based on requirement of application
4 Compare Spark and Hadoop architecture
5 Compare various methods used in data Analytics and big data trends.

**Unit I: Introduction (6)**
Database Management Systems, Structured Data, SQL. Unstructured data, NOSQL, Advantages of NOSQL, Comparative study of SQL and NOSQL. Big data overview, characteristics of Big Data, Case study- SAP HANA.

**Unit II: Data Analytic Life Cycle (6)**
Data Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach. Data Analytic Life Cycle: Discovery, Data preparation, Model Planning, Model Building, Communicate Results, Opearationalize. Case Study: GINA

**Unit III: Big Data Architectures, Hadoop (8)**
Introduction to Big Data and Hadoop, Building blocks of hadoop: Ecosystem, HDFS, HBASE, YARN, Map Reduce working.

**Unit IV: Introduction to Spark (7)**
Spark Framework, Architecture of Spark, Resilient Distributed Datasets, Data Sharing using Spark RDD, Operations in Spark;
Introduction to Kafka: need, use cases, components.

**Unit V: Machine learning (8)**

Supervised, unsupervised learning; Classification, Clustering; Time series analysis, basic data analysis using python: libraries,functions.

Text Analysis: Text Pre-processing, Topic modelling algorithms, Text Similarity measure.

**Unit VI: Big Data Trends and applications (7)**

Exploratory data analysis, Big data Visualization using python;

IoT and big data, Edge computing, Hybrid cloud.

Applications of Big data, Case study: E-commerce, healthcare.

**Text Books:**

1 "Data Science and Big Data Analytics", Wiley, 1stEdition (January 2015)
2 "Big Data, Black Book" ,Dreamtech Press (27 May 2015),ISBN-13-978-9351197577

**Reference Books:**

1 Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game",MC Press(November 2012)
2 J.Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "Big Data for Dummies", 1st Edition (April 2013)
3 Tom White, "Hadoop: The Definitive Guide", O′Reilly, 3rdedition (June 2012)
4 Abraham Silberschatz, Henry Korth, S. Sudarshan, "Database System concepts",McGraw Hill Education, 6thEdition (December 2013).
5 Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing (November 2013)
6 Shiva Achari ,"Hadoop Essentials - Tackling the Challenges of Big Data with Hadoop" ,Packt Publishing(April 2015), ISBN:978-1-78439-668-8

**Online/Web/Other References:**

1 https://nptel.ac.in/courses/106/104/106104189/
2 https://hadoop.apache.org/docs/stable/
3 https://kafka.apache.org/documentation/
4 https://spark.apache.org/

## 20OE801B Cyber Physical System

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20EC404 Embedded System, 20EC603 Control Systems

**Course Objectives:**

1 To introduce modeling of the Cyber Physical System (CPS).

2 To analyze the CPS.

3 To explain the software modules.

**Course Outcomes:**

After completion of the course, students will be able to

1 Categorize the essential modeling formalism of CPS

2 Analyze the functional behavior of CPS based on standard modeling formalisms

3 Apply specific software for the CPS using existing synthesis tools

4 Design CPS requirements based on operating system and hardware architecture constraints

**Unit I: Cyber Physical Systems (CPS) applications and Characteristics (07)**

CPS in the real world, Basic principles of design and validation of CPS, CPS: From features to software components, Mapping software components to Electronic Control Unit (ECU), CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal methods for Safety Assurance of CPS.

**Unit II: CPS physical systems modeling (07)**

Stability Analysis: CLF (Common Lyapunov function), MLF (Multiple Lyapunov function), stability under slow switching, Performance under Packet drop and Noise.

**Unit III: CPS computer systems modeling (07)**

CPS SW Verification: Frama-C, C Bounded Model Checker (CBMC), Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Hybrid Automata Modelling: Flow pipe construction using Flowstar (Flow*), Polyhedral Hybrid Automaton Verifier (Phaver) tools (Reliability testing).

**Unit IV: Operating systems and hardware architecture support for CPS (07)**

CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques, CPS HW platforms: Processors, Sensors, Actuators, CPS Network.

**Unit V: Analysis and verification of CPS (07)**

Advanced Automata based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, Reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

**Unit VI: CPS case studies (07)**

Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

**Text Books:**

1 Lee, Edward Ashford, and SanjitArunkumarSeshia, "Introduction to embedded systems: A cyber physical systems approach", MIT Press, (2nd Edition), (2017).
2 Rajeev Alur, "Principles of Cyber-Physical Systems". MIT Press, (1st Edition), (2015).
3 Wolf, Marilyn, "High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing". Elsevier, (1st Edition), (2014).

**Reference Books:**

1 P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag, (1st Edition), (2009).
2 Raj Rajkumar, Dionisio De Niz , and Mark Klein, "Cyber-Physical Systems", *SEI Series in Software Engineering*, (1st Edition), (2018).
3 André Platzer, "Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics", *Springer*, (1st Edition), (2010).
4 Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", *CRC Press*, (2nd edition), (2011).

**Online/Web/Other References:**

1 Coursera course, Cyber Physical system modelling
https://www.coursera.org/learn/cyber-physical-systems

## 20OE801C Digital Control

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Basics of Control Systems

**Course Objectives:** To
1 Understand the basic components of a digital control system.
2 Design various Digital Controllers and Study response of those controllers.
3 Learn and understand the stability of the system in the Z plane.
4 Introduce Optimal Control Design and Its need.

**Course Outcomes:** Students will be able to

1 Analyse system design in various planes S-W-Z and its mapping.
2 Analyse system stability in the S and Z plane.
3 Design and analyse systems using classical methods and State Space.
4 Design Optimal Control for a Discrete System.

**Unit 1: Introduction to Discrete Time Control System (08)**
Basic building blocks of Discrete Time Control System, Sampling Theorem, Choice of Sampling Rate, Z Transform and Inverse Z Transform for applications of solving Differential Equations, Impulse Sampling, Reconstruction – Zero Order Hold

**Unit 2: Pulse Transfer Function and Digital Controllers (08)**
Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop System, Pulse Transfer Function of Digital PID Controller, Design of Deadbeat Controller

**Unit 3: Stability Analysis of Discrete Control System (08)**
Stability regions in S plane W plane and Z plane, Mapping between three planes, Stability Tests for Discrete Systems

**Unit 4: Design of Discrete Control System by State Space Approach (07)**
Different Canonical Forms, Relation between Pulse Transfer Function and State Equation, Solution of Discrete Time State Space Equations, Eigen Values, Eigen Vectors

**Unit 5: Pole Placement and Observer Design (07)**

Concept of Controllability and Observability, Pole Placement Design by State Feedback, Design of Feedback Gain Matrix by Ackerman's Formula, State Observer Types.

**Unit 6: Introduction to Optimal Control (05)**

Basics of Optimal Control, Quadratic Optimal Control, Performance Index.

**Text Books:**

1 K. Ogata, "Discrete Time Control Systems", Prentice Hall, Second Edition.
2 M. Gopal, "Discrete Control and State Variable Methods", Tata McGraw Hill.
3 Kannan Moudgalya, "Digital Control", John Wiley and Sons.

**Reference Books:**

1 G. F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, Third Edition.
2 M. Gopal, "Digital Control Engineering", Wiley Eastern LTD.
3 Forsytheand W, Goodall R, "Digital Control".
4 Contantine H. Houpis, Gary B. Lamount, "Digital Control Systems", McGraw Hill International, Second Edition.

## 20OE801D Industrial Engineering and Management

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
The Industrial Engineering course prepares students to…
1 Understand type of organisation and calculate partial and total productivity
2 Learn the fundamental knowledge, skills, tools and techniques of methods study and work measurement.
3 Understand type of production environments, resource planning and control methods.
4 Learn basic resource scheduling techniques, human resource management and industrial safety norms.

**Course Outcomes:**
Students will be able to
1 Identify type of organisation and analyze partial and total productivity
2 Manage and implement different techniques of methods study and work measurement of process under consideration for improvement.
3 Analyze production environment under consideration w.r.to its resource planning and control.
4 Apply basic resource scheduling and human resource management techniques.

| | | | |
|---|---|---|---|
| **1** | | **Introduction to Industrial Management and Productivity Analysis** | **6** |
| | 1 | Industrial management: Functions and principles of management; Organisation: Concept, characteristics, structures and types of organisation- (formal line, military, functional, line and staff organisation); | |
| | 2 | Productivity analysis: Definition, measurement of productivity: productivity models and index (numerical); factors affecting the productivity; productivity improvement techniques; | |
| | 3 | Definition and scope of Industrial Engineering. | |
| **2** | | **Method Study** | **7** |
| | 1 | Work Study: Definition, objective and scope of work-study. | |
| | 2 | Method Study : Definition, objective and scope of method study, activity recording and exam aids, Charts to record moments in shop - operation process charts, flow process charts, travel chart, two handed chart and multiple activity charts. Charts to record movement at work place - principles of motion economy, classification of moments, SIMO chart, and micro motion study. Definition and installation of the improved method; | |
| | 3 | Human factors in Work-Study; | |
| | 4 | Value Engineering and Value Analysis. | |

| | | | |
|---|---|---|---|
| **3** | | **Work Measurements** | **6** |
| | 1 | Introduction: Definition, objectives and uses; Work measurement techniques: | |
| | 2 | Time study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination(numerical); | |
| | 3 | Work sampling: Need and procedure, sample size determinations (numerical); | |
| | 4 | Synthetic motion studies: PMTS and MTM. Introduction to MOST (numerical). | |
| **4** | | **Production Management** | **7** |
| | 1 | Production Planning and Control: Types of production systems, functions of PPC, Aggregate production planning; Master Production Schedule; ERP | |
| | 2 | Forecasting techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality; (Numerical). | |
| | 3 | Supply Chain Management: Concept, Strategies, Supply Chain Network, Push and Pull Systems, Logistics, Distribution; Order Control strategies: MTO, MTA, MTS. | |
| **5** | | **Facility Management** | 6 |
| | 1 | Facility Layout: Factors affecting facility location; Types of Plant Layout; Computer Aided Layout Design Techniques; Assembly Line Balancing (Numerical); | |
| | 2 | Material Handling and Inventory Control: Principles, Types of Material Handling Devices; Stores Management, Inventory costs, Types of inventory models - Deterministic and Probabilistic, Concept of EOQ, purchase model without shortages (Numerical); ABC and VED Analysis (Numerical). | |
| **6** | | **Project Scheduling, Human Resource and Industrial Safety** | 6 |
| | 1 | Scheduling Techniques: CPM and PERT(Numerical); | |
| | 2 | Human Resource Development: Functions: Manpower Planning, Recruitment, Selection, Training; Concept of KRA (Key Result Areas); Performance Appraisal (Self, Superior, Peer, $360^0$); | |

**Text Books:**

1 Industrial Engineering and Production Management, M Mahajan, Dhanpat Rai and Co.
2 Industrial engineering and management by O. P. Khanna, Dhanpatrai publication
3 Industrial Engineering , Martend Telsang, S. Chand Publication.
4 Industrial Organisation & Engineering Economics by Banga and Sharma, Khanna publication.
5 Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
6 J. K. Sharma, Operations Research : Theory And Application, Laxmi pub. India.

**Reference Books:**

1 Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008
2 Maynard's Industrial Engineering Hand Book By H.B. Maynard, KJell, McGraw Hill Education, 2001
3 Zandin K.B. - Most Work Measurement Systems, ISBN 0824709535, CRC Press, 2002.

Assignment based evaluations are designed. **This evaluation is treated as T1-Marks**. Marks will be calculated (at the end of semester) on the basis of successful completion / submission of assignments explained to you time to time on the basis of syllabus content. [Note: these assignments are part of activity based learning. Hence, students are to work in a group to complete following assignments].

| Assignment Details | Mapped COs |
|---|---|
| 1. Case study based Assignment on Method Study. [Data may be collected from: 1) Day to day activity : Workshop, Library, Admin area, Canteen, Parking 2) Students visiting industrial area for project 3) Quality concept Assignments in a Group.] | **CO1** |
| 2. Hands on Assignment on application of Work Measurement technique(s). [1) Using stopwatch work measurement can be completed. (E.g. in workshop)] | **CO1, CO1** |
| 3. Simulation / Assignment on Routing & Scheduling Model. [Open Source Softwares 1) Flexsim (Videos are available online) 2) Arena - Student Version 3) Pro model – Student Version 4) Excel templates available online. Note: Backward / Forward Scheduling concepts are to be included.] | **CO1, CO4** |
| 4. Assignment on simulation of Manufacturing System / Service System Operations for demand forecasting of the given product using any two methods. [1) Data from shops malls, manufacturing company, etc.] | **CO1, CO4** |
| 5. Assignment on simulation determination of EOQ and plot the graphs. [1) Use of any freeware available.] | **CO1, CO4** |
| 6. Assignment on analysis of Manufacturing / Service Operation for Capacity Planning. [1) Define capacity term for the real life environment you are working for (e.g. foundry= tons of casting, hospital = no. of bed, etc.) 2) Study and collect the data of Variation in demand and capacity planning. 3) Analysis the pattern of data set and report… how they manage the change in capacity.] | **CO1, CO4** |
| 7. Case study based assignment on supply chain model. [1) Select any real life supply chain (any engineering product processing, vendors for vegetable grocery, etc.) 2) Identify all major supply chain elements and prepare supply chain diagram and report.] | **CO1, CO4** |
| 8. Assignment on analysis of (selected) plant layout modeling / Simulation for bottleneck / line balancing. [Plant layout with its detail (with Scale) and identify the type.] | **CO1, CO4** |
| 9. Assignment on analysis of material handling system - for the selected plant layout. [This assignment must be completed with the help of plant layout visited in earlier assignment.] | **CO1, CO4** |
| 10. Case study based assignment on identification of Key Result Areas for performance appraisal for selected company (3600 feedback). [Real life case studies.] | **CO1, CO4** |
| 11. Assignment on industrial safety audit of selected work environment. [Download standard questionnaire and visit any work environment and submit it as assignment.] | **CO1, CO4** |
| **Note**: If student groups working with industry for their project, they are advised to collect data related to above mentioned assignments for submission. | |

## 20OE 801E Introduction to Cyber Crime and Forensics

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**
**To facilitate the learners to-**

1 Learn fundamental concepts of cyber security
2 Understand Security challenges presented by mobile devices and information system access in cybercrime world
3 Learn tools used in Computer forensics and Cyber Applications
4 Understand risks associated with social media networking

**Course Outcomes:**
**By taking this course the learner will be able to-**

1 Classify Cyber Crimes
2 Identify threats and risks within context of Cyber Security
3 Outline Relevant laws and Acts in Cyber Security
4 Appraise various roles and tools used in Cyber Security/ Digital forensics

**Unit I: Introduction to Cybercrime: (7)**
Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Ethical dimensions of cybercrime,Ethics and Morality,Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes

**Unit II: Cyber Offenses**: **(7)**
How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Typical Cyber Crimes like Social Engineering, Cyber stalking, Cyber Defamation, Intellectual property Infringement Botnets: The Fuel for Cybercrime, Dark net

**Unit III: Cybercrime:Mobile and Wireless Devices** : **(8)**
Introduction, Trends in Mobility, Financial Frauds in Mobile and Wireless Computing, Security Challenges Posed by Mobile Devices, structure of Sim card, Sim card forensics, Sim card cloning, Organizational Measures for Handling Mobile,Mobile Apps and cybercrime, Whats app forward frauds, End point detection systems, End point detection systems in devices in organisation

**Unit IV: Methods Used in Cybercrime: (8)**
Introduction, Proxy Servers and Anonymizers,Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow

**Unit V: Digital Forensics- (6)**
Introduction to Digital Forensics, Forensics Software and Hardware, Evaluating computer forensic tools , Software tools and Hardware Tools, New Trends, Mobile forensics for android, Sample Case studies.

**Unit VI: Cyber Security Tools- (6)**
wireshark, Nmap, Nessus, Ncat, Burp Suite, Snort, Nikto Carer Opprtunities and trends in Cyber Security.

**Text Books:**
1 Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA. ISBN 978-81-265-2179-1
2 Information Security & Cyber Laws By Sarika Gupta, Gaurav Gupta,Khanna Publication ISBN: 978-93-810-6824-3 2019
3 Computer Forensics and Investigations Bill Nelson, Amelia Phillips and Christopher Stuart Cengage learning. ISBN 978-81-315-1946-2

**Reference Books:**
1 Intoduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group
2 Eoghan Casey,"Digital evidence and computer crime Forensic Science,Computers and the Internet , ELSVIER,2011 ISBN 978-0-12-374268-1

## 20OE801F Instrumentation in Food and Agriculture

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisites:** Basics of sensors and transducers, knowledge of Unit operations and basics of process control, PLC and pneumatic and hydraulic instrumentation

**Course Objectives:**
1 To know the scope of Instrumentation in agriculture field
2 To know greenhouse, food packaging automation schemes
3 Understand sensors used in agriculture field and weather monitoring stations
4 To get acquainted with food quality standards

**Course Outcomes:** The student will be able to
1. Identify the different unit operations, process control equipments involved in different types of process industries
2. Select appropriate measurement techniques for measurement of various process parameters related to soil, green house, Dam and agro-metrology
3. Analyse and develop various control loops for processes involved in various food processing plants
4. Assess various automation tools to develop automation strategy to Dam, Green house, food processing and packaging in accordance to various food standards

**Unit 1: Process Control in Agriculture and Food Industries (08)**
Sensors in Agriculture (Hygrometers, Anemometers, fine wire thermocouple, etc), Sensors in Food (ph, temperature sensor for pasteurization, brix sensor, etc), Flow diagram of some continuous processes like sugar plant, dairy, juice extraction, etc & batch process (Fermentation)

**Unit 2: Instrumentation in Irrigation and Green House (09)**
SCADA for DAM parameters & control, irrigation canal management systems, Auto drip & sprinkler irrigation systems
Green House Automation: Construction of green houses, Sensors for greenhouse, Control of ventilation, cooling & heating, wind speed, temperature & humidity

**Unit 3: Instrumentation in Farm equipments, Food Safety and Sanitation (09)**
Instrumentation for farm equipment: Implementation of hydraulic, pneumatic and electronic control circuits in harvesters cotton pickers, tractors, etc; Classification of pumps, pump characteristics, selection and installation.
Food safety standards (Food safety and standards bill 2005, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products)
Sanitation regulatory requirements: Sanitation standards operating procedure (SSOP's), Sanitation performance standards (SPS), 11 principles of sanitary facility design, Sanitation best practices.

**Unit 4: Automation in Food Packaging (08)**

Ware house management, Cold Storage Units, PLC and SCADA in food packaging

**Unit 5: Smart Instrumentation in Agriculture and Food Industries (08)**

Wireless sensors, Application of IOT in agriculture and food industries, application of Image processing in agriculture and food industries, application of robots in agriculture and food industries, Case studies.

**Text Books:**

1 D. Patranabis, "Principles of Industrial instrumentation", TMH (2010), ISBN-13: 978-0070699717
2 Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3 Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015,Person, ISBN: 9789332549456, 9332549451
4 Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584

**Reference Books:**

1 Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812
2 Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
3 Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-084933862

## 20OE801G Medical IoT

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisites:**

**Course Objectives:**
1 To understand smart Objects and IoT Architecture
2 To learn sensor Interfacing
3 To learn IoT Protocols
4 To build simple IoT based Health care system

**Course Outcomes:**
1 Ascent the basic concepts of IOT in healthcare
2 Relate the existing hardware platforms and sensor interfaces for various healthcare-based Applications
3 Comprehend the ways of communication between the client and the server in IOT
4 Build various applications in healthcare using IOT based approach with appropriate case studies.

**Unit 1: Medical Measurements (06)**
Cardiovascular system, respiratory system, nervous system etc. Measurement of Heart, Brain and Muscle activity using wearable sensors. Monitor health parameters like Blood Pressure, ECG, EMG, EEG, HR, RR, SPO2 etc.

**Unit 2: Sensors & Smart Patient Devices (08)**
Role of Wearables, Challenges and Opportunities, Future of Wearables, Social Aspects, Wearable Haptics, Intelligent Clothing, Industry Sectors' Overview – Sports, Healthcare, Military, Environment Monitoring, Mining Industry, Public Sector and Safety.

**Unit 3: Wearable mechatronics device (08)**
Accelerometers, Gyroscopic Sensors; In – Shoe Force and Pressure Measurement its applications. Physical Activity Monitoring: Human Kinetics, Cardiac Activity.
Cuffless Blood Pressure Monitor, Study of Flexible and Wearable Piezo resistive Sensors for Cuffless Blood Pressure Measurement, Wearable Pulse Oximeter, Wearable Sweat Analysis, Wearable Heart Rate Measurement**.**

**Unit 4: Device Connectivity and Security / Biomedical Sensors with Internet connectivity (08)**
Gateway, Embedded Systems for devices like RPi, Arduino, etc, Protocols as applied to medical devices.
Sensor interface: Temperature sensor, pressure sensor, optical sensor etc. Wireless body area network. IoT Privacy and Security.

**Unit 5: Data Analytics for Medical Applications (06)**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit 6: IoT in Biomedical Applications - Case Studies (06)**

Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Applicatio development in mobile and cloud Environments.

Case Study1: Wireless Patient Monitor system; Design an IoT System for Vital Sign Monitors Weight measuring device, Blood pressure measuring device, ECG, Blood glucose measuring Heart rates measuring devices and Pulse Oximeters etc.

Case Study2: Wearable Fitness & Activity Monitor; Walking time measuring device ii. Ste counting device iii. Speed measuring device iv. Calorie spent measuring device v. Time spent i rest or sleeping measuring device.

**Text Books:**

1 Joseph D. Bronzino, "Handbook of Biomedical Engineering", 2nd edition –Volume II, CRC press, 2010.
2 Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications", Elsevier Inc., 2014.
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
4 Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

**Reference Books:**

1 Subhas Chandra Mukhopadhyay and Tarikul Islam, "Wearable Sensors - Applications, design and implementation" IOP Publishing Ltd 2017.
2 Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors", Springer Nature Singapore Pte Ltd. 2018.
3 Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
4 "The Internet of Things: Key Applications and Protocols", by, Wiley
5 Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

## 20OE801H QUANTUM COMPUTING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS04 Physics, 20BS01 Linear Algebra & Univariate Calculus,20BS03 Multivariate Calculus

**Course Objectives:**

1 To give an introduction to quantum computation
2 To explain the basics of quantum mechanics
3 To analyze quantum circuits using qubit gates
4 To elaborate difference between classical and quantum information theory
5 To explain quantum algorithms
6 To explain noise and error correction

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe the basics of quantum computation
CO2 Apply the concepts of quantum mechanics
CO3 Design of quantum circuits using qubit gates
CO4 Comparison between classical and quantum information theory
CO5 Utilize quantum algorithms
CO6 Apply noise and quantum error correction

**Unit I: Introduction to Quantum Computation (03)**

Quantum bits, Bloch sphere representation of a qubit, multiple qubits.

**Unit II: Background Mathematics and Physics (08)**

Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics, Measurements in bases other than computational basis.

**Unit III: Quantum Circuits (08)**

Single qubit gates, Multiple qubit gates, Design of quantum circuits.

**Unit IV: Quantum Information and Cryptography**

Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Quantum Cryptography, No cloning theorem.

**Unit V: Quantum Algorithms**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit VI: Noise and error correction**

Graph states and codes, Quantum error correction, fault-tolerant computation.

**Text Books:**

1 Michael Nielsen and Isaac Chuang, **"Quantum Computation and Quantum Information"**, *CambridgeUniversity Press*, *UK*, (10th Edition), (2012).
2 Phillip Kaye, Raymond Laflamme and Michele Mosca,**"An Introduction to Quantum Computing"**, *Oxford University Press*, *UK*, (1st Edition), (2007).

**Reference Books:**

1 N. David Mermin, **"Quantum Computer Science An Introduction"**,*Cambridge University Press*, UK, (1st Edition), (2007).
2 NosonYanofsky and MircoMannucci, **"Quantum Computing for Computer Scientists"**, *Cambridge University Press*, (1st edition), (2008).

**Online Resources:**

1 NPTEL Course **"Quantum Computing"**
https://onlinecourses.nptel.ac.in/noc19_cy31/

## 20OE801I RENEWABLE ENERGY SOURCES

**Teaching Scheme** | **Examination scheme:**
Lectures: 3 Hours / Week | ISE: 50 Marks
ESE: 50 Marks
**Credits: 3**

**Course Objectives:**
**To make students**

1. Understanding basic characteristics of renewable sources of energy and technologies for their utilization.
2. Learning engineering approach for renewable energy projects.
3. For analyze energy potential of renewable sources of energy.

**Course Outcomes:**
**Students will be able to**

1. Understand of different renewable sources of energy and technologies for their utilization.
2. Select engineering approach to problem solving when implementing the projects on renewable sources of energy.
3. Undertake simple analysis of energy potential of renewable sources of energy.
4. Describe main elements of technical systems designed for utilisation of renewable sources of energy.

**Unit/Module: 1 Solar Energy 8 hours CO: 1**
Solar potential, Solar radiation geometry, Solar radiation data, radiation measurement, Types of Solar Collectors, Collection efficiency, Applications of Solar Energy, Solar Desalination system, Solar dryer, Solar Energy storage. Solar PV Principle, Photo-cell materials, Applications.

**Unit/Module: 2 Wind Energy 7 hours CO: 2,3**
Wind parameters and wind data, Power from wind, Site selection, selection of components, Blade material, Wind energy conversion systems and their classification, Construction and working of typical wind mill, wind farms, present status.

**Unit/Module: 3 Biomass Technology 7 hours CO: 2,3**
Introduction to biomass technology, Combustion and fermentation, Biomass gasification, types of gasifire, Pyrolysis, various applications of Biomass energy, Bio-fuel types, and applications.

**Unit/Module: 4 Ocean – Tidal – Geothermal Energy 6 hours CO: 3**
Introduction to OTEC, open and closed cycle OTEC systems, Energy through waves and tides. Geothermal Energy, Energy generation through geothermal system, types of geothermal resources, Introduction of tidal systems, Environmental impact.

**Unit/Module: 5 Hydrogen - Fuel Cell – Hybrid Energy System 7 hours CO: 4**
Introduction to hydrogen and fuel cell technology, applications of hydrogen and fuel cell technology. Need for hybrid energy systems, Case studies of hybrid energy system such as Solar-PV, Wind-PV, Micro hydel- PV, Biomass-Diesel systems.

**Total Theory hours: 35 hours**

**Text Books:**

1 Solar Energy by Dr. S.P.Sukhatme Tata McGraw Hill.
2 Non Conventional Energy Sources by G.D.Rai.- Khanna Publishers.
3 Energy Technology by S. Rao, Dr. B.B.Parulekar Khanna Publishers.

**Reference Books:**

1 Fan Lin You,Hong ye (2012), Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press
2 John. A. Duffie, William A.Beckman (2013) Solar Engineering of Thermal processes, Wiley
3 Godfrey Boyle (2017), Renewable Energy, power for sustainable future, Oxford University Press.
4 A.R.Jha (2010), Wind turbine technology, CRC Press.

## 20OE 801J Soft Computing

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

1. To understand basics in soft computing
2. To understand concepts of fuzzy logic and fuzzy sets
3. To understand supervised neural network architecture, training and testing algorithms and tools for the same
4. To understand unsupervised neural network architecture, training and testing algorithms
5. To understand concept for optimization, evolutionary programming and genetic algorithm and tools for the same
6. To understand concept swarm intelligent systems and tools for the same

**Course Outcomes:**

After completion of the course, students will be able to

1 Identify various soft computing and artificial neural network constituents to solve the problems in engineering domain
2 Experiment with fuzzy logic principles
3 Apply Supervised learning algorithms in artificial neural networks to simple real life problems
4 Apply Unsupervised learning algorithms in artificial neural networks to simple real life problems
5 Apply principles of genetic algorithm in solving engineering optimization problems
6 Apply principles of swarm intelligence in solving engineering optimization problems

**Unit I: Introduction to Intelligent systems, soft tools and Artificial Neural network (07)**

Soft computing constituents and conventional Artificial Intelligence, Artificial Neural network: definition, advantages of artificial neural network, Fuzzy Set Theory, Genetic algorithm, hybrid systems: neuro fuzzy, neuro genetic, fuzzy genetic, soft computing, Introduction to Artificial Neural Network: Fundamental concepts, basic models of artificial neural network, important terminologies of ANNs, McCulloch- Pitts Neuron, linear separability.

**Unit II: Fuzzy logic and fuzzy sets (07)**

Introduction to fuzzy logic, fuzzy sets, fuzzy set operations, properties of fuzzy sets, classical relation, fuzzy relation, membership function, fuzzification, Methods of membership value assignments, lambda-cuts for fuzzy set, lambda-cuts for fuzzy relations, defuzzification. Introduction to tools for fuzzy logic using MATLAB/ Python

**Unit III: Supervised Learning Networks (07)**

Introduction, Perceptron Networks: Perceptron learning rule, Architecture, perceptron training algorithm for single output classes, perceptron training algorithm for multiple output classes, perceptron network testing algorithm, Back Propagation Network: flowchart for training process, training algorithm, linear factors of back- propagation networks, number of training data, number of hidden layer nodes, testing algorithm of back- propagation networks. Introduction to tools for Supervised Learning Networks using MATLAB/ Python

**Unit IV: Associative Memory Networks and Unsupervised Learning Networks (07)**

Associative Memory Networks: Introduction, Training algorithm for pattern association: Hebb rule, Auto-associative Memory networks, Bidirectional associative memory: architecture, discrete bidirectional associative memory, Unsupervised Learning Networks: Introduction, Fixed wright competitive nets: max net, Kohonen Self organizing feature maps

**Unit V: Genetic Algorithm (07)**

Introduction, Traditional Optimization and Search Techniques, biological background, genetic algorithms and search space, genetic algorithm vs. traditional algorithms, basic terminologies in in genetic algorithm, simple GA, operations in genetic algorithm: encoding- binary, octal, selection-Roulette wheel selection, random selection, crossover- single point cross over, two point crossover, mutation- flipping, interchanging, stopping condition for genetic algorithm flow, constraints in genetic algorithm. Introduction to tools for Genetic Algorithm using MATLAB/ Python

**Unit VI: Swarm Intelligent Systems (07)**

Introduction, background of Ant Intelligent systems, Importance of the Ant Colony Paradigm, Ant colony systems, Development of Ant colony systems, Applications of Ant Colony Intelligence, the working of ant colony systems, practical swarm intelligent systems: The basic of PSO method, Characteristic features. Introduction to tools for Swarm Intelligent Systems using MATLAB/ Python

**Text Books:**

1 S.N. Sivanandam- **"Principles of Soft Computing",** Third Edition, Wiley India-ISBN 9788126577132, 20018
2 B K Tripathy, J Anuradha, "Soft Computing- Advances and Applications", Cengage India, ISBN: 78-8131526194, $1^{st}$, 2018
3 P.Padhy, **"Artificial Intelligence and Intelligent Systems"** Oxford University Press, ISBN 10: 0195671546, 2005

**Reference Books:**

1 De Jong, **"Evolutionary Computation: A Unified Approach",** Cambridge (Massachusetts): MIT Press. ISBN: 0-262-04194-4. 2006

2 J. S. R. Jang, CT Sun and E.Mizutani, **"Neuro-Fuzzy and Soft Computing" ,** PHI PVT LTD, ISBN 0-13-261066-3. 2015

3 S. Rajsekaran and G.A. Vijayalakshmi Pai, **"Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications"** , Prentice Hall of India, ISBN: 0451211243, 2003

4 1. Sinha N.K., **" Soft Computing And Intelligent Systems: Theory And Applications"**, ISBN-13: 978-0126464900, Elsevier. 2007.

# 20OE 801K Software Testing and Quality Assurance

**Teaching Scheme:**
Lectures : 3 hours/week
Tutorial : --

**Examination Scheme:**
In-Semester : 50 Marks
End-Semester : 50 Marks
Credit : 3

**Prerequisites:**

**Course Objectives:**

Familiarize students with
1. Testing strategies in projects.
2. Levels of testing strategies
3. Various quality assurance models
4. Automated Testing Tools

**Course Outcomes:**

Students should be able to
1. Explain different terminologies in software testing.
2. Apply appropriate testing technique based on the project scenario
3. Choose quality assurance models for the project
4. Make use of modern testing tools suitable for the project

**Unit – I Fundamentals 7 Hours**

Testing as a Process, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, Testing fundamentals, the defect repository and test design, Defect examples, Developer /Tester support for developing a defect repository. Process model to represent Different phases, Lifecycle models

**Unit – II Levels of testing 7 Hours**

Need for levels of testing, Unit testing, Integration testing, System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing, Stress testing, Regression testing, Alpha, Beta and Acceptance testing.

**Unit – III Testing techniques 7 Hours**

Using White Box Approach to Test design - Static Testing, Structural Testing, Unit Functional Testing, Challenges in White box testing, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing.

**Unit – IV Fundamentals of software quality assurance 7 Hours**

SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

**Unit – V Quality assurance models 7 Hours**

Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM, Clean-room software engineering, Defect Injection and prevention, Inspections & Walkthroughs, Case Tools and their effect on Software Quality.

**Unit – VI Software test automation 7 Hours**

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug. Combining Manual and Automated Testing

**Text Books**

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson
2. Ilene Burnstein, "Practical Software Testing", Springer International edition

**Reference Books**

1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications
2. William Perry, "Effective Methods of Software Testing", Wiley Publishing, Third Edition
3. Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition
4. Watts S Humphrey, "Managing the Software Process", Pearson Education Inc.

## 20OE 802A Applied Statistics with R programming

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Mathematics

**Course Objectives:**

Familiarize students with

1 Fundamentals in Statistics
2 Evaluation and Interpretation of applied statistics
3 Hypothesis Test
4 R programming used in statistical analysis

**Course Outcomes:**

Students should be able to

1 Apply probability for statistical analysis.
2 Draw inferences from statistical analysis of data
3 Apply statistical methods and hypothesis tests on data
4 Explain Multivariate Analysis

**Unit I: Probability** **7 Hours**

Introduction, conditional probability, Bayes Theorem and independence, random variable and Probability distribution, normal distribution.

**Unit II: Basic statistical measures** **9 Hours**

Introduction to statistics, type of data, processing the data, classification, graphical representation. Introduction Measures of central Tendency: Arithmetic Mean, Weighted Arithmetic Mean, Median, mode, Measurement of variation: Quartile, Average and Standard Deviations, Coefficient Variation, Measurement of skewness
Case Study with R programming

**Unit III: Analysis of Variance** **8 Hours**

Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, ANOVA, Completely randomized design, Latin square Design, Duncan's Multiple Range Test
Case Study with R programming

**Unit IV: Types of hypothesis** **9 Hours**

Introduction , types of hypothesis, Tests of hypothesis concerning means, hypothesis concerning proportions, Hypothesis concerning variations (Chi-square and F-tests), Chi square test for checking independence of categorized data, goodness of Fit Test
Case Study with R programming

**Unit V: Multivariate Analysis 9 Hours**

Correlation: Introduction , types of correlations, Correlation Analysis, correlation coefficients, Regression: Introduction, Linear Regression, Regression analysis, regression coefficients. MANOVA, Discrimination Analysis, Factor Analysis, Principle Component Analysis and Independent Component Analysis
Case Study with R programming

**Text Books:**

1 S.P. Gupta, "Statistical Methods", Sultan Chand and sons Publication, 41st Edition.
2 B.L. Agarwal, "Basic Statistics", New Age Publication, 9th Edition
3 A. Papoulis, S.U. Pillai, "Probability Random Variables and Stochastic Processes", Tata McGraw Hill, (4th Edition)

**Reference Books:**

1 S. M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier Publication, 5th Edition
2 Piegorsch W.W, "Statistical Data Analytics", Wiley Publication.
3 E. Rukmangadchari, E.K.Reddy, "Probability and Statistics", Pearson India Pvt.Ltd.,1st Edition
4 Rohatgi A.K. Md e. Saleh, "Introduction to Probability and Statistics", Wiley Publication Pvt. Ltd. 3rd Edition.

**Web References**

1 NPTEL NOC: Descriptive Statistics with R software, Prof. Shalabh, IIT Kanpur,
2 NPTEL NOC: Applied Statistics and Econometrics, Prof. Mukherjee, IIT Kanpur

**20OE802-B Automobile Engineering (AE)**

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| | ESE**:** 50 Marks |
| | **Credits: 3** |

**Course Objectives:**
**To make students**

1 To study layout of the vehicles.
2 To understand function of various components of automotive systems
3 To understand use of alternative fuels for vehicle.

**Course Outcomes:**
**Students will be able to**

1 Identify different layouts of automobile vehicle and engine auxiliary systems.
2 Explain latest transmission, steering, braking and suspension systems in vehicle.
3 Explain EV, HEV, latest trends in AI technologies
4 Understand energy sources, current emission norms and emission control systems.

**Unit/Module: 1 Vehicle Structure and Engine auxiliary systems 6 hours CO: 1**

Vehicle construction and different layouts, chassis, frame and body, components of engine. Electronically controlled gasoline injection system for SI engines. Electronically controlled diesel injection system, electronic ignition system. Introduction to Vehicle Maintenance and Servicing.

**Unit/Module: 2 Transmission Systems 6 hours CO: 2**

Introduction to transmission system, Automatic transmission system (fluid coupling, clutch less drive, fluid flywheel – torque converter), Semi-automatic transmission, continuously variable transmission (CVT), dual clutch hybrid transmission

**Unit/Module: 3 Steering, Brakes and Suspension Systems 6 hours CO: 2**

Introduction to Steering geometry and its function, Power Steering. Introduction to suspension system, Active and passive Suspension. Introduction to Braking Systems, Regenerative breaking, Anti-lock Braking System (ABS), EBS and Traction Control.

**Unit/Module: 4 Electric and hybrid vehicles 6 hours CO: 3**

Concept of electric and hybrid vehicle, EV and HEV fundamentals, architecture of EV and HEV power train, drives and energy sources in EV and HEV, Artificial intelligence technologies such as Autonomous Vehicles, computer vision assist drivers to improve safety, improve services such as vehicle inspection or insurance. Role of IoT to secure communication between vehicles as well as vehicles and infrastructure components

**Unit/Module: 5 Modern Energy Sources and optimizing supply chain 6 hours CO: 4**

Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LNG), Bio-fuels, lithium-ion battery, hydrogen fuel cell in Automobiles, Introduction to Optimization of Supply Chain in Automotive Industry

**Unit/Module: 6 Emission control in automobiles 6 hours CO: 4**

Emission and Fuel Roadmap Euro 6 / BS V norms (proposed 2020-21), Effect of car emissions on human health and the environment. Exhaust gas re-circulation (EGR) and Engine emission control (three-way catalytic converter system SCR and particulate filter).

**Text Books:**

1 Kirpal Singh, Automobile Engineering Vol 1 and 2, Standard Publishers, 7th Edition, 1997
2 M. Chris and M. A. Masrur, Hybrid Electric Vehicles, Wiley Publications, 2nd Edition, 2017
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press

**Reference Books:**

1 K. K. Jain and R. B. Asthana, Automobile Engineering, Tata McGraw Hill Publishers, New Delhi, 1999.
2 Barry Hollembeak, "Automotive Electricity and Electronics" Cengage Learning, Cliftorn Park, USA 2007.
3 Dr. K. R. Govindan, Automobile Engineering, Anuradha Publications, Chennai, 2013.
4 Joseph Heiner, Automotive Mechanics, Litton Education Publishing Ins., New York, 1999.
5 Angelin, Automotive Mechanics, Tata McGraw Hill Pub. Comp. Ltd., 10th Edition, 2004.
6 Josep Aulinas, Hanky Sjafrie, AI for Cars, Chapman and Hall/CRC Press, 1st Edition.

## 20OE802C AUTONOMOUS ROBOTS

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1 To explain fundamentals of robotic system
2 To introduce kinematics, dynamics and control for robotics systems
3 To introduce trajectory planning for motion
4 To describe application of robots in automation

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain and classify different components used in developing autonomous robot |
| CO2 | Select sensors, actuators and grippers for autonomous robot |
| CO3 | Apply formulations to obtain kinematics, dynamics and trajectory planning of autonomous robot |
| CO4 | Develop path planning and navigation algorithm for autonomous robot |
| CO5 | Design robot for automation |

**Unit I: Introduction to Robotics (10 )**
Definition of robotics, Types of robots, Components of Robot system, Classification of robots , Robot architecture, Robot locomotion, Specification of robot, Robot sensors for position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and robot vision, Actuators and end effectors.

**Unit II: Introduction to Mechanics of Robotic Arm (10)**
Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and inverse kinematic analysis, Dynamics and inverse Dynamics of robots, Newton–Eller formulation, Trajectory and Path planning, Application of robotic arm.

**Unit III: Mobile robot Kinematics and Dynamics (08)**
Forward and inverse kinematics, holonomic and nonholonomic constraints, Kinematic models of simple car and legged robots, Dynamic simulation of mobile robots.

**Unit IV: Localization (06)**
Odometric position estimation, Belief representation, Probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, Positioning beacon systems.

**Unit V: Introduction to Planning and Navigation (08)**
Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm, A-star, D-star, Voronoi diagrams, Probabilistic Road Maps (PRM), Rapidly exploring Random Trees (RRT), Markov Decision Processes (MDP), Stochastic Dynamic Programming (SDP).

**Text Books:**

1 R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).
2 Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).
3 Robin R. Murphy, **"Introduction to Artificial Intelligence for Robotics"**, *The MIT Press,*(2nd Edition), (2000).
4 S. K. Saha, **"Introduction to Robotics"**, *Tata McGraw Hill,* (2nd Edition), (2014).

**Reference Books:**

1 K. S.Fu, R. C. Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence" ,** *Tata McGraw Hill* **,** (2nd Edition), (2008).
2 Robert J. Schilling, **"Fundamentals of Robotics- Analysis and Control",***Prentices Hall India*, (1st Edition), (2008).

**Online Resources:**

1 NPTEL Course **"Wheeled Mobile Robot"**
https://nptel.ac.in/courses/112/106/112106298/

## 20OE802D Building Automation and Energy Audit

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**

1 To understand Need and Applications Building automation systems.
2 To understand the working of various Building automation components.
3 To Select and Implement Building automation with various applications.

**Course Outcomes:** The student will be able to

1 Investigate the system requirements for developing building automation systems
2 Compare and choose the suitable building automation systems for the applications
3 Design building automation system for required application
4 Evaluate the performance of the designed building automation system

**Unit 1: Fire Alarm Systems I (08)**

Introduction: to BAS, Need and Applications of BAS, Block diagram of BAS.FAS: Need and Applications of FAS, Types of FAS, Block diagram of FAS, Fire, Fire Development Stages, Fire Signatures, Initiation Devices, Notification Appliances, IDC Placements, NAC Placements, Fire Suppression: Fire Extinguishers & Its Classification, Fire Suppression Systems.

**Unit 2: Fire Alarm Systems II (08)**

IDC, NAC, SLC, FAS Wiring Standards, FAS Communication Protocols, Voltage Drop Analysis, Battery Capacity Analysis, Cause & Effect Matrix.

**Unit 3: Access Control Systems (06)**

Introduction to Security Systems, Types of Security systems, Access Control Systems: Introduction, Applications, Concept, Generic Model, Components, Card Technologies, Communication Protocols for ACS, Biometrics for ACS, CCTV System Types: CCTV Components, Digital Video Management System

**Unit 4: HVAC- Air Systems (06)**

Human Comfort Parameters and Air Properties Need of HVAC System, HVAC Block Diagram. AHU: Concept, Working, AHU Functions, AHU Components: Dampers, Filters, Cooling coil, Heating coil, etc., AHU Configurations, AHU Locations, AHU Terminal Units: CAV, VAV, Measurement and Control Loops for Air Systems.

**Unit 5: HVAC- Water Systems (07)**

Cold Water System: Refrigeration Cycles, Chillers, Cooling Towers, Types of chilled water system, Concept of Free Cooling : Direct Waterside, Series Waterside, Parallel Waterside. Hot Water Systems: Heating Circuits, Boilers, Types of Boilers, Heat Exchangers: Steam Input and Hot Water Input, Solar Hot Water System, Measurement and Control Loops for Water Systems.

**Unit 6: Building Energy Management System (07)**

Overview of Building Energy Management Systems, BEMS Control systems overview, Benefits of BEMS, Energy System Monitoring, Application of Energy Efficient Strategies, Effective Energy management, Computerized Energy Management Systems.

**Text Books:**

1 Robert Gagnon, Design of Special Hazards and Fire Alarm Systems
2 Damjanovski, Vlado, CCTV, Butterworth-Heinemann, 3rd ed
3 Benantar M., Access Control System
4 Montgomery R, Fundamentals of HVAC Control Systems, Elsevier Publications
5 Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6 James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7 "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1 "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2 "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
3 "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4 "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

## 20OE 802E Data Analysis and Visualization

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data analysis and the statistical tools used for analysis
2 Identify the relevant data analysis method for a real time application
3 Select the appropriate data visualization method for the application in hand
4 Understand recent trends in data analysis and visualization

**Unit 1: INTRODUCTION TO DATA ANALYTICS (06)**
Introduction to Data, Data types and their relationships, Data Analytics workflow, Types of analysis Applications.

**Unit 2: BASIC DATA ANALYTICS (08)**
Statistical analysis, Attribute correlation, Regression analysis, Dimensionality reduction, Feature extraction and selection, Time series prediction, Hypothesis Analysis
Case study, Python based examples

**Unit 3: MACHINE LEARNING FOR DATA ANALYTICS (10)**
Data analysis methods used for Clustering, Classification, Regression, Outlier Detection, Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 4: DATA VISUALIZATION (10)**
Purpose and types of Visualization, Graphical Representation, Multidimensional Visualization, Handling data Cleaning, data reduction for visualization, Sorting and Scaling, Multivariate Glyphs
Case study, Python based examples

**Unit 5: RENDS IN DATA ANALYSIS AND VISUALIZATION (08)**

Deep Learning for Data Analysis, handling of small and Big Data,
Storytelling and Data Visualization Dashboards
Case study, Python based examples, Demo with tool like Tableau.

**Text Books:**

1 Dr. Anil Maheshwari, '**Data Analytics'**, McGraw Hill Education (India) Pvt. Ltd. (2017)

2 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)

2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)

3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)

4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching

2 NPTEL Courses

a Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/

b Data Analytics with Python https://nptel.ac.in/courses/106/107/106107220/

c Python for Data Science https://nptel.ac.in/courses/106/106/106106212/

d Introduction to Learning Analytics https://nptel.ac.in/courses/127/101/127101012/

e Data Analytics with Python https://onlinecourses.nptel.ac.in/noc20_cs46/preview

## 20OE 802F Data Science Using Python

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data science.
2 Identify the relevant Python method used in data science.
3 Select the appropriate data operation method for the application in hand.
4 Understand recent trends in data science and analysis.

**Unit 1: INTRODUCTION TO DATA (06)**
Introduction to Data, Data types and their relationships, Handling different types of data using Python, Handling numeric and categorical data using Python

**Unit 2: BASIC DATA Processing using NumPy, Pandas (08)**
Statistical operations, data cleaning, missing data, indexing, slicing, iterating, attribute selection, dimensionality reduction, Handling tabular data, time series
Case study, Python based examples

**Unit 3: MACHINE LEARNING using Sci-Kit, Tensorflow - I (08)**
Clustering, Classification, Regression, Outlier Detection
Case study, Python based examples

**Unit 4: MACHINE LEARNING using Sci-Kit, Tensorflow- II (08)**
Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 5: REGRESSION ANALYSIS AND PREDICTIVE ANALYSIS (06)**

Introduction to types of analysis - Predictive, descriptive and decision based, Regression analysis, types - linear, logistic, ridge, lasso

**Unit 6: DATA VISUALIZATION AND GRAPHICS USING Matplotlib / Seaborn (06)**

Basic visualization plots - Area, histogram, bar, Specialized plots - pie, box, scatter, bibble, Waffle, Word clouds, Seaborn, Regression plots
Introduction to Folium, maps with markers, choropleth maps, dashboards

**Text Books:**

1 Aurélien Géron, '**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**', O'Reilly Media (2017)
2 Samir Madhavan, '**Mastering Python for data science**', Packt (2015)
3 David Beazley, '**Python CookBook**', O'reilly (2013)
4 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching
2 NPTEL Courses
   a Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
   b Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/

## 20OE802G Industrial Drives and Control

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisites:**

**Course Objectives:**

1 To evaluate and select a suitable drive for a particular application.
2 To analyse the basic drive system dynamics
3 To develop the basic design of an electric drive system.

**Course Outcomes:**

1 Selection of appropriate drive for the given application
2 Selection of suitable control system scheme along with the interlocking for given application
3 Analysis of the control drive dynamics for the desired drive system
4 Design of the total electric drive system based on desired application

**Unit 1: Introduction to Industrial Drives (07)**

Concept of electric drive, Power modulators, Motors used in drives, types of loads choice of drives, classification of drives Multi quadrant operation of Drives.

**Unit 2: Introduction to Control Systems (07)**

Open and closed loop systems with examples, automatic control, speed control of motors

**Unit 3: Electrical Control of Machines (08)**

Manual control – Magnetic control – Semi-automatic and Automatic control of Modern machinery – Development of Control circuits–Two wire and Three wire control – Remote control –

**Unit 4: Interlocking of drives (08)**

Control circuit components –Symbols for control components–Fuses, Switches and Fuse Switch units.

**Unit 5: Dynamics and Control of Electric Drives (06)**

D.C. motor drives, Induction motor drives, Synchronous and Brushless D.C. motor drives.

**Unit 6: Industrial process and drives (06)**

Process flow diagram of paper mill, cement mill, sugar mill, steel mill, Hoists and cranes, centrifugal pumps and compressors, solar powered pump drives, selection of drives for the above processes

**Text Books:**

1. Electrical Motor Drives, R. Krishnan [PHI-2003]
2. Electric Drives, Vedam Subrahmaniam [TMH-1994]
3. Industrial Drives and Control, Sandeep M. Chaudhari, Nilesh R. Ahire [Nirali Prakashan]

**Reference Books:**

1. Control of Electric Drives,W. Leonard, [Springer- 2001]
2. Electrical Drives, Second Edition, S.A. Nasar, Boldea [CRC Press - 2006]

## 20OE802H Smart Sensors and Systems

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 Theoretical understanding of various physical phenomena behind the operation of different types of sensors and microsystems
2 Overview of micro/nano fabrication process
3 Develop a complete sensor or sensor system, MEMS device or microsystem

**Course Outcomes:**

1 Selection of suitable sensor along with the associated electronics and fabrication process for given application
2 Selection of appropriate smart sensors for the desired application in the field of Automobile, Biomedical, Military, Space and Défense.
3 Design of application-based sensors in the field of Military, Défense, Spacecraft and environment
4 Analysis of the system designed for applications in the field of Biomedical and Automobile

**Unit 1: Introduction to Smart Sensors and Systems (07)**

Principles of Sensing, Classification and Terminology of Sensors. Introduction to micromachining - Fabrication and miniaturization techniques
Digital Signal Controllers (Microcontrollers and Digital Signal Processors) for Smart sensors
Key features, Certain case studies - for eg: temperature, fingerprint recognition

**Unit 2: Microfabrication process (08)**

Fabrication and miniaturization techniques, Steps involved in fabrication

**Unit 3: Smart sensors in Biomedical field (08)**

Bio-analytical [sample preparation and detection of compound] sensors & systems, Transduction modes & classifications,
Hall Effect sensors and associated signal conditioning circuits, Sensors for displacement (linear and angular), velocity, acceleration, force, torque, vibration and shock measurements. Sensor measurements for conductivity and viscosity. Electrochemical transducer in Biology and medicine Biochemical Transducer, Enzyme-based electrochemical biosensors, electronic tongue, few related Case studies

**Unit 4: Smart sensors in Automobile industry (07)**

Introduction to Modern Automotive Systems and need for electronics in Automobiles, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Sensors for chassis management, Powertrain sensors, Air Bag and Seat Belt Pre tensioner Systems, Case studies explaining the Modern Trends and Technical Solutions, Related communication systems

**Unit 5: Smart sensors related to Environment and in Spacecraft (06)**

Human Toxicology Ecotoxicology, W ater and air pollution sources
E-nose for Sensitive and Selective Chemical Sensing, Chemical sensors, Ocean environment
Smart sensors in spacecraft - in monitoring applications, Smart Instrumentation Point Bus (SIP), Solid state micro-gyroscopes, related Case studies

**Unit 6: Smart sensors in Military and Defence (06)**

Types of sensors (Accelerometers, Inertial Sensors, Pressure Sensors, Force Sensors, Motion Sensors, Gyroscopes, Temperature Sensor and Others), Device-based Sensor, Clothing-based Sensor, Application based sensors - Wrist Wear, Foot Wear, Eye Wear, Body Wear and Neck Wear, intelligent sensor technology for surveillance and electronic intelligence, Case studies, related communication systems

**Text Books:**

1 Understanding Smart Sensors, Randy Frank [Artech House, Boston London]
2 Smart Sensors for Environmental and Medical Applications, Hamida Halilil, Hadi Heidari [Wiley]
3 Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, S Nihtianov, Antonio Luque [Science Direct]

**Reference Books:**

1 Smart Sensors and Systems, Lin, Y.-L., Kyung, C.-M., Yasuura, H., Liu, Y. [Springer]
2 Smart Sensor Systems, Gerard Miejer [Wiley]

## 20OE802I Wireless Networks

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Nil

**Course Objectives:**

1 To explain the importance of wireless communication and multiple access techniques
2 To elaborate the behavior of communication system for indoor and outdoor wireless networks
3 To introduce 3G, 4G cellular network components and 5G future wireless network
4 To explain MIMO technology
5 To introduce visible light communications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain fundamentals of wireless communication and multiple access techniques |
| CO2 | Analyze the behavior of communication system for indoor and outdoor wireless networks |
| CO3 | Apply 3G, 4G cellular network standards and describe 5G future wireless network |
| CO4 | Interpret MIMO technology its advantages and limitations |
| CO5 | Explain LiFi networking and technology for indoor network access |

**Unit I: Introduction to wireless communication (08)**
Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Media, Spread spectrum, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA.

**Unit II: Wireless indoor and outdoor networks (08)**
WLAN, WiFi, Bluetooth, Zigbee, Ultra Wideband communication, Infrared, UHF narrowband, WiMax, Limitation of indoor networks.

**Unit III: Cellular Network (08)**
Spectrum reuse and re-framing, Cell cluster concept, Co-channel and adjacent channel interference, Cell site, call blocking and delay, Channel allocation strategies, 3G and 4G standard.

**Unit IV: Future Wireless networks (10)**
Introduction to 5G, Modulation techniques for 5G, Architecture, MIMO, Massive MIMO, Limitations and applications.

**Unit V: Visible Light Communications (08)**
LiFi Technology, LiFi Networking, LiFi technology for indoor network access, Applications.

**Text Books:**

1 T. Rappaport, "**Wireless Communications - Principles and Practice**", *Prentice Hall* , (2nd Edition) , (2011).
2 Vijay Garg, "**Wireless Communications and networking**", *Elsevier*, (1st Edition), (2007).
3 **Jonathan Rodriguez,** "Fundamentals of 5G Mobile Networks"***, Wiley*, (1st Edition),(2015).**
4 Mohamed Gado, Doaa Abd El-Moghith, "**Li-Fi Technology for Indoor Access**", *LAMBERT Academic Publishing*, (1st Edition), (2015).

**Reference Books:**

1 Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "**3G Evolution HSPA and LTE for Mobile Broadband"**, *Academic Press*, (2nd Edition) , (2008).
2 Anurag Kumar, D.Manjunath, Joy kuri, "**Wireless Networking**", *Elsevier,* (1st Edition), (2011).
3 Simon Haykin, Michael Moher, David Koilpillai, "**Modern Wireless Communications**", *Pearson Education* , (1st Edition), (2013)
4 Aditya K. Jagannatham, "**Principles of Modern Wireless Communications Systems***", McGraw Hill Education (India) Private Limited*, (1st Edition), (2016).

**Online Resources:**

1 NPTEL Course on **"Introduction to Wireless and Cellular Communications",** https://nptel.ac.in/courses/108/106/106106167/#
2 NPTEL Course on **"Advanced 3G and 4G Wireless Mobile Communications**", https://nptel.ac.in/courses/117/104/117104099/

**Autonomous Program Structure of**
**Final Year B. Tech. Eight Semester**
**(Mechanical Engineering)**
**Academic Year: 2023-2024 onwards**

| Course Code | Course Title | Teaching Scheme Hrs /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Practical | Oral | | |
| 20PEME801 | Programme Elective – I* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802 | Programme Elective - II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME803 | Programme Elective -III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME804 | Programme Elective -IV | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE801 | Open Elective III** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE802 | Open Elective IV*** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802L | Programme Elective – II Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **18** | **0** | **2** | **325** | **300** | **0** | **25** | **650** | **19** |
| | **Grand Total** | **20** | | | **625** | | **25** | | | |

*NPTEL / Swayam Course, **Open Elective-III: Department Level Course,***Open Elective-IV: Multi-disciplinary Course.

**20PEME802 Programme Elective – II**
**20PEME802L Programme Elective – II Lab**

A. Mechanics of Composite Materials
B. Computational Fluid Dynamics
C. Finite Element Method

**20PEME803 Programme Elective - III**

A. Industrial Internet of Things
B. Product Design and Development
C. Data Science for Mechanical Engineering
D. Design Thinking for Innovations

**20PEME804 Programme Elective - IV**

A. Advanced Refrigeration and Air Conditioning
B. Advance Solid Mechanics
C. Optimization Techniques

| 20OE801 Open Elective-III | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

| 20OE802 Open Elective-IV | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

## Final Year B. Tech. -- Semester-II

| | | L | T | P |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II**<br>**Mechanics of Composite Material** | | | |
| **Course Code** | **20PEME802 A** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives: To make students**

1. Understand a perspective utilization and processing of composite materials
2. Micro and macro mechanical analysis of the composite material at lamina level
3. Analyze the laminated composite material at macro level
4. Understand testing methods of composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Define need, utilization of class of composite material, its constitution and list its application fields
2. Demonstrate the various fabrication process of composite materials
3. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
4. Analyze laminated composites using classical lamination theory
5. Express testing method of evaluation of mechanical properties of polymer composites as per ASTM standard

| **Unit/Module: 1** | **Introduction to composite** | **6 hours** | **CO: 1** |
|---|---|---|---|

Introduction to advanced materials and types, Definition, General Characteristics, Applications, Fibers, Types of fibers, Mechanical Properties of fibers; Matrix, Types of matrix, Polymer Matrix- Thermoset and Thermoplastic, Fillers/Additives/Modifiers of Fiber Reinforced Composites

| **Unit/Module: 2** | **Manufacturing of composites** | **6 hours** | **CO: 2** |
|---|---|---|---|

fabrication process for thermoset and thermoplastic PMC, open mould process as hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, and Closed mould process as pultrusion, performing, thermo-forming, injection molding, blow molding, Process parameters.

| **Unit/Module: 3** | **Elastic and strength Behaviour of Lamina** | **9 hours** | **CO: 3** |
|---|---|---|---|

**Micromechanical Analysis of Lamina**: Introduction, Volume and mass fraction, density, void content, evaluation of elastic moduli, ultimate strength of unidirectional lamina
**Macro-mechanical Analysis of Lamina**: Review and definition of stress, strain and Elastic Moduli, Hooke's Law for different types of materials, Hook's law for 2D unidirectional and angular lamina, engineering constants of an angle lamina, Strength failure theories of an angle lamina

| **Unit/Module: 4** | **Elastic Behavior of Laminate** | **9 hours** | **CO: 4** |
|---|---|---|---|
| Introduction to Laminate Code, Strain-displacement relations, Stress-strain relation for a laminate, force and moment resultants related to mid plane strains and curvatures, In-Plane engineering constants of a laminate, Flexural engineering constants of a laminate | | | |
| **Unit/Module: 5** | **Testing of Composites** | **6 hours** | **CO: 5** |
| Societies for Testing Standards, Background to Mechanical Testing of Composites, Test Method and analysis of Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Inter-laminar Shear Strength properties, Impact Properties. | | | |
| | **Total Lab hours:** | **36 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, Taylor & Francis Group, 2012. |

**Reference Books:**

| | |
|---|---|
| 1. | Robert M. Jones, "Mechanics of Composite Materials" 2nd Edition, CRC Press 1998 |
| 2. | Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 2010 |
| 3. | Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004. |

| Course Name | Programme Elective – II<br>Computational Fluid Dynamics | L | T | P |
|---|---|---|---|---|
| Course Code | PEME802 B | 3 | - | - |
| Prerequisites | Fluid dynamics, Heat transfer, Numerical methods | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Finite volume method (FVM) of discretization for differential equations ,
2. Development of solution of discretized equations using various methods,
3. CFD tools to solve practical problems
4. Interpret CFD results of complex problems

**Course Outcomes: Students will be able to**

1. Discretize a given differential equation with FVM,
2. Write a simple codes for diffusion and convection problems,
3. Solve fluid flow and heat transfer problems with CFD tools
4. Apply CFD techniques to real life industrial problems.

| Unit/Module: 1 | Introduction to CFD | 4 hours | CO: 1 |
|---|---|---|---|

What is CFD, Advantages of CFD, Applications: as a design and analysis tool, applications in aerospace, applications in automobile and EV, applications in bioscience etc.

| Unit/Module: 2 | CFD Fundamentals | 6 hours | CO: 2 |
|---|---|---|---|

Governing differential equations of fluid dynamics and heat transfer, RTT, continuity equation, Navier Stokes equations and energy equation, RANS, different types of boundary conditions.

| Unit/Module: 3 | CFD Procedure | 8 hours | CO: 3 |
|---|---|---|---|

Finite volume method, discretization of conduction and convection equations, various convective schemes, discretization of momentum equations, pressure velocity coupling, SIMPLE algorithm.

| Unit/Module: 4 | CFD Mesh Generation | 6 hours | CO: 4 |
|---|---|---|---|

Types of meshes, structuared, body-fitted and unstructured meshes, mesh refinement, moving meshes, mesh quality.

| Unit/Module: 5 | CFD Solution and Postprocessing | 6 hours | CO: 5 |
|---|---|---|---|

Convergence, residual and tolerance, consistency and stability, accuracy, sources of errors in solution, mesh independence study, verification and validation.

| | | | |
|---|---|---|---|
| **Unit/Module: 6** | **Applications with Examples** | **4 hours** | **CO: 6** |
| Lid driven cavity, pipe flow, flow over bends, heat transfer coupled with fluid flow, turbulent flow through a channel, flow over an aerofoil etc. | | | |
| | **Total Lab hours:** | **34 hours** | |

**Text Books:**


| | |
|---|---|
| 1. | Jiyuan Tu, Guan-Heng Yeho and Chaoqun Liu, Fluid Dynamics: A Practical Approach, Elsevier. |
| 2. | S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill. |
| 3. | John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis |
| 4. | Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education. |
| 5. | 4. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995. |
| 6. | Ansys Fluent User's Guide, Ansys Inc. |

| Course Name | **Programme Elective – II**<br>**Finite Element Method** | L | T | P |
|---|---|---|---|---|
| **Course Code** | **20PEME802 C** | **3** | **-** | **-** |
| **Pre-requisite** | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

**To make students**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem using FEM
4. To evaluate dynamic analysis problem using FEM

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply element stiffness matrices and load vectors to solve beam and rigid frame problems
3. Derive and apply isoparametric elements and numerical integration to solve plane stress problems
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution
5. Evaluate dynamic analysis of beam using FEM formulation

| Unit/Module: 1 | Introduction to Finite Element Method | 6 hours | CO: 1 |
|---|---|---|---|

General description and engineering applications of finite element method, Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems.
Different approaches: Potential energy method, Rayleigh-Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process.
Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes.
Types of Analysis: Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis.

| Unit/Module: 2 | Analysis of Beams and Rigid Frames | 8 hours | CO: 2 |
|---|---|---|---|

Introduction, Beam Analysis Using two Noded Elements, Analysis of Rigid Plane Frame Using 2 Noded Beam Elements, Timoshenko Beam Element: Formulation, element stiffness matrix, assemblage stiffness matrix and solve for static load

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Analysis of Plane stress with isoparametric elements and numerical integration** | **8 hours** | **CO: 3** |
| Concept of isoperimetric elements, Terms isoperimetric, super parametric, and sub parametric.<br>Coordinate mapping: Natural coordinates, Area coordinates (for triangular elements), higher-order triangular and quadrilateral elements, geometry associative mesh, quality checks, mesh refinement- p vs h refinements, Uniqueness of mapping – Jacobian matrix.<br>Numerical integration: Gauss Quadrature in one and two dimensions, Order of Gauss integration, full and reduced integration, sub-modelling, sub structuring. | | | |
| **Unit/Module: 4** | **Steady-State Heat Transfer** | **6 hours** | **CO: 4** |
| Introduction, One-dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin fin, essential and natural boundary conditions and solving for temperature distribution | | | |
| **Unit/Module: 5** | **Dynamic Analysis** | **8 hours** | **CO: 5** |
| Types of dynamic analysis, general dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.<br>Undamped-free vibration: Eigenvalue problem, evaluation of eigenvalues and eigenvectors. | | | |
| | **Total hours:** | **36 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Daryl Logan, First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd. |
| 2. | S.S. Bhavikatti, Finite Element Analysis, New Age International (P) Ltd, 2005 |
| **Reference Books:** | |
| 1. | R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India |
| 2. | Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005. |
| 3. | G Lakshmi Narasaiah, Finite Element Analysis, BS Publications, 2008. |
| 4. | Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002. |
| 5. | P., Seshu, Textbook of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010. |

| | | L | T | P |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – III**<br>**Industrial Internet of Things** | | | |
| **Course Code** | **20PEME803 A** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Understand protocol, prototype of IoT based smart system
2. Understand Automatic Storage Management.
3. Understand Internet of Things-Ethics and Governance.
4. Understand Smart Manufacturing techniques, smart design, and fabrication Smart application.

**Course Outcomes:**

**Students will be able to**

After successful completion of the course, student will be able to

1. Apply protocol and prototype concepts for IIOT.
2. Justify the role of Automatic storage Management in IIOT
3. Follow ethical practices while developing IIOT applications
4. Design Smart manufacturing and Fabrication applications.

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | **The Internet of Things, Thinking about Prototyping, Prototyping Embedded devices** | **6 hours** | **CO: 1** |

1**The Internet of Things**: **Protocols and Prototyping, Prototyping Embedded devices** An overview; Design Principles for Connected Devices, Internet Principles– Electronics, Embedded Computing Basics, Arduino/Raspberry Pi/ BeagleBone Black/ etc. Prototyping online Components – Getting Started with an API, Writing a New API(Application programming interface)

| | | | |
|---|---|---|---|
| **Unit/Module: 2** | **Automatic Storage Management** | **6 hours** | **CO: 2** |

**Real Time Reactions and Automatic Storage Management**, Other Protocols. Techniques for Writing Embedded Code – Memory Management, Performance. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud.Smart Connected System Design Case Study.

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Internet of Things-Ethics, Privacy, Security and Governance** | **4 hours** | **CO: 3** |

Introduction, Ethics Overview of Governance, Privacy and Security Issues,

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Introduction to Smart Manufacturing** | **8 hours** | **CO: 4** |

Smart manufacturing, Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise

| | | | |
|---|---|---|---|
| operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG) | | | |
| **Unit/Module: 5** | **Smart Design/Fabrication, Smart Applications, Tools for IIOT** | **8 hours** | **CO: 4** |
| Smart Design/Fabrication - Digital Tools, Manufacturing Systems and Standards.<br>Smart Applications Case study | | | |
| | **Total Lab hours:** | **32 hours** | |
| **Text Books:** | | | |

| | |
|---|---|
| 1. | Designing the Internet of Things by Adrian McEwen and Hakim Cassimally |
| 2. | Getting Started with the Internet of Things: Connecting<br>Sensors and Microcontrollers to the Cloud by Cuno Pfister |
| 3. | Foundational Elements of an IOT Solution - The Edge, Cloud and Application Development, Joe Biron& Jonathan Follett, Oreilly, First Edition, March 2016 |
| 4. | The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, 2016, Lucas Darnell |
| 5 | Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland |
| 6 | Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014. (ISBN: 978-8173719547) |

| Course Name | Programme Elective – III<br>Product Design and Development | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME803 B | 3 | - | - |
| Pre-requisite | Manufacturing Processes, Industrial Inspection, Quality Control, Machin Design | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives:**

**Course prepares students to**

1. Understand to Product Design Process and Product Policy.
2. Learn the fundamental of Product Design Morphology Tools.
3. Understand Design for Manufacturing and Assembly.
4. Learn Design for Environment, Quality and IPR.

**Course Outcomes:**

**Students will be able to**

1. Analyse to identify different phases of product design and Product life-cycle,
2. Apply product design morphology tools to analyse requirements/functionality,
3. Apply techniques of Design for Manufacturing and Assembly for product design,
4. Identify factors while designing for Environment w.r.to manufacturing reusability, standards

| Unit/Module: 1 | Introduction to Product Design Process and Product Policy | 6 hours | CO: 1 |
|---|---|---|---|

- Introduction to product design: Product design process, Product life-cycle,
- Product policy of an organization. Selection of a Profitable product, Product design process, Product analysis,
- System engineering in product design: Boundary Diagram and P-Diagram.

| Unit/Module: 2 | Product Design Morphology Tools | 6 hours | CO: 1 |
|---|---|---|---|

- Problem identification and selection, Product Characteristics, KJ Model, DFMEA,
- Analysis of functions, and Anatomy of function: Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST),
- Visual Design, and Quality Function Deployment (QFD),
- Value engineering in product design; Advantages, Applications in product design,
- Ergonomics in product design, Case studies.

| Unit/Module: 3 | Material and Manufacturing Process Selection | 8 hours | CO: 2 |
|---|---|---|---|

- DFX and DFMA during product design: Advantages and case studies,
- Classification and Selection: Introduction to Manufacturing processes,
- Introduction to selection of Manufacturing processes and materials for product design.

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Product Design for Assembly and Maintenance** | **6 hours** | **CO: 3** |

- Design for Assembly: The assembly process, Characteristics and applications, General taxonomies of assembly operation and systems, Examples of common assemblies;
- DFA for design consideration and design recommendation for Part Handling- Insertion, Fasteners [e.g. for manual assembly, high-speed automatic assembly and robot assembly],
- DFA analysis (evaluating assembly): Assembly Metrics, DFA index, Example of worksheet.

| | | | |
|---|---|---|---|
| **Unit/Module: 5** | **Product Design for Manufacturing** | **5 hours** | **CO: 3** |

- Design for Marching: Turning, Milling, Round-Holes Machining, Grinding etc.
- Design for Forming and Joining Processes: Design for Castings, Injection Molding, Forging, Sheet-metal stamping Welding Extrusion and Powder Metal Processing
- Product design for Rapid Prototyping:, Needs, Advantages, Working Principle

  [Process steps, typical characteristics and applications; Defects; Suitable materials; Dimensional factors and tolerances Design consideration and recommendations for selected process],

| | | | |
|---|---|---|---|
| **Unit/Module: 6** | **Design for Environment, Quality and IPR** | **3 hours** | **CO: 4** |

- Product design for Environment (w.r.to Standards / Norms),
- Product design for Quality Control (Inspection requirements w.r.to GD&T),
- Introduction to Reverse Engineering and Frugal Technology,
- Product design and IPR.

| | | | |
|---|---|---|---|
| | **Total Lecture hours:** | **36 hours** | |

**Text Books:**

| | |
|---|---|
| 4. | Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education |
| 5. | Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press. |
| 6. | Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520. |

**Reference Books:**

| | |
|---|---|
| 1. | G. Boothroyd, P. Dewhurst, W. A. Knight, Product Design for Manufacture and Assembly, CRC Press. |
| 2. | K. T. Ulrich and S. D. Eppinger, Product Design and Development, McGraw-Hill Higher Education. |
| 3. | Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill. |

| | |
|---|---|
| 4. | G E Dieter, Engineering Design - A Material Processing Approach, McGraw Hill. |
| 5. | B. R. Fischer, Mechanical Tolerance stackup and analysis, CRC Press. |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective - III**<br>**Data Science for Mechanical Engineering** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 C** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Relevance of data science in mechanical engineering
2. Mathematics and statistical fundamentals for data science
3. Machine learning and AI software frameworks
4. Current trends in mechanical engineering using data science

**Course Outcomes:**

**Students will be able to**

1. Solve data driven problems
2. Use ML software frameworks
3. Apply reinforcement learning to robotic problems
4. Undertake research problem in mechanical engineering that involves data science concepts

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | | **6 hours** | **CO: 1** |
| Mathematical and statistical foundations of data science | | | |
| **Unit/Module: 2** | | **4 hours** | **CO: 2** |
| Introduction to data science, machine learning, and Artificial Intelligence | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** |
| Foundations of Python programming for data science, numpy, pandas, OpenCV, matplotlib etc. | | | |
| **Unit/Module: 4** | | **8 hours** | **CO: 4** |
| Introduction to Neural Networks and Deep Learning: Theoretical concepts, ML frameworks such as Tensorflow, PyTorch | | | |
| **Unit/Module: 5** | | **6 hours** | **CO: 5** |
| Reinforcement learning: Applications of RL in Robotics, OpenAI Gym for RL environment | | | |
| **Unit/Module: 6** | | **4 hours** | **CO: 6** |
| Applications and case studies: Recent research in solid mechanics, fluid dynamics and robotics in | | | |

| | | | |
|---|---|---|---|
| context of data science | | | |
| | **Total Lab hours:** | **32 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Andreas Müller, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Relly Media |
| 2. | Laura Igual, Introduction to Data Science, Springer |
| 3. | Gareth James, Introduction to Statistical learning, Springer, 2017 |
| 4. | www.tensorflow.org, www.pytorch.org, www.openai.com, www.python.org |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective - III<br>Design Thinking for Innovations** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 D** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |
| **Course Objectives: To make students** | | | | |
| 1. Principles of innovative mindset<br>2. Methods and techniques to define customer needs<br>3. Generate a pool of ideas and solutions<br>4. Seek solutions to real life problems though innovations | | | | |
| **Course Outcomes: Students will be able to** | | | | |
| 1. Identify needs and problems for innovations<br>2. Create ideas and find alternate solutions<br>3. Implement ideas and create prototypes<br>4. Apply design thinking principle to real life problems | | | | |
| **Unit/Module: 1** | **Principles of design thinking** | **4 hours** | **CO: 1** | |
| Empathise, define, ideate, prototype and test | | | | |
| **Unit/Module: 2** | | **6 hours** | **CO: 2** | |
| Need identification and problem definition | | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** | |
| Ideation and brainstorming | | | | |
| **Unit/Module: 4** | | **4 hours** | **CO: 4** | |
| Implementation, Prototyping and testing of ideas | | | | |
| **Unit/Module: 5** | | **4 hours** | **CO: 5** | |
| Applications and examples of Design Thinking | | | | |
| **Unit/Module: 6** | **Design Thinking case studies** | **6 hours** | **CO: 6** | |
| business, manufacturing, service industries and public services. | | | | |
| | **Total Lab hours:** | **30 hours** | | |

| **Text Books:** | |
|---|---|
| 1. | Christian Muller-Rotenberg, Design Thinking for Dummies, Wiley 2020 |
| 2. | Design Thinking Toolkit, Ideo.org |
| 3. | Harry Plattner, Christopher Meinel, Larry Leifer, Design Thinking, Springer |
| 4. | Jeane Liedtka, Solving Problems with Design Thinking, Columbia Uni. Press, 2013 |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – IV**<br>**Advanced Refrigeration and Air Conditioning** | **L** | **T** | **P** |
| **Course Code** | **20PEME804_A** | **3** | **-** | **-** |
| **Prerequisite** | 1. Heat Transfer<br>2. Fluid Mechanics<br>3. Applied Thermodynamics | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: To make students**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

**Course Outcomes: Students will be able to**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

| **Unit/Module: 1** | **Refrigerants** | **3 hours** | **CO: 1** |
|---|---|---|---|

Classification of refrigerants, designation of refrigerants, desirable properties of refrigerants, environmental issues, selection of environment friendly refrigerants, alternative refrigerants

| **Unit/Module: 2** | **Vapor Refrigeration Cycles** | **6 hours** | **CO: 2** |
|---|---|---|---|

Advanced vapor compression cycles – Trans critical cycle, Ejector refrigeration cycle

Vapor absorption systems- Aqua ammonia system, Electrolux refrigerator

| **Unit/Module: 3** | Air Conditioning Load Estimation | **15 hours** | **CO: 3** |
|---|---|---|---|

Refrigeration and Air Conditioning System Components: –
Compressors- Reciprocating, centrifugal, screw, scroll, inverter based
Evaporators
Condensers- Shell and Tube type , evaporative condenser
Expansion Devices- Capillary tube, Thermostatic Expansion valve, Electronic Expansion valve

Cooling Towers
Air cooling v/s Air Conditioning, Review of psychrometric processes, Thermodynamic of human body
Factors impacting heating/cooling load
Concept of infiltration, ventilation, indoor air quality requirements, solar radiation
Cooling Load Temperature Difference method
Overview of energy codes – ECBC, Eco Niwas Samhita, IECC
Overview of Energy Simulation Softwares

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Advanced Air Conditioning systems** | **6 hours** | **CO: 4** |
| Desiccant air conditioning systems, evaporative cooling, thermal energy storage air conditioning systems, radiant cooling heat pump systems, Under floor air delivery systems<br><br>Selection Criteria | | | |
| **Unit/Module: 5** | **Air Distribution System** | **6 hours** | **CO: 5** |
| Ducts - Air flow through simple duct system. Pressure losses in duct<br>Method of duct system design- equal friction, velocity reduction method, static regain method<br>Air handling unit- Fan coil unit, filters, supply and return grills | | | |
| **Unit/Module: 6** | **Building Energy Efficiency** | **3 hours** | **CO:6** |
| Introduction to high performance buildings, building controls and building management system, commissioning and audits of building systems, Green building rating systems | | | |
| | **Total course hours:** | **hours** | **39** |

**Text Books:**

| | |
|---|---|
| 1. | Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill |
| 2. | Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd |
| 3. | McQuiston, Heating Ventilating and air Conditioning: Analysis and Design, Wiley India |
| 4. | Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpat Rai & Company, New Delhi |
| 5. | ASHRAE Handbooks |
| 6 | Threlkeld J.L., Thermal Environmental Engineering, Prentice Hall Inc. New Delhi |
| 7 | Shan Wang, Handbook of Refrigeration and Air Conditioning, McGraw Hill Publications |

| **Course Name** | **Programme Elective – IV**<br>**Advanced Solid Mechanics** | **L** | **T** | **P** |
|---|---|---|---|---|
| **Course Code** | **20PEME804_B** | **3** | **0** | **0** |
| **Pre-requisites** | Basics of Engineering Mechanics and Strength of Materials | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: To make students**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

**Course Outcomes : Students will be able to**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

| **Unit :1** | **Mathematical Preliminaries:** | **7 hours** | **CO: 1** |
|---|---|---|---|

Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor.

| **Unit : 2** | **Analysis of Stress and Strain:** | **8 hours** | **CO: 2** |
|---|---|---|---|

Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity.

| Unit : 3 | Problem formulation and solution strategies: | 7 hours | CO: 3 |
|---|---|---|---|

Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lame-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods.

| Unit : 4 | Two-dimensional problems: | 7 hours | CO: 4 |
|---|---|---|---|

Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method.

| Unit : 5 | Applications: | 7 hours | CO: 5 |
|---|---|---|---|

Torsion of noncircular shafts: Warping and Prandtl stress function, Torsion analysis of circular, elliptical, and rectangular cylinder using Warping and Prandtl function, Membrane analogy, Photo elasticity, Plates and shells – Fundamental equations, Kirchhoff's theory, axisymmetric bending of circular plates, membrane theory of shells of revolutions.

| | Total Theory Lecture hours: | 35 hours | |
|---|---|---|---|

**Text Books:**

| | |
|---|---|
| 1. | Elasticity, Theory, Applications, and Numerics by Martin H. Sadd |
| 2. | Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier |
| 3. | Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications. |

**Reference Books:**

| | |
|---|---|
| 1. | Continuum Mechanics, A.J.M Spencer, Dover Publications, INC |
| 2 | Advanced Mechanics of Materials by H. Ford and J. M. Alexander |
| 3 | The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science+Business Media, LLC |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – IV**<br>**Optimization Techniques** | **L** | **T** | **P** |
| **Course Code** | **20PEME804 C** | **3** | **-** | **-** |
| **Prerequisite** | Engineering Mathematics | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

1 To introduce to the students optimization problems and various solution techniques ,

2 To impart knowledge of various classical and modern optimization techniques

3 To make students aware about industrial optimization problems

4 To expose students to numerical techniques to solve optimization problems

**Course Outcomes:** Upon completion of this course, the student will be able to:

1 formulate objective functions and constraint equations for a given classical problem,

2 apply classical and modern method of optimization to standard problems

3 solve realistic and industrial design problems

4 use computational tools such as MATLAB/OCTAVE to get solutions

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | **Introduction to Optimization** | **4 hours** | **CO: 1** |

Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Graphical Optimization Techniques.

| | | | |
|---|---|---|---|
| **Unit/Module: 2** | **Classical Optimization Techniques** | **6 hours** | **CO: 2** |

Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints: Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification, Convex Programming Problems.

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Linear Programming: Simplex Method** | **4 hours** | **CO: 3** |

Applications of Linear Programming,Standard Form of a Linear Programming Problem, Simplex Algorithm, Two Phases of the Simplex Method

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Nonlinear Programming** | **6 hours** | **CO: 4** |
| Introduction, Unrestricted Search, Interval Halving Method, Golden Section Method, Quadratic Interpolation Method, Newton's Method, Practical Considerations | | | |
| **Unit/Module: 5** | **Intro to Special Optimization Methods** | **6 hours** | **CO: 5** |
| Dynamic Programming, Optimal Control | | | |
| **Unit/Module: 6** | **Modern Methods of Optimization** | **6 hours** | **CO: 6** |
| Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Neural-Network-Based Optimization, Practical Aspects of Optimization | | | |
| | **Total Lab hours:** | **32 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Engineering Optimization -Theory and Practice/ Singerusu S. Rao/ New Age. |
| 2. | Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons |
| 3. | Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Hall of India |

| Course Name | Programme Elective – II Lab<br>Mechanics of Composite Material Lab | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME802L_A | - | - | 2 |
| Pre-requisite | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives:**

**To make students**

1. Micro and macro mechanical analysis of the composite material at lamina level
2. Analyze the laminated composite material at macro level
3. Manufacture the unidirectional laminated composite material
4. Test composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
2. Analyze laminated composites using classical lamination theory
3. Fabricate the unidirectional composite laminate using compression molding process
4. Test and evaluate mechanical properties of polymer composites as per ASTM standards

**Lab Work:**

1. Develop a program for micro mechanical analysis of composite lamina
2. Develop a program for macro mechanical analysis of composite lamina and laminate
3. Develop a program for failure analysis of composite laminate using different failure theories.
4. Manufacturing of unidirectional and multidirectional fiber reinforced polymer matrix composites
5. Tensile testing of composite lamina to find out tensile strength and tensile modulus
6. Flexural testing of composite lamina to find out flexural strength and flexural modulus
7. Izod/Charpy impact test of composite lamina to find out impact strength

**Text Books:**

1. P K Mallik, "Fibrer Reinforced Composites: Materials, Manufacturing and Design", CRC Press, Taylor & Francis Group, Third Edition 2015.

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II Lab**<br>**Computational Fluid Dynamics Lab** | **L** | **T** | **P** |
| **Course Code** | **20PEME802 L_B** | **-** | **-** | **2** |
| **Prerequisites** | Fluid Dynamics, HT, CFD | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: Introduce students to**

1. To develop simple FVM codes
2. To set up and solve fluid flow and HT problems with CFD tools
3. To carry out simulations of real life CFD problems

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Develop simple FVM codes
2. Use CFD tools
3. Simulate CFD problems and postprocess the results.
4. Interpret CFD results and draw scientific conclusions

**Lab Work:**

1. Finite Volume Method code for two-dimensional conduction problem.
2. FVM code for convection problem.
3. Demonstration and study of NSE Solver
4. Lid driven cavity problem using Ansys Fluent
5. Flow through a channel: Fluent tutorial
6. Flow over airfoil: Fluent tutorial
7. 2-D heat transfer problems in Fluent
8. Simple turbulent flow simulations in Fluent

**Text Books/References:**

1. ANSYS user guide https://www.ansys.com/academic/learning-resources

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II Lab**<br>**Finite Element Method Lab** | **L** | **T** | **P** |
| **Course Code** | **20PEME802L_C** | **-** | **-** | **2** |
| **Pre-requisite** | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem in FEM
4. To evaluate natural frequency through dynamic analysis of mechanical component

**Course Outcomes:** After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply beam and rigid frame element stiffness matrices and load vectors to solve for displacements and stresses.
3. Derive and apply isoparametric formulation of element stiffness matrices and load vectors to solve plane stress problems for displacements and stresses.
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution

**Lab Work:**

1. A computer program for stress analysis of beam using linear and quadratic elements
2. A computer program for stress analysis of rigid frame using FEM formulation
3. A computer program for stress analysis of plane stress using the isoparametric formulation
4. A computer program for 1-D temperature analysis for heat transfer problem
5. Static stress concentration factor calculation for a plate with center hole using FEA software
6. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
7. Modal analysis of any machine component using FEA software.
8. Temperature distribution analysis of Steady-state heat transfer problem using FEA software

**Text Books/References:**

| | |
|---|---|
| 1. | Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition |
| 2. | ANSYS user guide https://www.ansys.com/academic/learning-resources |

**Autonomous Program Structure of**
**Final Year B. Tech. Eight Semester**
**(Mechanical Engineering)**
**Academic Year: 2023-2024 onwards**

| Course Code | Course Title | Teaching Scheme Hrs /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Practical | Oral | | |
| 20PEME801 | Programme Elective – I* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802 | Programme Elective - II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME803 | Programme Elective -III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME804 | Programme Elective -IV | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE801 | Open Elective III** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE802 | Open Elective IV*** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802L | Programme Elective – II Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **18** | **0** | **2** | **325** | **300** | **0** | **25** | **650** | **19** |
| | **Grand Total** | **20** | | | **625** | | **25** | | | |

*NPTEL / Swayam Course, **Open Elective-III: Department Level Course,***Open Elective-IV: Multi-disciplinary Course.

| |
|---|
| **20PEME802 Programme Elective – II**<br>**20PEME802L Programme Elective – II Lab**<br>A. Mechanics of Composite Materials<br>B. Computational Fluid Dynamics<br>C. Finite Element Method |
| **20PEME803 Programme Elective - III**<br>A. Industrial Internet of Things<br>B. Product Design and Development<br>C. Data Science for Mechanical Engineering<br>D. Design Thinking for Innovations |
| **20PEME804 Programme Elective - IV**<br>A. Advanced Refrigeration and Air Conditioning<br>B. Advance Solid Mechanics<br>C. Optimization Techniques |

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

## Final Year B. Tech. -- Semester-II

| Course Name | Programme Elective – II<br>Mechanics of Composite Material | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME802 A | 3 | - | - |
| Pre-requisite | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives: To make students**

1. Understand a perspective utilization and processing of composite materials
2. Micro and macro mechanical analysis of the composite material at lamina level
3. Analyze the laminated composite material at macro level
4. Understand testing methods of composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Define need, utilization of class of composite material, its constitution and list its application fields
2. Demonstrate the various fabrication process of composite materials
3. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
4. Analyze laminated composites using classical lamination theory
5. Express testing method of evaluation of mechanical properties of polymer composites as per ASTM standard

| Unit/Module: 1 | Introduction to composite | 6 hours | CO: 1 |
|---|---|---|---|

Introduction to advanced materials and types, Definition, General Characteristics, Applications, Fibers, Types of fibers, Mechanical Properties of fibers; Matrix, Types of matrix, Polymer Matrix- Thermoset and Thermoplastic, Fillers/Additives/Modifiers of Fiber Reinforced Composites

| Unit/Module: 2 | Manufacturing of composites | 6 hours | CO: 2 |
|---|---|---|---|

fabrication process for thermoset and thermoplastic PMC, open mould process as hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, and Closed mould process as pultrusion, performing, thermo-forming, injection molding, blow molding, Process parameters.

| Unit/Module: 3 | Elastic and strength Behaviour of Lamina | 9 hours | CO: 3 |
|---|---|---|---|

**Micromechanical Analysis of Lamina**: Introduction, Volume and mass fraction, density, void content, evaluation of elastic moduli, ultimate strength of unidirectional lamina
**Macro-mechanical Analysis of Lamina**: Review and definition of stress, strain and Elastic Moduli, Hooke's Law for different types of materials, Hook's law for 2D unidirectional and angular lamina, engineering constants of an angle lamina, Strength failure theories of an angle lamina

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Elastic Behavior of Laminate** | **9 hours** | **CO: 4** |
| Introduction to Laminate Code, Strain-displacement relations, Stress-strain relation for a laminate, force and moment resultants related to mid plane strains and curvatures, In-Plane engineering constants of a laminate, Flexural engineering constants of a laminate | | | |
| **Unit/Module: 5** | **Testing of Composites** | **6 hours** | **CO: 5** |
| Societies for Testing Standards, Background to Mechanical Testing of Composites, Test Method and analysis of Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Inter-laminar Shear Strength properties, Impact Properties. | | | |
| | **Total Lab hours:** | **36 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, Taylor & Francis Group, 2012. |

**Reference Books:**

| | |
|---|---|
| 1. | Robert M. Jones, "Mechanics of Composite Materials" 2nd Edition, CRC Press 1998 |
| 2. | Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 2010 |
| 3. | Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004. |

| | | L | T | P |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II**<br>**Computational Fluid Dynamics** | | | |
| **Course Code** | **PEME802 B** | **3** | **-** | **-** |
| **Prerequisites** | Fluid dynamics, Heat transfer, Numerical methods | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: To make students**

1. Finite volume method (FVM) of discretization for differential equations ,
2. Development of solution of discretized equations using various methods,
3. CFD tools to solve practical problems
4. Interpret CFD results of complex problems

**Course Outcomes: Students will be able to**

1. Discretize a given differential equation with FVM,
2. Write a simple codes for diffusion and convection problems,
3. Solve fluid flow and heat transfer problems with CFD tools
4. Apply CFD techniques to real life industrial problems.

| **Unit/Module: 1** | **Introduction to CFD** | **4 hours** | **CO: 1** |
|---|---|---|---|

What is CFD, Advantages of CFD, Applications: as a design and analysis tool, applications in aerospace, applications in automobile and EV, applications in bioscience etc.

| **Unit/Module: 2** | **CFD Fundamentals** | **6 hours** | **CO: 2** |
|---|---|---|---|

Governing differential equations of fluid dynamics and heat transfer, RTT, continuity equation, Navier Stokes equations and energy equation, RANS, different types of boundary conditions.

| **Unit/Module: 3** | **CFD Procedure** | **8 hours** | **CO: 3** |
|---|---|---|---|

Finite volume method, discretization of conduction and convection equations, various convective schemes, discretization of momentum equations, pressure velocity coupling, SIMPLE algorithm.

| **Unit/Module: 4** | **CFD Mesh Generation** | **6 hours** | **CO: 4** |
|---|---|---|---|

Types of meshes, structuared, body-fitted and unstructured meshes, mesh refinement, moving meshes, mesh quality.

| **Unit/Module: 5** | **CFD Solution and Postprocessing** | **6 hours** | **CO: 5** |
|---|---|---|---|

Convergence, residual and tolerance, consistency and stability, accuracy, sources of errors in solution, mesh independence study, verification and validation.

| **Unit/Module: 6** | **Applications with Examples** | **4 hours** | **CO: 6** |
|---|---|---|---|
| Lid driven cavity, pipe flow, flow over bends, heat transfer coupled with fluid flow, turbulent flow through a channel, flow over an aerofoil etc. | | | |
| | **Total Lab hours:** | **34 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Jiyuan Tu, Guan-Heng Yeho and Chaoqun Liu, Fluid Dynamics: A Practical Approach, Elsevier. |
| 2. | S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill. |
| 3. | John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis |
| 4. | Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education. |
| 5. | 4. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995. |
| 6. | Ansys Fluent User's Guide, Ansys Inc. |

| Course Name | Programme Elective – II<br>Finite Element Method | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME802 C | 3 | - | - |
| Pre-requisite | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

**To make students**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem using FEM
4. To evaluate dynamic analysis problem using FEM

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply element stiffness matrices and load vectors to solve beam and rigid frame problems
3. Derive and apply isoparametric elements and numerical integration to solve plane stress problems
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution
5. Evaluate dynamic analysis of beam using FEM formulation

| Unit/Module: 1 | Introduction to Finite Element Method | 6 hours | CO: 1 |
|---|---|---|---|

General description and engineering applications of finite element method, Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems.
Different approaches: Potential energy method, Rayleigh-Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process.
Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes.
Types of Analysis: Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis.

| Unit/Module: 2 | Analysis of Beams and Rigid Frames | 8 hours | CO: 2 |
|---|---|---|---|

Introduction, Beam Analysis Using two Noded Elements, Analysis of Rigid Plane Frame Using 2 Noded Beam Elements, Timoshenko Beam Element: Formulation, element stiffness matrix, assemblage stiffness matrix and solve for static load

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Analysis of Plane stress with isoparametric elements and numerical integration** | **8 hours** | **CO: 3** |
| Concept of isoperimetric elements, Terms isoperimetric, super parametric, and sub parametric.<br>Coordinate mapping: Natural coordinates, Area coordinates (for triangular elements), higher-order triangular and quadrilateral elements, geometry associative mesh, quality checks, mesh refinement- p vs h refinements, Uniqueness of mapping – Jacobian matrix.<br>Numerical integration: Gauss Quadrature in one and two dimensions, Order of Gauss integration, full and reduced integration, sub-modelling, sub structuring. | | | |
| **Unit/Module: 4** | **Steady-State Heat Transfer** | **6 hours** | **CO: 4** |
| Introduction, One-dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin fin, essential and natural boundary conditions and solving for temperature distribution | | | |
| **Unit/Module: 5** | **Dynamic Analysis** | **8 hours** | **CO: 5** |
| Types of dynamic analysis, general dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.<br>Undamped-free vibration: Eigenvalue problem, evaluation of eigenvalues and eigenvectors. | | | |
| | **Total hours:** | **36 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Daryl Logan, First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd. |
| 2. | S.S. Bhavikatti, Finite Element Analysis, New Age International (P) Ltd, 2005 |
| **Reference Books:** | |
| 1. | R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India |
| 2. | Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005. |
| 3. | G Lakshmi Narasaiah, Finite Element Analysis, BS Publications, 2008. |
| 4. | Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002. |
| 5. | P., Seshu, Textbook of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010. |

| Course Name | **Programme Elective – III**<br>**Industrial Internet of Things** | L | T | P |
|---|---|---|---|---|
| **Course Code** | **20PEME803 A** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Understand protocol, prototype of IoT based smart system
2. Understand Automatic Storage Management.
3. Understand Internet of Things-Ethics and Governance.
4. Understand Smart Manufacturing techniques, smart design, and fabrication Smart application.

**Course Outcomes:**

**Students will be able to**

After successful completion of the course, student will be able to
1. Apply protocol and prototype concepts for IIOT.
2. Justify the role of Automatic storage Management in IIOT
3. Follow ethical practices while developing IIOT applications
4. Design Smart manufacturing and Fabrication applications.

| **Unit/Module: 1** | **The Internet of Things, Thinking about Prototyping, Prototyping Embedded devices** | **6 hours** | **CO: 1** |
|---|---|---|---|

1**The Internet of Things**: **Protocols and Prototyping, Prototyping Embedded devices** An overview; Design Principles for Connected Devices, Internet Principles– Electronics, Embedded Computing Basics, Arduino/Raspberry Pi/ BeagleBone Black/ etc. Prototyping online Components – Getting Started with an API, Writing a New API(Application programming interface)

| **Unit/Module: 2** | **Automatic Storage Management** | **6 hours** | **CO: 2** |
|---|---|---|---|

**Real Time Reactions and Automatic Storage Management**, Other Protocols. Techniques for Writing Embedded Code – Memory Management, Performance. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud.Smart Connected System Design Case Study.

| **Unit/Module: 3** | **Internet of Things-Ethics, Privacy, Security and Governance** | **4 hours** | **CO: 3** |
|---|---|---|---|

Introduction, Ethics Overview of Governance, Privacy and Security Issues,

| **Unit/Module: 4** | **Introduction to Smart Manufacturing** | **8 hours** | **CO: 4** |
|---|---|---|---|

Smart manufacturing, Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise

| | | | |
|---|---|---|---|
| operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG) | | | |
| **Unit/Module: 5** | **Smart Design/Fabrication, Smart Applications, Tools for IIOT** | **8 hours** | **CO: 4** |
| Smart Design/Fabrication - Digital Tools, Manufacturing Systems and Standards.<br>Smart Applications Case study | | | |
| | **Total Lab hours:** | **32 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Designing the Internet of Things by Adrian McEwen and Hakim Cassimally |
| 2. | Getting Started with the Internet of Things: Connecting<br>Sensors and Microcontrollers to the Cloud by Cuno Pfister |
| 3. | Foundational Elements of an IOT Solution - The Edge, Cloud and Application Development, Joe Biron& Jonathan Follett, Oreilly, First Edition, March 2016 |
| 4. | The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, 2016, Lucas Darnell |
| 5 | Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland |
| 6 | Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014. (ISBN: 978-8173719547) |

| Course Name | Programme Elective – III<br>Product Design and Development | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME803 B | 3 | - | - |
| Pre-requisite | Manufacturing Processes, Industrial Inspection, Quality Control, Machin Design | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives:**

**Course prepares students to**

1. Understand to Product Design Process and Product Policy.
2. Learn the fundamental of Product Design Morphology Tools.
3. Understand Design for Manufacturing and Assembly.
4. Learn Design for Environment, Quality and IPR.

**Course Outcomes:**

**Students will be able to**

1. Analyse to identify different phases of product design and Product life-cycle,
2. Apply product design morphology tools to analyse requirements/functionality,
3. Apply techniques of Design for Manufacturing and Assembly for product design,
4. Identify factors while designing for Environment w.r.to manufacturing reusability, standards

| Unit/Module: 1 | Introduction to Product Design Process and Product Policy | 6 hours | CO: 1 |
|---|---|---|---|

- Introduction to product design: Product design process, Product life-cycle,
- Product policy of an organization. Selection of a Profitable product, Product design process, Product analysis,
- System engineering in product design: Boundary Diagram and P-Diagram.

| Unit/Module: 2 | Product Design Morphology Tools | 6 hours | CO: 1 |
|---|---|---|---|

- Problem identification and selection, Product Characteristics, KJ Model, DFMEA,
- Analysis of functions, and Anatomy of function: Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST),
- Visual Design, and Quality Function Deployment (QFD),
- Value engineering in product design; Advantages, Applications in product design,
- Ergonomics in product design, Case studies.

| Unit/Module: 3 | Material and Manufacturing Process Selection | 8 hours | CO: 2 |
|---|---|---|---|

- DFX and DFMA during product design: Advantages and case studies,
- Classification and Selection: Introduction to Manufacturing processes,
- Introduction to selection of Manufacturing processes and materials for product design.

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Product Design for Assembly and Maintenance** | **6 hours** | **CO: 3** |

- Design for Assembly: The assembly process, Characteristics and applications, General taxonomies of assembly operation and systems, Examples of common assemblies;
- DFA for design consideration and design recommendation for Part Handling- Insertion, Fasteners [e.g. for manual assembly, high-speed automatic assembly and robot assembly],
- DFA analysis (evaluating assembly): Assembly Metrics, DFA index, Example of worksheet.

| | | | |
|---|---|---|---|
| **Unit/Module: 5** | **Product Design for Manufacturing** | **5 hours** | **CO: 3** |

- Design for Marching: Turning, Milling, Round-Holes Machining, Grinding etc.
- Design for Forming and Joining Processes: Design for Castings, Injection Molding, Forging, Sheet-metal stamping Welding Extrusion and Powder Metal Processing
- Product design for Rapid Prototyping:, Needs, Advantages, Working Principle

  [Process steps, typical characteristics and applications; Defects; Suitable materials; Dimensional factors and tolerances Design consideration and recommendations for selected process],

| | | | |
|---|---|---|---|
| **Unit/Module: 6** | **Design for Environment, Quality and IPR** | **3 hours** | **CO: 4** |

- Product design for Environment (w.r.to Standards / Norms),
- Product design for Quality Control (Inspection requirements w.r.to GD&T),
- Introduction to Reverse Engineering and Frugal Technology,
- Product design and IPR.

| | | | |
|---|---|---|---|
| | **Total Lecture hours:** | **36 hours** | |

**Text Books:**


| | |
|---|---|
| 4. | Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education |
| 5. | Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press. |
| 6. | Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520. |


**Reference Books:**


| | |
|---|---|
| 1. | G. Boothroyd, P. Dewhurst, W. A. Knight, Product Design for Manufacture and Assembly, CRC Press. |
| 2. | K. T. Ulrich and S. D. Eppinger, Product Design and Development, McGraw-Hill Higher Education. |
| 3. | Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill. |

| | |
|---|---|
| 4. | G E Dieter, Engineering Design - A Material Processing Approach, McGraw Hill. |
| 5. | B. R. Fischer, Mechanical Tolerance stackup and analysis, CRC Press. |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective - III**<br>**Data Science for Mechanical Engineering** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 C** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Relevance of data science in mechanical engineering
2. Mathematics and statistical fundamentals for data science
3. Machine learning and AI software frameworks
4. Current trends in mechanical engineering using data science

**Course Outcomes:**

**Students will be able to**

1. Solve data driven problems
2. Use ML software frameworks
3. Apply reinforcement learning to robotic problems
4. Undertake research problem in mechanical engineering that involves data science concepts

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | | **6 hours** | **CO: 1** |
| Mathematical and statistical foundations of data science | | | |
| **Unit/Module: 2** | | **4 hours** | **CO: 2** |
| Introduction to data science, machine learning, and Artificial Intelligence | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** |
| Foundations of Python programming for data science, numpy, pandas, OpenCV, matplotlib etc. | | | |
| **Unit/Module: 4** | | **8 hours** | **CO: 4** |
| Introduction to Neural Networks and Deep Learning: Theoretical concepts, ML frameworks such as Tensorflow, PyTorch | | | |
| **Unit/Module: 5** | | **6 hours** | **CO: 5** |
| Reinforcement learning: Applications of RL in Robotics, OpenAI Gym for RL environment | | | |
| **Unit/Module: 6** | | **4 hours** | **CO: 6** |
| Applications and case studies: Recent research in solid mechanics, fluid dynamics and robotics in | | | |

| | | | |
|---|---|---|---|
| context of data science | | | |
| | **Total Lab hours:** | **32 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Andreas Müller, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Relly Media |
| 2. | Laura Igual, Introduction to Data Science, Springer |
| 3. | Gareth James, Introduction to Statistical learning, Springer, 2017 |
| 4. | www.tensorflow.org, www.pytorch.org, www.openai.com, www.python.org |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective - III**<br>**Design Thinking for Innovations** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 D** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: To make students**

1. Principles of innovative mindset
2. Methods and techniques to define customer needs
3. Generate a pool of ideas and solutions
4. Seek solutions to real life problems though innovations

**Course Outcomes: Students will be able to**

1. Identify needs and problems for innovations
2. Create ideas and find alternate solutions
3. Implement ideas and create prototypes
4. Apply design thinking principle to real life problems

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | **Principles of design thinking** | **4 hours** | **CO: 1** |
| Empathise, define, ideate, prototype and test | | | |
| **Unit/Module: 2** | | **6 hours** | **CO: 2** |
| Need identification and problem definition | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** |
| Ideation and brainstorming | | | |
| **Unit/Module: 4** | | **4 hours** | **CO: 4** |
| Implementation, Prototyping and testing of ideas | | | |
| **Unit/Module: 5** | | **4 hours** | **CO: 5** |
| Applications and examples of Design Thinking | | | |
| **Unit/Module: 6** | **Design Thinking case studies** | **6 hours** | **CO: 6** |
| business, manufacturing, service industries and public services. | | | |
| | **Total Lab hours:** | **30 hours** | |

| **Text Books:** | |
|---|---|
| 1. | Christian Muller-Rotenberg, Design Thinking for Dummies, Wiley 2020 |
| 2. | Design Thinking Toolkit, Ideo.org |
| 3. | Harry Plattner, Christopher Meinel, Larry Leifer, Design Thinking, Springer |
| 4. | Jeane Liedtka, Solving Problems with Design Thinking, Columbia Uni. Press, 2013 |

| Course Name | Programme Elective – IV<br>Advanced Refrigeration and Air Conditioning | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME804_A | 3 | - | - |
| Prerequisite | 1. Heat Transfer<br>2. Fluid Mechanics<br>3. Applied Thermodynamics | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

**Course Outcomes: Students will be able to**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

| Unit/Module: 1 | Refrigerants | 3 hours | CO: 1 |
|---|---|---|---|

Classification of refrigerants, designation of refrigerants, desirable properties of refrigerants, environmental issues, selection of environment friendly refrigerants, alternative refrigerants

| Unit/Module: 2 | Vapor Refrigeration Cycles | 6 hours | CO: 2 |
|---|---|---|---|

Advanced vapor compression cycles – Trans critical cycle, Ejector refrigeration cycle

Vapor absorption systems- Aqua ammonia system, Electrolux refrigerator

| Unit/Module: 3 | Air Conditioning Load Estimation | 15 hours | CO: 3 |
|---|---|---|---|

Refrigeration and Air Conditioning System Components: –
Compressors- Reciprocating, centrifugal, screw, scroll, inverter based
Evaporators
Condensers- Shell and Tube type , evaporative condenser
Expansion Devices- Capillary tube, Thermostatic Expansion valve, Electronic Expansion valve

Cooling Towers
Air cooling v/s Air Conditioning, Review of psychrometric processes, Thermodynamic of human body
Factors impacting heating/cooling load
Concept of infiltration, ventilation, indoor air quality requirements, solar radiation
Cooling Load Temperature Difference method
Overview of energy codes – ECBC, Eco Niwas Samhita, IECC
Overview of Energy Simulation Softwares

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Advanced Air Conditioning systems** | **6 hours** | **CO: 4** |
| Desiccant air conditioning systems, evaporative cooling, thermal energy storage air conditioning systems, radiant cooling heat pump systems, Under floor air delivery systems<br><br>Selection Criteria | | | |
| **Unit/Module: 5** | **Air Distribution System** | **6 hours** | **CO: 5** |
| Ducts - Air flow through simple duct system. Pressure losses in duct<br>Method of duct system design- equal friction, velocity reduction method, static regain method<br>Air handling unit- Fan coil unit, filters, supply and return grills | | | |
| **Unit/Module: 6** | **Building Energy Efficiency** | **3 hours** | **CO:6** |
| Introduction to high performance buildings, building controls and building management system, commissioning and audits of building systems, Green building rating systems | | | |
| | **Total course hours:** | **hours** | **39** |

**Text Books:**

| | |
|---|---|
| 1. | Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill |
| 2. | Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd |
| 3. | McQuiston, Heating Ventilating and air Conditioning: Analysis and Design, Wiley India |
| 4. | Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpat Rai & Company, New Delhi |
| 5. | ASHRAE Handbooks |
| 6 | Threlkeld J.L., Thermal Environmental Engineering, Prentice Hall Inc. New Delhi |
| 7 | Shan Wang, Handbook of Refrigeration and Air Conditioning, McGraw Hill Publications |

| Course Name | Programme Elective – IV<br>Advanced Solid Mechanics | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME804_B | 3 | 0 | 0 |
| Pre-requisites | Basics of Engineering Mechanics and Strength of Materials | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

**Course Outcomes : Students will be able to**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

| Unit :1 | Mathematical Preliminaries: | 7 hours | CO: 1 |
|---|---|---|---|

Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor.

| Unit : 2 | Analysis of Stress and Strain: | 8 hours | CO: 2 |
|---|---|---|---|

Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity.

| Unit : 3 | Problem formulation and solution strategies: | 7 hours | CO: 3 |
|---|---|---|---|
| Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lame-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. | | | |
| **Unit : 4** | **Two-dimensional problems:** | **7 hours** | **CO: 4** |
| Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. | | | |
| **Unit : 5** | **Applications:** | **7 hours** | **CO: 5** |
| Torsion of noncircular shafts: Warping and Prandtl stress function, Torsion analysis of circular, elliptical, and rectangular cylinder using Warping and Prandtl function, Membrane analogy, Photo elasticity, Plates and shells – Fundamental equations, Kirchhoff's theory, axisymmetric bending of circular plates, membrane theory of shells of revolutions. | | | |
| | **Total Theory Lecture hours:** | **35 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Elasticity, Theory, Applications, and Numerics by Martin H. Sadd |
| 2. | Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier |
| 3. | Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications. |

**Reference Books:**

| | |
|---|---|
| 1. | Continuum Mechanics, A.J.M Spencer, Dover Publications, INC |
| 2 | Advanced Mechanics of Materials by H. Ford and J. M. Alexander |
| 3 | The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science+Business Media, LLC |

| Course Name | Programme Elective – IV<br>Optimization Techniques | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME804 C | 3 | - | - |
| Prerequisite | Engineering Mathematics | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives:**

1 To introduce to the students optimization problems and various solution techniques ,

2 To impart knowledge of various classical and modern optimization techniques

3 To make students aware about industrial optimization problems

4 To expose students to numerical techniques to solve optimization problems

**Course Outcomes:** Upon completion of this course, the student will be able to:

1 formulate objective functions and constraint equations for a given classical problem,

2 apply classical and modern method of optimization to standard problems

3 solve realistic and industrial design problems

4 use computational tools such as MATLAB/OCTAVE to get solutions

| Unit/Module: 1 | Introduction to Optimization | 4 hours | CO: 1 |
|---|---|---|---|

Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Graphical Optimization Techniques.

| Unit/Module: 2 | Classical Optimization Techniques | 6 hours | CO: 2 |
|---|---|---|---|

Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints: Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification, Convex Programming Problems.

| Unit/Module: 3 | Linear Programming: Simplex Method | 4 hours | CO: 3 |
|---|---|---|---|

Applications of Linear Programming,Standard Form of a Linear Programming Problem, Simplex Algorithm, Two Phases of the Simplex Method

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Nonlinear Programming** | **6 hours** | **CO: 4** |
| Introduction, Unrestricted Search, Interval Halving Method, Golden Section Method, Quadratic Interpolation Method, Newton's Method, Practical Considerations | | | |
| **Unit/Module: 5** | **Intro to Special Optimization Methods** | **6 hours** | **CO: 5** |
| Dynamic Programming, Optimal Control | | | |
| **Unit/Module: 6** | **Modern Methods of Optimization** | **6 hours** | **CO: 6** |
| Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Neural-Network-Based Optimization, Practical Aspects of Optimization | | | |
| | **Total Lab hours:** | **32 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Engineering Optimization -Theory and Practice/ Singerusu S. Rao/ New Age. |
| 2. | Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons |
| 3. | Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Hall of India |

| **Course Name** | **Programme Elective – II Lab**<br>**Mechanics of Composite Material Lab** | **L** | **T** | **P** |
|---|---|---|---|---|
| **Course Code** | **20PEME802L_A** | **-** | **-** | **2** |
| **Pre-requisite** | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives:**

**To make students**

1. Micro and macro mechanical analysis of the composite material at lamina level
2. Analyze the laminated composite material at macro level
3. Manufacture the unidirectional laminated composite material
4. Test composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
2. Analyze laminated composites using classical lamination theory
3. Fabricate the unidirectional composite laminate using compression molding process
4. Test and evaluate mechanical properties of polymer composites as per ASTM standards

**Lab Work:**

1. Develop a program for micro mechanical analysis of composite lamina
2. Develop a program for macro mechanical analysis of composite lamina and laminate
3. Develop a program for failure analysis of composite laminate using different failure theories.
4. Manufacturing of unidirectional and multidirectional fiber reinforced polymer matrix composites
5. Tensile testing of composite lamina to find out tensile strength and tensile modulus
6. Flexural testing of composite lamina to find out flexural strength and flexural modulus
7. Izod/Charpy impact test of composite lamina to find out impact strength

**Text Books:**

1. P K Mallik, "Fibrer Reinforced Composites: Materials, Manufacturing and Design", CRC Press, Taylor & Francis Group, Third Edition 2015.

| Course Name | **Programme Elective – II Lab**<br>**Computational Fluid Dynamics Lab** | L | T | P |
|---|---|---|---|---|
| **Course Code** | **20PEME802 L_B** | - | - | 2 |
| **Prerequisites** | Fluid Dynamics, HT, CFD | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: Introduce students to**

1. To develop simple FVM codes
2. To set up and solve fluid flow and HT problems with CFD tools
3. To carry out simulations of real life CFD problems

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Develop simple FVM codes
2. Use CFD tools
3. Simulate CFD problems and postprocess the results.
4. Interpret CFD results and draw scientific conclusions

**Lab Work:**

1. Finite Volume Method code for two-dimensional conduction problem.
2. FVM code for convection problem.
3. Demonstration and study of NSE Solver
4. Lid driven cavity problem using Ansys Fluent
5. Flow through a channel: Fluent tutorial
6. Flow over airfoil: Fluent tutorial
7. 2-D heat transfer problems in Fluent
8. Simple turbulent flow simulations in Fluent

**Text Books/References:**

| | |
|---|---|
| 1. | ANSYS user guide https://www.ansys.com/academic/learning-resources |

| Course Name | Programme Elective – II Lab<br>Finite Element Method Lab | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME802L_C | - | - | 2 |
| Pre-requisite | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem in FEM
4. To evaluate natural frequency through dynamic analysis of mechanical component

**Course Outcomes:** After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply beam and rigid frame element stiffness matrices and load vectors to solve for displacements and stresses.
3. Derive and apply isoparametric formulation of element stiffness matrices and load vectors to solve plane stress problems for displacements and stresses.
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution

**Lab Work:**

1. A computer program for stress analysis of beam using linear and quadratic elements
2. A computer program for stress analysis of rigid frame using FEM formulation
3. A computer program for stress analysis of plane stress using the isoparametric formulation
4. A computer program for 1-D temperature analysis for heat transfer problem
5. Static stress concentration factor calculation for a plate with center hole using FEA software
6. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
7. Modal analysis of any machine component using FEA software.
8. Temperature distribution analysis of Steady-state heat transfer problem using FEA software

**Text Books/References:**

1. Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition
2. ANSYS user guide https://www.ansys.com/academic/learning-resources

**Autonomous Program Structure of**
**Final Year B. Tech. Eight Semester**
**(Mechanical Engineering)**
**Academic Year: 2023-2024 onwards**

| Course Code | Course Title | Teaching Scheme Hrs /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Practical | Oral | | |
| 20PEME801 | Programme Elective – I* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802 | Programme Elective - II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME803 | Programme Elective -III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME804 | Programme Elective -IV | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE801 | Open Elective III** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE802 | Open Elective IV*** | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEME802L | Programme Elective – II Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **18** | **0** | **2** | **325** | **300** | **0** | **25** | **650** | **19** |
| | **Grand Total** | **20** | | | **625** | | **25** | | | |

*NPTEL / Swayam Course, **Open Elective-III: Department Level Course,***Open Elective-IV: Multi-disciplinary Course.

| |
|---|
| **20PEME802 Programme Elective – II**<br>**20PEME802L Programme Elective – II Lab**<br>A. Mechanics of Composite Materials<br>B. Computational Fluid Dynamics<br>C. Finite Element Method |
| **20PEME803 Programme Elective - III**<br>A. Industrial Internet of Things<br>B. Product Design and Development<br>C. Data Science for Mechanical Engineering<br>D. Design Thinking for Innovations |
| **20PEME804 Programme Elective - IV**<br>A. Advanced Refrigeration and Air Conditioning<br>B. Advance Solid Mechanics<br>C. Optimization Techniques |

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

## Final Year B. Tech. -- Semester-II

| **Course Name** | **Programme Elective – II**<br>**Mechanics of Composite Material** | **L** | **T** | **P** |
|---|---|---|---|---|
| **Course Code** | **20PEME802 A** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives: To make students**

1. Understand a perspective utilization and processing of composite materials
2. Micro and macro mechanical analysis of the composite material at lamina level
3. Analyze the laminated composite material at macro level
4. Understand testing methods of composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Define need, utilization of class of composite material, its constitution and list its application fields
2. Demonstrate the various fabrication process of composite materials
3. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
4. Analyze laminated composites using classical lamination theory
5. Express testing method of evaluation of mechanical properties of polymer composites as per ASTM standard

| **Unit/Module: 1** | **Introduction to composite** | **6 hours** | **CO: 1** |
|---|---|---|---|

Introduction to advanced materials and types, Definition, General Characteristics, Applications, Fibers, Types of fibers, Mechanical Properties of fibers; Matrix, Types of matrix, Polymer Matrix- Thermoset and Thermoplastic, Fillers/Additives/Modifiers of Fiber Reinforced Composites

| **Unit/Module: 2** | **Manufacturing of composites** | **6 hours** | **CO: 2** |
|---|---|---|---|

fabrication process for thermoset and thermoplastic PMC, open mould process as hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, and Closed mould process as pultrusion, performing, thermo-forming, injection molding, blow molding, Process parameters.

| **Unit/Module: 3** | **Elastic and strength Behaviour of Lamina** | **9 hours** | **CO: 3** |
|---|---|---|---|

**Micromechanical Analysis of Lamina**: Introduction, Volume and mass fraction, density, void content, evaluation of elastic moduli, ultimate strength of unidirectional lamina

**Macro-mechanical Analysis of Lamina**: Review and definition of stress, strain and Elastic Moduli, Hooke's Law for different types of materials, Hook's law for 2D unidirectional and angular lamina, engineering constants of an angle lamina, Strength failure theories of an angle lamina

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Elastic Behavior of Laminate** | **9 hours** | **CO: 4** |
| Introduction to Laminate Code, Strain-displacement relations, Stress-strain relation for a laminate, force and moment resultants related to mid plane strains and curvatures, In-Plane engineering constants of a laminate, Flexural engineering constants of a laminate | | | |
| **Unit/Module: 5** | **Testing of Composites** | **6 hours** | **CO: 5** |
| Societies for Testing Standards, Background to Mechanical Testing of Composites, Test Method and analysis of Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Inter-laminar Shear Strength properties, Impact Properties. | | | |
| | **Total Lab hours:** | **36 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, Taylor & Francis Group, 2012. |
| **Reference Books:** | |
| 1. | Robert M. Jones, "Mechanics of Composite Materials" 2nd Edition, CRC Press 1998 |
| 2. | Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 2010 |
| 3. | Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004. |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II**<br>**Computational Fluid Dynamics** | **L** | **T** | **P** |
| **Course Code** | **PEME802 B** | **3** | **-** | **-** |
| **Prerequisites** | Fluid dynamics, Heat transfer, Numerical methods | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: To make students**

1. Finite volume method (FVM) of discretization for differential equations ,
2. Development of solution of discretized equations using various methods,
3. CFD tools to solve practical problems
4. Interpret CFD results of complex problems

**Course Outcomes: Students will be able to**

1. Discretize a given differential equation with FVM,
2. Write a simple codes for diffusion and convection problems,
3. Solve fluid flow and heat transfer problems with CFD tools
4. Apply CFD techniques to real life industrial problems.

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | **Introduction to CFD** | **4 hours** | **CO: 1** |

What is CFD, Advantages of CFD, Applications: as a design and analysis tool, applications in aerospace, applications in automobile and EV, applications in bioscience etc.

| | | | |
|---|---|---|---|
| **Unit/Module: 2** | **CFD Fundamentals** | **6 hours** | **CO: 2** |

Governing differential equations of fluid dynamics and heat transfer, RTT, continuity equation, Navier Stokes equations and energy equation, RANS, different types of boundary conditions.

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **CFD Procedure** | **8 hours** | **CO: 3** |

Finite volume method, discretization of conduction and convection equations, various convective schemes, discretization of momentum equations, pressure velocity coupling, SIMPLE algorithm.

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **CFD Mesh Generation** | **6 hours** | **CO: 4** |

Types of meshes, structuared, body-fitted and unstructured meshes, mesh refinement, moving meshes, mesh quality.

| | | | |
|---|---|---|---|
| **Unit/Module: 5** | **CFD Solution and Postprocessing** | **6 hours** | **CO: 5** |

Convergence, residual and tolerance, consistency and stability, accuracy, sources of errors in solution, mesh independence study, verification and validation.

| | | | |
|---|---|---|---|
| **Unit/Module: 6** | **Applications with Examples** | **4 hours** | **CO: 6** |
| Lid driven cavity, pipe flow, flow over bends, heat transfer coupled with fluid flow, turbulent flow through a channel, flow over an aerofoil etc. | | | |
| | **Total Lab hours:** | **34 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Jiyuan Tu, Guan-Heng Yeho and Chaoqun Liu, Fluid Dynamics: A Practical Approach, Elsevier. |
| 2. | S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill. |
| 3. | John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis |
| 4. | Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education. |
| 5. | 4. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995. |
| 6. | Ansys Fluent User's Guide, Ansys Inc. |

| Course Name | **Programme Elective – II**<br>**Finite Element Method** | **L** | **T** | **P** |
|---|---|---|---|---|
| **Course Code** | **20PEME802 C** | **3** | **-** | **-** |
| **Pre-requisite** | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

**To make students**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem using FEM
4. To evaluate dynamic analysis problem using FEM

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply element stiffness matrices and load vectors to solve beam and rigid frame problems
3. Derive and apply isoparametric elements and numerical integration to solve plane stress problems
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution
5. Evaluate dynamic analysis of beam using FEM formulation

| **Unit/Module: 1** | **Introduction to Finite Element Method** | **6 hours** | **CO: 1** |
|---|---|---|---|

General description and engineering applications of finite element method, Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems.
Different approaches: Potential energy method, Rayleigh-Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process.
Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes.
Types of Analysis: Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis.

| **Unit/Module: 2** | **Analysis of Beams and Rigid Frames** | **8 hours** | **CO: 2** |
|---|---|---|---|

Introduction, Beam Analysis Using two Noded Elements, Analysis of Rigid Plane Frame Using 2 Noded Beam Elements, Timoshenko Beam Element: Formulation, element stiffness matrix, assemblage stiffness matrix and solve for static load

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Analysis of Plane stress with isoparametric elements and numerical integration** | **8 hours** | **CO: 3** |
| Concept of isoperimetric elements, Terms isoperimetric, super parametric, and sub parametric.<br>Coordinate mapping: Natural coordinates, Area coordinates (for triangular elements), higher-order triangular and quadrilateral elements, geometry associative mesh, quality checks, mesh refinement- p vs h refinements, Uniqueness of mapping – Jacobian matrix.<br>Numerical integration: Gauss Quadrature in one and two dimensions, Order of Gauss integration, full and reduced integration, sub-modelling, sub structuring. | | | |
| **Unit/Module: 4** | **Steady-State Heat Transfer** | **6 hours** | **CO: 4** |
| Introduction, One-dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin fin, essential and natural boundary conditions and solving for temperature distribution | | | |
| **Unit/Module: 5** | **Dynamic Analysis** | **8 hours** | **CO: 5** |
| Types of dynamic analysis, general dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.<br>Undamped-free vibration: Eigenvalue problem, evaluation of eigenvalues and eigenvectors. | | | |
| | **Total hours:** | **36 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Daryl Logan, First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd. |
| 2. | S.S. Bhavikatti, Finite Element Analysis, New Age International (P) Ltd, 2005 |
| **Reference Books:** | |
| 1. | R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India |
| 2. | Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005. |
| 3. | G Lakshmi Narasaiah, Finite Element Analysis, BS Publications, 2008. |
| 4. | Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002. |
| 5. | P., Seshu, Textbook of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010. |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – III**<br>**Industrial Internet of Things** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 A** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Understand protocol, prototype of IoT based smart system
2. Understand Automatic Storage Management.
3. Understand Internet of Things-Ethics and Governance.
4. Understand Smart Manufacturing techniques, smart design, and fabrication Smart application.

**Course Outcomes:**

**Students will be able to**

After successful completion of the course, student will be able to

1. Apply protocol and prototype concepts for IIOT.
2. Justify the role of Automatic storage Management in IIOT
3. Follow ethical practices while developing IIOT applications
4. Design Smart manufacturing and Fabrication applications.

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | **The Internet of Things, Thinking about Prototyping, Prototyping Embedded devices** | **6 hours** | **CO: 1** |

1**The Internet of Things**: **Protocols and Prototyping, Prototyping Embedded devices** An overview; Design Principles for Connected Devices, Internet Principles– Electronics, Embedded Computing Basics, Arduino/Raspberry Pi/ BeagleBone Black/ etc. Prototyping online Components – Getting Started with an API, Writing a New API(Application programming interface)

| | | | |
|---|---|---|---|
| **Unit/Module: 2** | **Automatic Storage Management** | **6 hours** | **CO: 2** |

**Real Time Reactions and Automatic Storage Management**, Other Protocols. Techniques for Writing Embedded Code – Memory Management, Performance. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud.Smart Connected System Design Case Study.

| | | | |
|---|---|---|---|
| **Unit/Module: 3** | **Internet of Things-Ethics, Privacy, Security and Governance** | **4 hours** | **CO: 3** |

Introduction, Ethics Overview of Governance, Privacy and Security Issues,

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Introduction to Smart Manufacturing** | **8 hours** | **CO: 4** |

Smart manufacturing, Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise

<table>
<tr><td colspan="5">operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG)</td></tr>
<tr><td colspan="2">Unit/Module: 5</td><td>Smart Design/Fabrication, Smart Applications, Tools for IIOT</td><td>8 hours</td><td>CO: 4</td></tr>
<tr><td colspan="5">Smart Design/Fabrication - Digital Tools, Manufacturing Systems and Standards.<br>Smart Applications Case study</td></tr>
<tr><td colspan="2"></td><td>Total Lab hours:</td><td>32 hours</td><td></td></tr>
<tr><td colspan="5">Text Books:</td></tr>
<tr><td>1.</td><td colspan="4">Designing the Internet of Things by Adrian McEwen and Hakim Cassimally</td></tr>
<tr><td>2.</td><td colspan="4">Getting Started with the Internet of Things: Connecting<br>Sensors and Microcontrollers to the Cloud by Cuno Pfister</td></tr>
<tr><td>3.</td><td colspan="4">Foundational Elements of an IOT Solution - The Edge, Cloud and Application Development, Joe Biron& Jonathan Follett, Oreilly, First Edition, March 2016</td></tr>
<tr><td>4.</td><td colspan="4">The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition, 2016, Lucas Darnell</td></tr>
<tr><td>5</td><td colspan="4">Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland</td></tr>
<tr><td>6</td><td colspan="4">Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014. (ISBN: 978-8173719547)</td></tr>
</table>

| Course Name | Programme Elective – III<br>Product Design and Development | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME803 B | 3 | - | - |
| Pre-requisite | Manufacturing Processes, Industrial Inspection, Quality Control, Machin Design | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives:**

**Course prepares students to**

1. Understand to Product Design Process and Product Policy.
2. Learn the fundamental of Product Design Morphology Tools.
3. Understand Design for Manufacturing and Assembly.
4. Learn Design for Environment, Quality and IPR.

**Course Outcomes:**

**Students will be able to**

1. Analyse to identify different phases of product design and Product life-cycle,
2. Apply product design morphology tools to analyse requirements/functionality,
3. Apply techniques of Design for Manufacturing and Assembly for product design,
4. Identify factors while designing for Environment w.r.to manufacturing reusability, standards

| Unit/Module: 1 | Introduction to Product Design Process and Product Policy | 6 hours | CO: 1 |
|---|---|---|---|

- Introduction to product design: Product design process, Product life-cycle,
- Product policy of an organization. Selection of a Profitable product, Product design process, Product analysis,
- System engineering in product design: Boundary Diagram and P-Diagram.

| Unit/Module: 2 | Product Design Morphology Tools | 6 hours | CO: 1 |
|---|---|---|---|

- Problem identification and selection, Product Characteristics, KJ Model, DFMEA,
- Analysis of functions, and Anatomy of function: Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST),
- Visual Design, and Quality Function Deployment (QFD),
- Value engineering in product design; Advantages, Applications in product design,
- Ergonomics in product design, Case studies.

| Unit/Module: 3 | Material and Manufacturing Process Selection | 8 hours | CO: 2 |
|---|---|---|---|

- DFX and DFMA during product design: Advantages and case studies,
- Classification and Selection: Introduction to Manufacturing processes,
- Introduction to selection of Manufacturing processes and materials for product design.

| **Unit/Module: 4** | **Product Design for Assembly and Maintenance** | **6 hours** | **CO: 3** |
|---|---|---|---|

- Design for Assembly: The assembly process, Characteristics and applications, General taxonomies of assembly operation and systems, Examples of common assemblies;
- DFA for design consideration and design recommendation for Part Handling- Insertion, Fasteners [e.g. for manual assembly, high-speed automatic assembly and robot assembly],
- DFA analysis (evaluating assembly): Assembly Metrics, DFA index, Example of worksheet.

| **Unit/Module: 5** | **Product Design for Manufacturing** | **5 hours** | **CO: 3** |
|---|---|---|---|

- Design for Marching: Turning, Milling, Round-Holes Machining, Grinding etc.
- Design for Forming and Joining Processes: Design for Castings, Injection Molding, Forging, Sheet-metal stamping Welding Extrusion and Powder Metal Processing
- Product design for Rapid Prototyping:, Needs, Advantages, Working Principle

  [Process steps, typical characteristics and applications; Defects; Suitable materials; Dimensional factors and tolerances Design consideration and recommendations for selected process],

| **Unit/Module: 6** | **Design for Environment, Quality and IPR** | **3 hours** | **CO: 4** |
|---|---|---|---|

- Product design for Environment (w.r.to Standards / Norms),
- Product design for Quality Control (Inspection requirements w.r.to GD&T),
- Introduction to Reverse Engineering and Frugal Technology,
- Product design and IPR.

| | | | |
|---|---|---|---|
| | **Total Lecture hours:** | **36 hours** | |

**Text Books:**

| | |
|---|---|
| 4. | Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education |
| 5. | Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press. |
| 6. | Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520. |

**Reference Books:**

| | |
|---|---|
| 1. | G. Boothroyd, P. Dewhurst, W. A. Knight, Product Design for Manufacture and Assembly, CRC Press. |
| 2. | K. T. Ulrich and S. D. Eppinger, Product Design and Development, McGraw-Hill Higher Education. |
| 3. | Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill. |

| | |
|---|---|
| 4. | G E Dieter, Engineering Design - A Material Processing Approach, McGraw Hill. |
| 5. | B. R. Fischer, Mechanical Tolerance stackup and analysis, CRC Press. |

| | | | | |
|---|---|---|---|---|
| **Course Name** | **Programme Elective - III**<br>**Data Science for Mechanical Engineering** | **L** | **T** | **P** |
| **Course Code** | **20PEME803 C** | **3** | **-** | **-** |
| **Pre-requisite** | Engineering fundamentals and principles | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

**To make students**

1. Relevance of data science in mechanical engineering
2. Mathematics and statistical fundamentals for data science
3. Machine learning and AI software frameworks
4. Current trends in mechanical engineering using data science

**Course Outcomes:**

**Students will be able to**

1. Solve data driven problems
2. Use ML software frameworks
3. Apply reinforcement learning to robotic problems
4. Undertake research problem in mechanical engineering that involves data science concepts

| | | | |
|---|---|---|---|
| **Unit/Module: 1** | | **6 hours** | **CO: 1** |
| Mathematical and statistical foundations of data science | | | |
| **Unit/Module: 2** | | **4 hours** | **CO: 2** |
| Introduction to data science, machine learning, and Artificial Intelligence | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** |
| Foundations of Python programming for data science, numpy, pandas, OpenCV, matplotlib etc. | | | |
| **Unit/Module: 4** | | **8 hours** | **CO: 4** |
| Introduction to Neural Networks and Deep Learning: Theoretical concepts, ML frameworks such as Tensorflow, PyTorch | | | |
| **Unit/Module: 5** | | **6 hours** | **CO: 5** |
| Reinforcement learning: Applications of RL in Robotics, OpenAI Gym for RL environment | | | |
| **Unit/Module: 6** | | **4 hours** | **CO: 6** |
| Applications and case studies: Recent research in solid mechanics, fluid dynamics and robotics in | | | |

| | | | |
|---|---|---|---|
| context of data science | | | |
| | **Total Lab hours:** | **32 hours** | |

| | |
|---|---|
| **Text Books:** | |
| 1. | Andreas Müller, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Relly Media |
| 2. | Laura Igual, Introduction to Data Science, Springer |
| 3. | Gareth James, Introduction to Statistical learning, Springer, 2017 |
| 4. | www.tensorflow.org, www.pytorch.org, www.openai.com, www.python.org |

| Course Name | Programme Elective - III<br>Design Thinking for Innovations | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME803 D | 3 | - | - |
| Pre-requisite | Engineering fundamentals and principles | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Principles of innovative mindset
2. Methods and techniques to define customer needs
3. Generate a pool of ideas and solutions
4. Seek solutions to real life problems though innovations

**Course Outcomes: Students will be able to**

1. Identify needs and problems for innovations
2. Create ideas and find alternate solutions
3. Implement ideas and create prototypes
4. Apply design thinking principle to real life problems

| Unit/Module | Title | Hours | CO |
|---|---|---|---|
| **Unit/Module: 1** | **Principles of design thinking** | **4 hours** | **CO: 1** |
| Empathise, define, ideate, prototype and test | | | |
| **Unit/Module: 2** | | **6 hours** | **CO: 2** |
| Need identification and problem definition | | | |
| **Unit/Module: 3** | | **6 hours** | **CO: 3** |
| Ideation and brainstorming | | | |
| **Unit/Module: 4** | | **4 hours** | **CO: 4** |
| Implementation, Prototyping and testing of ideas | | | |
| **Unit/Module: 5** | | **4 hours** | **CO: 5** |
| Applications and examples of Design Thinking | | | |
| **Unit/Module: 6** | **Design Thinking case studies** | **6 hours** | **CO: 6** |
| business, manufacturing, service industries and public services. | | | |
| | **Total Lab hours:** | **30 hours** | |

| **Text Books:** | |
|---|---|
| 1. | Christian Muller-Rotenberg, Design Thinking for Dummies, Wiley 2020 |
| 2. | Design Thinking Toolkit, Ideo.org |
| 3. | Harry Plattner, Christopher Meinel, Larry Leifer, Design Thinking, Springer |
| 4. | Jeane Liedtka, Solving Problems with Design Thinking, Columbia Uni. Press, 2013 |

| Course Name | Programme Elective – IV<br>Advanced Refrigeration and Air Conditioning | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME804_A | 3 | - | - |
| Prerequisite | 1. Heat Transfer<br>2. Fluid Mechanics<br>3. Applied Thermodynamics | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

**Course Outcomes: Students will be able to**

1. Select appropriate refrigerant for the given application analyze refrigeration cycles and understand heat driven refrigeration systems
2. Analyze refrigeration cycles and understand heat driven refrigeration systems.
3. Estimate cooling load for air conditioning systems.
4. Analyze various air conditioning systems.
5. Analyze duct systems for air distribution.
6. Appraise energy performance of the buildings

| Unit/Module: 1 | Refrigerants | 3 hours | CO: 1 |
|---|---|---|---|

Classification of refrigerants, designation of refrigerants, desirable properties of refrigerants, environmental issues, selection of environment friendly refrigerants, alternative refrigerants

| Unit/Module: 2 | Vapor Refrigeration Cycles | 6 hours | CO: 2 |
|---|---|---|---|

Advanced vapor compression cycles – Trans critical cycle, Ejector refrigeration cycle

Vapor absorption systems- Aqua ammonia system, Electrolux refrigerator

| Unit/Module: 3 | Air Conditioning Load Estimation | 15 hours | CO: 3 |
|---|---|---|---|

Refrigeration and Air Conditioning System Components: –
Compressors- Reciprocating, centrifugal, screw, scroll, inverter based
Evaporators
Condensers- Shell and Tube type , evaporative condenser
Expansion Devices- Capillary tube, Thermostatic Expansion valve, Electronic Expansion valve

Cooling Towers
Air cooling v/s Air Conditioning, Review of psychrometric processes, Thermodynamic of human body
Factors impacting heating/cooling load
Concept of infiltration, ventilation, indoor air quality requirements, solar radiation
Cooling Load Temperature Difference method
Overview of energy codes – ECBC, Eco Niwas Samhita, IECC
Overview of Energy Simulation Softwares

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Advanced Air Conditioning systems** | **6 hours** | **CO: 4** |
| Desiccant air conditioning systems, evaporative cooling, thermal energy storage air conditioning systems, radiant cooling heat pump systems, Under floor air delivery systems<br><br>Selection Criteria | | | |
| **Unit/Module: 5** | **Air Distribution System** | **6 hours** | **CO: 5** |
| Ducts - Air flow through simple duct system. Pressure losses in duct<br>Method of duct system design- equal friction, velocity reduction method, static regain method<br>Air handling unit- Fan coil unit, filters, supply and return grills | | | |
| **Unit/Module: 6** | **Building Energy Efficiency** | **3 hours** | **CO:6** |
| Introduction to high performance buildings, building controls and building management system, commissioning and audits of building systems, Green building rating systems | | | |
| | **Total course hours:** | **hours** | **39** |

**Text Books:**

| | |
|---|---|
| 1. | Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill |
| 2. | Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd |
| 3. | McQuiston, Heating Ventilating and air Conditioning: Analysis and Design, Wiley India |
| 4. | Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpat Rai & Company, New Delhi |
| 5. | ASHRAE Handbooks |
| 6 | Threlkeld J.L., Thermal Environmental Engineering, Prentice Hall Inc. New Delhi |
| 7 | Shan Wang, Handbook of Refrigeration and Air Conditioning, McGraw Hill Publications |

| Course Name | Programme Elective – IV<br>Advanced Solid Mechanics | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME804_B | 3 | 0 | 0 |
| Pre-requisites | Basics of Engineering Mechanics and Strength of Materials | Syllabus Version | | |
| | | V:1.1 | | |

**Course Objectives: To make students**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

**Course Outcomes : Students will be able to**

1. Understand the concept of tensor.
2. Analyse advanced concept of stress and strain in structural problems.
3. Apply the concept of different elastic functions to solve complex problems.
4. Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.
5. Implement advanced concept of solid mechanics in torsion, plates and shells

| Unit :1 | Mathematical Preliminaries: | 7 hours | CO: 1 |
|---|---|---|---|

Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor.

| Unit : 2 | Analysis of Stress and Strain: | 8 hours | CO: 2 |
|---|---|---|---|

Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity.

| Unit : 3 | Problem formulation and solution strategies: | 7 hours | CO: 3 |
|---|---|---|---|
| Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lame-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. | | | |
| **Unit : 4** | **Two-dimensional problems:** | **7 hours** | **CO: 4** |
| Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. | | | |
| **Unit : 5** | **Applications:** | **7 hours** | **CO: 5** |
| Torsion of noncircular shafts: Warping and Prandtl stress function, Torsion analysis of circular, elliptical, and rectangular cylinder using Warping and Prandtl function, Membrane analogy, Photo elasticity, Plates and shells – Fundamental equations, Kirchhoff's theory, axisymmetric bending of circular plates, membrane theory of shells of revolutions. | | | |
| | **Total Theory Lecture hours:** | **35 hours** | |

**Text Books:**

| | |
|---|---|
| 1. | Elasticity, Theory, Applications, and Numerics by Martin H. Sadd |
| 2. | Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier |
| 3. | Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications. |

**Reference Books:**

| | |
|---|---|
| 1. | Continuum Mechanics, A.J.M Spencer, Dover Publications, INC |
| 2 | Advanced Mechanics of Materials by H. Ford and J. M. Alexander |
| 3 | The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science+Business Media, LLC |

| Course Name | **Programme Elective – IV Optimization Techniques** | **L** | **T** | **P** |
|---|---|---|---|---|
| **Course Code** | **20PEME804 C** | **3** | **-** | **-** |
| **Prerequisite** | Engineering Mathematics | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives:**

1 To introduce to the students optimization problems and various solution techniques ,

2 To impart knowledge of various classical and modern optimization techniques

3 To make students aware about industrial optimization problems

4 To expose students to numerical techniques to solve optimization problems

**Course Outcomes:** Upon completion of this course, the student will be able to:

1 formulate objective functions and constraint equations for a given classical problem,

2 apply classical and modern method of optimization to standard problems

3 solve realistic and industrial design problems

4 use computational tools such as MATLAB/OCTAVE to get solutions

| **Unit/Module: 1** | **Introduction to Optimization** | **4 hours** | **CO: 1** |
|---|---|---|---|

Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Graphical Optimization Techniques.

| **Unit/Module: 2** | **Classical Optimization Techniques** | **6 hours** | **CO: 2** |
|---|---|---|---|

Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints: Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification, Convex Programming Problems.

| **Unit/Module: 3** | **Linear Programming: Simplex Method** | **4 hours** | **CO: 3** |
|---|---|---|---|

Applications of Linear Programming,Standard Form of a Linear Programming Problem, Simplex Algorithm, Two Phases of the Simplex Method

| | | | |
|---|---|---|---|
| **Unit/Module: 4** | **Nonlinear Programming** | **6 hours** | **CO: 4** |
| Introduction, Unrestricted Search, Interval Halving Method, Golden Section Method, Quadratic Interpolation Method, Newton's Method, Practical Considerations | | | |
| **Unit/Module: 5** | **Intro to Special Optimization Methods** | **6 hours** | **CO: 5** |
| Dynamic Programming, Optimal Control | | | |
| **Unit/Module: 6** | **Modern Methods of Optimization** | **6 hours** | **CO: 6** |
| Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Neural-Network-Based Optimization, Practical Aspects of Optimization | | | |
| | **Total Lab hours:** | **32 hours** | |

| **Text Books:** | |
|---|---|
| 1. | Engineering Optimization -Theory and Practice/ Singerusu S. Rao/ New Age. |
| 2. | Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons |
| 3. | Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Hall of India |

| | | L | T | P |
|---|---|---|---|---|
| **Course Name** | **Programme Elective – II Lab**<br>**Mechanics of Composite Material Lab** | **L** | **T** | **P** |
| **Course Code** | **20PEME802L_A** | **-** | **-** | **2** |
| **Pre-requisite** | Engineering Mechanics, Strength of Materials, Engineering Metallurgy | | | |

**Course Objectives:**

**To make students**

1. Micro and macro mechanical analysis of the composite material at lamina level
2. Analyze the laminated composite material at macro level
3. Manufacture the unidirectional laminated composite material
4. Test composite materials to evaluate mechanical properties

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Analyze lamina at micro-mechanical and macro-mechanical level of polymer matrix composites
2. Analyze laminated composites using classical lamination theory
3. Fabricate the unidirectional composite laminate using compression molding process
4. Test and evaluate mechanical properties of polymer composites as per ASTM standards

**Lab Work:**

1. Develop a program for micro mechanical analysis of composite lamina
2. Develop a program for macro mechanical analysis of composite lamina and laminate
3. Develop a program for failure analysis of composite laminate using different failure theories.
4. Manufacturing of unidirectional and multidirectional fiber reinforced polymer matrix composites
5. Tensile testing of composite lamina to find out tensile strength and tensile modulus
6. Flexural testing of composite lamina to find out flexural strength and flexural modulus
7. Izod/Charpy impact test of composite lamina to find out impact strength

**Text Books:**

1. P K Mallik, "Fibrer Reinforced Composites: Materials, Manufacturing and Design", CRC Press, Taylor & Francis Group, Third Edition 2015.

| Course Name | Programme Elective – II Lab<br>Computational Fluid Dynamics Lab | L | T | P |
|---|---|---|---|---|
| **Course Code** | **20PEME802 L_B** | - | - | 2 |
| **Prerequisites** | Fluid Dynamics, HT, CFD | **Syllabus Version** | | |
| | | **V:1.1** | | |

**Course Objectives: Introduce students to**

1. To develop simple FVM codes
2. To set up and solve fluid flow and HT problems with CFD tools
3. To carry out simulations of real life CFD problems

**Course Outcomes:**

After successful completion of the course, students will be able to

1. Develop simple FVM codes
2. Use CFD tools
3. Simulate CFD problems and postprocess the results.
4. Interpret CFD results and draw scientific conclusions

**Lab Work:**

1. Finite Volume Method code for two-dimensional conduction problem.
2. FVM code for convection problem.
3. Demonstration and study of NSE Solver
4. Lid driven cavity problem using Ansys Fluent
5. Flow through a channel: Fluent tutorial
6. Flow over airfoil: Fluent tutorial
7. 2-D heat transfer problems in Fluent
8. Simple turbulent flow simulations in Fluent

**Text Books/References:**

1. ANSYS user guide https://www.ansys.com/academic/learning-resources

| Course Name | Programme Elective – II Lab<br>Finite Element Method Lab | L | T | P |
|---|---|---|---|---|
| Course Code | 20PEME802L_C | - | - | 2 |
| Pre-requisite | Strength of Materials, Engineering Metallurgy, Heat Transfer | | | |

**Course Objectives:**

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics problems
2. To familiarize students with finite element method for displacement and stress analysis of 1D and 2D problems
3. To evaluate temperature distribution of heat transfer problem in FEM
4. To evaluate natural frequency through dynamic analysis of mechanical component

**Course Outcomes:** After successful completion of the course, students will be able to

1. Understand the different FEM techniques used to solve mechanical engineering problems.
2. Derive and apply beam and rigid frame element stiffness matrices and load vectors to solve for displacements and stresses.
3. Derive and apply isoparametric formulation of element stiffness matrices and load vectors to solve plane stress problems for displacements and stresses.
4. Apply 1D heat transfer FEM formulation to solve for temperature distribution

**Lab Work:**

1. A computer program for stress analysis of beam using linear and quadratic elements
2. A computer program for stress analysis of rigid frame using FEM formulation
3. A computer program for stress analysis of plane stress using the isoparametric formulation
4. A computer program for 1-D temperature analysis for heat transfer problem
5. Static stress concentration factor calculation for a plate with center hole using FEA software
6. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
7. Modal analysis of any machine component using FEA software.
8. Temperature distribution analysis of Steady-state heat transfer problem using FEA software

**Text Books/References:**


| | |
|---|---|
| 1. | Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition |
| 2. | ANSYS user guide https://www.ansys.com/academic/learning-resources |

**Autonomous Program Structure of**
**Third and Final Year B. Tech.**
**Academic Year: 2022-2023 Onwards**

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Oral | Practical | | |
| 20OEHS 501 | Open HS Elective –I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 601 | Open Elective-II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 801 | Open Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 802 | Open Elective-IV* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |

* **Inter-disciplinary Course**

20OEHS 501 Open Elective I (Humanities)

| **Sr. No.** | **Course Code** | **Course Title** |
|---|---|---|
| 1 | 20OEHS501A | Entrepreneurship Development |
| 2 | 20OEHS501B | Intellectual Property Rights |
| 3 | 20OEHS501C | Introduction to Digital Marketing |
| 4 | 20OEHS501D | Law for Engineers |
| 5 | 20OEHS501E | Organizational Behaviour |
| 6 | 20OEHS501F | Project Management |

20OE601 Open Elective-II

| **20OE601 Open Elective-II** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE601A | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601B | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601C | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601D | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601E | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601F | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601G | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601H | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601I | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601J | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601K | Multimedia Systems | Y | Y | Y | N | Y |

20OE801 Open Elective-III

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

20OE802 Open Elective-IV

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

## 20OEHS501A ENTREPRENEURSHIP DEVELOPMENT

**Teaching Scheme** | **Examination scheme:**

**Lectures:** 3 Hours / Week

**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Prerequisite:** NA

**Course Objectives:**

1. Understand the fit between individual entrepreneurial ambitions
2. Select a problem worth solving
3. Identify customers
4. Develop a solution for your customers' problems and problem solution
5. Build and demonstrate an MVP (Minimum Viable product)
6. Structure a business model around the problem, customer, and solution and present Business Model Canvas

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe what it takes to be an entrepreneur
CO2 Analyze business opportunities and the basics to create, launch and manage new businesses
CO3 Develop Business Model for their Idea/Problem
CO4 Create MVP (Minimum Viable Product)

**Module 1: Introduction (03)**

Discover yourself, Principles of Effectuation, Identify your entrepreneurial style

**Module 2: Problem Identification and Idea generation (04)**

Identify Problems worth Solving, Introduction to Design Thinking, Generate ideas that are potential solutions to the problem identified

**Module 3: Customer Segmentation (07)**

Customer identification, Market, Creative solution, Unique Value proposition

**Module 4: Business Model Canvas (04)**

Types of business models, Business Plan documentation, Risk identification

**Module 5: Validation (09)**
Identification of MVP, Solution development, Building products/services, Build-measure-learn loop for development, Market fit of solution

**Module 6: Money (05)**
Revenue streams, Pricing and cost, Venture financing, Investor expectations

**Module 7: Team building (03)**
Shared leadership, role of good team, Collaboration tools and techniques

**Module 8: Marketing and sales (03)**
Positioning, Channels and strategies, Sales planning

**Module 9: Support (04)**
Project management, Planning and tracking, Business Regulation

**Text Books:**

1. Course contents available at: https://staging.learnwise.org/ - Through a Cloud Technology Platform – WF Learn Wise Platform
2. PDF documents can be downloaded from the website for the distribution to students.

**Sample References:**

1. Effectuation: https://necrophone.com/2014/01/20/effectuation-the-best-theory-ofentrepreneurship-you-actually-follow-whethe
2. Value Proposition: https://www.youtube.com/watch?v=jZN6CUieuOQ&list=PLw540Wq5kay866m6A6xI7KOwE_Ah7is4m
3. The Lean BMC: https://www.youtube.com/watch?v=FjB_e7UO1hc
4. Define your MVP: https://startups.fb.com/en-in/categories/development/
5. Designing Experiments: https://www.youtube.com/watch?v=WiMZWCg1Hu8&t=111s
6. Beating the Competition: https://www.youtube.com/watch?v=46uP6vOj5G
7. Google : Think branding: https://www.youtube.com/watch?v=1l2CUjkg0ug

## 20OEHS501B Intellectual Property Rights

**Teaching Scheme** | **Examination scheme:**
**Lectures:** 3 Hours / Week | **ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Prerequisite: No pre-requisite**

**Course Objectives:**
**To facilitate learners to,**

1 Overview of Intellectual Properties (IP) regime in India and International arrangements
2 Introduce the types of IP as Patents, Copyrights, Trade Secrets etc.
3 Understand the process and steps involved in filing Intellectual Properties
4 Understand intricacies involved in drafting patent applications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Demonstrate the concepts of Intellectual Property Rights, patents and other forms of IP |
| CO2 | Apply appropriate type of IP for the Intellectual property |
| CO3 | Analyze the patentability of inventive step by searching patents |
| CO4 | Construct patent drafts for given Patent specification |
| CO5 | Understand the advances in patent law, in national and international scenario |

**Unit 1: Introduction (06)**
Intellectual Property (IP) Vs. Physical property, History of IP in India, Importance of IP, Patentable inventions / art, types of IPR-Patents, Copyright, Industrial Design, Trade Marks etc., Basic principles of IPR, Economic Importance of Intellectual Property Rights, IPR-ownership, morality, public order, traditional knowledge

**Unit II: Patents (08)**
Introduction to Patents, Patentable Inventions as per the Indian Patent Act, Patent searching, types of Patent applications, Procedure for filing application (National and International), Patents offices, Register of Patents, Rights and obligations of patentee, Term of patent, Patent of Addition

**Unit III: Drafting of patent applications (08)**
Fundamentals of drafting, structure of the patent specification-Field of invention, prior art, patent classifiations, technical advance, Invention Disclosure Form, problem solution statement, claims, preamble, body, summary

**Unit IV: Transfer and Infringement of Patent Rights (06)**
Working of patents, compulsory licensing, Revocation of patents, Transfer of Patent Rights-Assignment, License; Concept of infringement, Infringement of Patents Rights, Infringement of Patents rights

**Unit V: Introduction to other types of IPs (08)**
Copyright, Trade Marks, Geographical Indications, Industrial Designs, Trade Secrets, Layout designs of Integrated Circuits : Introduction, Work protected by, ownership and infringement, Application process

**Unit VI : Advances in IPR (06)**
International Patenting, Patent Co-operation Treaty (PCT), Commercialization of Patents, Advances in IPR

**Text Books:**
1 Niraja Pandey, Khushdeep Dharni, "Intellectual Property Rights", PHI
2 N. S. Rathore, "Intellectual Propoerty Rights: Drafting,Interpretation of Patents Specification and Claims" , New India Publishing Agency

**Reference Books:**
1 Venkataraman M., "An introduction to Intellectual property Rights", Venkataraman M.
2 Mishra, "An introduction to Intellectual property Rights", Central Law Publications
3 R Anita, V. Bhanoji Rao, "Intellectual property Rights, - A Primer", Eastern book Company
4 R Puri, "Practical approach to intellectual propert Rights"
5 P Ganguly, "IPR unlisting the knowlege economy"

**Online Resources:**
1 NPTEL course material on "Patent Drafting for Biginners" - https://onlinecourses.nptel.ac.in/noc18_hs17/preview
2 IP India : www.ipindia.nic.in/
3 WIPO, World Intellectual property Organization - www.wipo.int/
4 Intellectual Property (IP) Policy | USPTO - https://www.uspto.gov/intellectualproperty-ip-policy

## 20OEHS501C Introduction to Digital Marketing

**Teaching Scheme**
**Lectures:** 3

**Examination scheme:**
In Semester: 50 marks
End Semester: 50 marks
**Credits: 3**

**Prerequisite:**

**Course Objectives:**

1 Interpret Digital marketing campaign strategy
2 Explain social media and its role in marketing strategy through various channels which it operates
3 Explore search engine optimization
4 Explain concepts related to mobile marketing

**Course Outcomes:**
After successfully completing the course students will be able to
1 Explore methods to illustrate website and webhosting concepts
2 Develop a marketing plan for product or service by integrating social media platforms to generate leads
3 Examine mobile marketing strategies to connect with customers
4 Demonstrate importance of organic ranking through SEO

**Unit I: Overview of Digital Marketing (08)**
Introduction to Digital Marketing,Understand customer needs, Benefits of Digital marketing, Digital marketing platforms and Strategies, Comparing Digital with Traditional Marketing,Latest Digital marketing trends, What is Domain Name, Types of Domain, Web Hosting Concepts, Domain/Hosting Business,introduction to wordpress

**Unit II: Digital Advertising with Google AdWords (08)**
Introduction to Paid Marketing, Google Account setup, Account Structure, Campaigns settings, AdGroup setup, Keyword Match Types, Keyword Research Tools, Understanding Ad Auction, What is Quality Score, My Client Centre, Google AdWords Editor Tool,
Interface Tour and BillingSettings

**Unit III: Social Media Marketing (08)**
Introduction to Social Media, Integrating Social Media with Other Disciplines, Facebook Marketing, Facebook account setup, Personal account properties, Facebook marketing strategy, Facebook business page setup, Types of Business pages, Cover photo designing, Page management options, twitter and Instagram marketing

**Unit IV: Mobile Marketing** **(06)**

Introduction to Mobile Marketing and m-commerce, create mobile app,case study:market potential of mobile commerce.

**Unit V: Search Engine Optimization** **(06)**

**I**ntroduction to Search Engines, On-Page Optimization, Off-Site Optimization, Social media monitoring Tool

**Unit VI : Case study and Future Trends in Digital marketing** **(06)**

Digital marketing Scenario in india and world, Digital Strategies Influence r marketing, AI in Digital Marketing

**Text Books:**

1 Seema Gupta, **"Digital Marketing**", *McGraw-Hill Publication*, (1st Edition), (2018).
2 Benjamin Mangold, **"Google Adwords and Google Analytics"**, *loves data* , (1st Edition), (2018).
3 Richard stokes, **"Pay per click",** *Entrepreneur Press*,(2nd Edition), (2014).
4 Suraj Bandyopadhyay **"Models for Social Networks with Statistical Applications"**, *Sage Publications*, (1st Edition), (2011).

**Reference Books:**

1 Ian Dodson, "**The Art of Digital Marketing",** *Wiley*, (1st Edition), (2016).
2 Sira. R Bowden , "**Beginners Guide Digital Marketing Part 2:** *Mobile Marketing", BookRix,* (1st Edition), (2016).

**Online Resources:**

NPTEL:Marketing Management: *https://nptel.ac.in/courses/110/104/110104070/*

**websites:**

1 https://www.searchenginejournal.com/seo-guide/panda-penguin-hummingbird/
2 https://www.lynda.com/Analytics-tutorials/Online-Marketing-Fundamentals/188429-2.html

## 20HS501D - LAW FOR ENGINEERS

**Teaching Scheme**
**Lectures:** 3 Hours / Week

**Examination scheme:**
**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Course Objectives:**

1 To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it
2 To make students aware of the theoretical and functional aspects of the Indian Parliamentary System
3 To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers
4 To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework
5 To make students learn about role of engineering in business organizations and e- governance

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify and explore the basic features and modalities about Indian constitution |
| CO2 | Differentiate and relate the functioning of Indian parliamentary system at the center and state level |
| CO3 | Differentiate different aspects of Indian Legal System and its related bodies |
| CO4 | Correlate and apply different laws and regulations related to engineering practices |
| CO5 | Correlate role of engineers with different organizations and governance models |

**Unit 1: Legal Structure and Constitutional Law (06)**
Legal Structure **:** Court System in India (District court, District Consumer court, Tribunals, High courts, Supreme Court), Arbitration, Constitutional Law: The Preamble, Fundamental Rights, Fundamental Duties, Emergency provisions: Kinds, Legal requirements and Legal effects.

**Unit II: RTI and Contract Law (06)**
Right to Information Act, 2005: Evolution and concept, Practice and procedures, Contract Law : General Principles of Contract under Indian Contract Act, Kinds of government contracts and dispute settlement, Standard form contracts : Nature, Advantages, Unilateral character, Principles of protection against possibility of exploitation, Clash between two standard forms contract.

**Unit III: Sale of Goods Law and Consumer Protection Act (06)**
Sale of Goods Law **:** Goods- movable property, Warranty, Guarantee, Consumer Protection Act **:** Consumer Rights and Legislative framework on Consumer protection.

**Unit IV: Environment Law and Labour Laws (08)**
Environment Law**:** Laws relating to industrial pollution, environmental protection, Labour Laws**:** Industrial Disputes Act, Collective bargaining; Industrial Employment, Health and safety at work, Accidents, PoSH Act 2013 **:** Laws relating to Equality and Empowerment of Women, The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013

**Unit V: Patent and Cyber Law (08)**
Law relating to Patents : Patents Act, 1970, Law relating to Intellectual property, Law relating to Copyright, Law relating to Trademarks, Cyber law Act 2000 : The Information Technology Act, 2000 (also known as ITA-2000, or the IT Act) - dealing with cybercrime and electronic commerce.

**Unit VI : Corporate Law and Land Law (08)**
**Corporate** Law**:** Meaning of corporation; Law relating to companies, public and private (Companies Act, 1956) general provisions, Corporate liability, civil and criminal, Code of Business Conduct (COBC) provides the ethical guidelines and expectations for conducting business, Land Law: Transfer of Property Act, Land disputes.

**Text Books:**
1 D.D. Basu, "**Shorter Constitution of India"**, Prentice Hall of India, December 2017
2 S.K. Awasthi & R.P. Kataria, "**Law relating to Protection of Human Rights"**, Orient Publishing, 2000
3 Wadhera , "**Intellectual Property Rights"**, Universal Law Publishing Co, 5th edition
4 O.P. Malhotra, "**Law of Industrial Disputes"**, N.M. Tripathi Publishers, 1968

**Reference Books:**
1 M.P. Jain, "**Indian Constitutional Law"**, Wadhwa & Co., 2018
2 S.K. Kapur, "**Human Rights under International Law and Indian Law"**, Central Law Agency, 7th edition
3 Avtarsingh, "**Law of Contract"**, Eastern Book Co, 2020
4 T. Ramappa, "**Intellectual Property Rights Law in India"**, Asia Law House, 2016

**Online Resources:**
1 **Companies Act, 2013 Key highlights and analysis by PWC.**
https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlightsandanalysis.pdf

## 20OEHS501E ORGANIZATIONAL BEHAVIOR

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1 Develop familiarity with the concepts related to organizational behavior.
2 Gain knowledge about personality traits and individual behavior.
3 Study group dynamics.
4 Get exposure to the recent trends in Organizational behavior.

**Course Outcomes:**

After completion of the course, students will be able to

1 Explain concepts of organizational behavior, its importance and culture.
2 Outline meaning of personality and how individual behavior impact organization.
3 Relate with ideas of group dynamics and influence of groups in work place.
4 Recall latest trends in Organizational behavior.

**Unit 1: Introduction (07)**

Management and Organizational Behavior (OB), Organizational behavior in historical perspective, Developing an OB model, Challenges and Opportunities for OB, Foundation of individual behavior.

**Unit II: Individual (08)**

Personality, personality frameworks, big five model, perception, individual decision making, attitudes, components of attitudes, attitudes and behavior, Job attitudes, values

**Unit III: Diversity and Ethics (06)**

Environmental context : diversity and ethics, Communication, Case studies

**Unit IV: Trends (07)**

International organizational behavior, emotional intelligence, strategic organizational behavior, Intra-preneurship, flat organization,Gig economy

**Unit V: Group Dynamics (08)**

Foundation of group behavior, stages of group development, group decision making, team building, organizational conflicts and negotiation, power and politics,employee engagement

**Unit VI : Dynamic Environment and Culture (06)**

Information technology and globalization, Human resource policies and practices, OKR (Objective and Key results )framework, Learning

**Text Books:**

1 Stephen P. Robbins, Timothi A.Judge, **'Organisational Behavior'**, 18th Global Edition, Pearson Education(2017),ISBN: 978-0-13-410398-3
2 Dr. S. S. Khanka, **'Organisational Behaviour (Text and Cases)',** S.Chand & Company Pvt.Ltd. (2018), ISBN 978-81-219-2014-8
3 Fred Luthans, **'Organizational Behavior '**, 12th Edition, McGraw Hill Publication (2017), ISBN-978-1-25-909743-0

**Reference Books:**

1 Moorhead, Griffin, 'Introduction to Organizational Behavior', India Edition (2010), Cengage Learning, ISBN: 978-81-315-1242-5
2 P. Subba Rao, 'Organisational Behaviour (Text , Cases and Games)' Himalaya Publishing House (2017), ISBN 978-93-5024-673-3
3 K. Aswathappa, 'Organisational Behavior : Text, Cases & Games', 12th Revised Edition,Himalaya Publishing House(2017), ISBN 978-93-5051-588-4

**Online Resources:**

1 NPTEL on "Organizational Behavior": https://nptel.ac.in/downloads/110105034/#

## 20OEHS501F PROJECT MANAGEMENT

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| Tutorial : 1 Hour/ Week | ESE**:** 50 Marks |
| | Credits: 3 |

**Course Objectives:**

1 To introduce concepts of Project management
2 To discuss life cycle of real life projects and activities involved in projects
3 To understand risks involved in a project

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify scope of a project and lifecycle of a project |
| CO2 | Develop a plan for a project |
| CO3 | Determine schedule of a project |
| CO4 | Assess risks involved in a project |
| CO5 | Estimate budget of a project |
| CO6 | Adapt project management tools and techniques |

**Unit 1: Introduction (07)**

Definition of project, Objectives of Project Management, Classification of projects, Life cycle phases of the project. Project management and Project manager, Role and responsibilities of the project manager, Stakeholder Identification, team building

**Unit II: Project Planning (07)**

Project Planning: Introduction and basic requirements, establishing project objectives, Statement of work (SOW), project specifications, Work Breakdown structure (WBS).

**Unit III: Project Scheduling (07)**

Project scheduling: Introduction and basic requirements, milestone scheduling, Network Scheduling techniques: PERT(Program Evaluation Review Technique), CPM(Critical Path Method), GANNT chart, Schedule control

**Unit IV: Risk Assessment and Management: (07)**

Risk Management Planning, Risk identification, Qualitative Risk analysis, Quantitative Risk analysis, Risk response planning, Risk monitoring and controlling

**Unit V: Project Cost Estimation (07)**

Resource Planning, Cost Estimating, Cost Budgeting, Budget control, Earned Value Analysis, Project Audits, Project closure

**Unit VI : Tools and Techniques for Project Management (07)**

Project Management tools, International Project Management, Collaborative development, Planning Quality Management, Quality metrics, Techniques for Quality Control (statistical control, six sigma, ISO)

**Text Books:**

1 1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), PMI.
2 PROJECT MANAGEMENT A Managerial Approach, Jack R. Meredith, John Wiley & Sons

**Reference Books:**

1 Morris, P. W. G., Pinto, J. K., The Wiley Guide to Managing Projects, 2004, John Wiley & Sons
2 Phillips, J.PMP Project Management Professional Study Guide, McGraw-Hill, 2003.

**Online Resources:**

1 http://www.pmi.org
2 https://www.ipma.world

## 20OEHS601A Automation and Control Engineering [ACE – OE-II]

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | ISE: 50 Marks |
| | ESE: 50 Marks |
| | Credits: 3 |

**Pre-requisite:** Engineering Mechanics, Fluid Mechanics, Basic Mathematics

**Course Objectives:**

**Course prepares students to**

1 To familiarize with the basic concepts of Industrial Automation
2 To acquaint with the concept of low cost automation with Hydraulic and Pneumatic systems.
3 To acquaint with the basic concepts of the Industrial Fluid Power and Factory Automation.
4 To familiarize with the working of different types of controllers and control actions.

**Course Outcomes:**

**Students will be able to**

1 Identify the elements of automation systems, levels of automation and types of automation.
2 Describe assembly line automation, Transfer system, and its components.
3 Analyze different hydraulics and pneumatics circuits for Industrial applications.
4 Study of control system and its types.
5 Develop the basic ladder logic using PLC for different industrial applications.

**Unit/Module: 1 Introduction to Automation 4 hours CO: 1**

Definition, Automation in Production system, Need of automation, Societal issues of automation, Automation strategies, levels of automation, types of automation, Architecture of an Industrial automation system.

**Unit/Module: 2 Hydraulics and Pneumatics devices 6 hours CO: 2**

Different types of Hydraulics and Pneumatics devices,

DCV: All possible configuration and valve designation for Single acting and double acting actuators

FCV, PCV, Actuator and auxiliary elements in hydraulic and pneumatic system, Industrial applications and Case studies.

**Unit/Module: 3 Hydraulic Systems 8 hours CO: 3**

ISO symbols for Hydraulics, Basics of Hydraulic system, Hydraulic Power Pack, Actuators, Circuits using Sequencing and cascading method, Design of Electro-Hydraulic circuits, Case studies and Industrial Applications. Digital and Servo hydraulic control circuits.

**Unit/Module: 4 Pneumatic Systems 6 hours CO: 4**

ISO symbols for Pneumatics, Basic circuits using linear and rotary pneumatic actuators, Circuits using Cascade method and shift register method, Design of Electro-pneumatic circuits using solenoids to operate single acting and double acting actuators.

**Unit/Module: 5 Assembly line Automation and control 6 hours CO: 5**

Automated Material handling systems, automated inspection, transfer lines, part placing and part escapement, AGV's and conveyors
Control System: Open loop, Close Loop, Mathematical Modelling of basic systems :Hydraulic, Pneumatic, Thermal and Fluid systems, Case Studies

**Unit/Module: 6 Controllers 6 hours CO: 6**

Programmable Logic Controller: Basics of PLC, PLC operating cycle, Architecture of PLC, PLC Ladder Programming, Logic Gates, Timers, Counters, Concept of Latching and Interlocking, Selection of PLC for different industrial applications.
Control Actions: On-Off controller, Proportional controller (P),Integral Controller(I) ,Derivative Controller(D),Compound Controller actions: PI,PD,PID

**Total Lecture hours: 36 hours**

**Text Books:**

1 Anthony Esposito, "Fluid Power with Applications",7th Edition, 2008,PHI Publication.
2 M.P.Groover, "Automation, Production System and Computer Aided Manufacturing",3rd Edition,PHI Publication,New Delhi.
3 M.P.Groover, "Industrial Robotics: Technology, Programming and Applications
4 Ogata, "Modern Control Engineering"
5 Nagrath and Gopal "Mathematical Modelling, Simulation and Analysis", MGH Pub
6 Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
7 Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons.

**Reference Books:**

1 C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi. ISBN: 8120309871
2 Vickers "Industrial Hydraulics" Manual, 3rd Edition, Vickers Inc.

## 20OE601B AUTOMOTIVE ELECTRONICS

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1 To explain the operation of basic automotive System components
2 To discuss sensors and actuators in automotive applications
3 To describe the system view of automotive control systems and In-vehicle Communication Protocols
4 To introduce diagnostic methodologies and safety aspects in automotive system

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain the functioning of automotive systems |
| CO2 | Identify key components of automotive control systems and represent in terms of block diagram |
| CO3 | Develop a model for simple systems using model based development. |
| CO4 | Compare communication protocols, safety systems and diagnostic systems Estimate |

**Unit 1: Fundamentals of Automotive Systems (10)**

Overview of an Automotive System, Basics of Spark Ignition, Compression Ignition Engines, Need of Electronics in Automobiles, Ignition systems, Transmission systems, Suspension system, Braking system, Steering system, Fuel Delivery system, Alternator and battery charging circuit, Basics of Hybrid Electric Vehicles.

**Unit II: Automotive Sensors, Actuators, Control Systems (08)**

Systems approach to Control and Instrumentation: Concept of a system, Analog and Digital system, Basic Measurement system, Types of Control Systems, Sensor Characteristics, In-vehicle Sensors: Air flow sensing, Crankshaft Angular Position sensing, Throttle angle sensing, Temperature sensing, EGO sensor, Vibration sensing (in Air Bags), Actuators: Fuel injector, EGR actuator, Ignition system, Variable Valve Timing (VVT), BLDC motor, Electronic Engine Control, Engine Management System strategies for improving engine performance and efficiency.

**Unit III: Microcontrollers / Microprocessors in Automotive Domain, Model Based Development (09)**

Critical review of Microcontroller / Microprocessor (Architecture of 8-bit /16-bit Microcontrollers with emphasis on Ports, Timers/Counters, Interrupts, Watchdog Timer and PWM ), Criteria to choose the appropriate microcontroller for automotive applications, Automotive grade processors, Fuel Maps and Ignition Maps, Introduction to Model Based Development.

**Unit IV: Automotive Communication Protocols (07)**

Overview of Automotive Communication Protocols, CAN, LIN, FLEXRAY, MOST, Communication Interface with ECUs, Interfacing with infotainment gadgets, Application of telematics in automotive domain: GPS and GPRS, Relevance of Protocols such as TCP/IP, Bluetooth, IEEE 802.11x standard, in automotive applications.

**Unit V: Safety Systems in Automobiles, Diagnostics, Standards (08)**

Active Safety Systems: Anti-lock Braking System (ABS), Traction Control System, Electronic Stability Program, Passive Safety systems: Airbag System, Advanced Driver Assistance System (ADAS), Anti-theft systems, Fundamentals of Diagnostics, Self Diagnostic System, On-Board Diagnostics and Off-Board Diagnostics, Importance of Reliability in Automotive Electronics, Reliability Testing with example, Environmental and EMC Testing for Automotive Electronic Components, ISO, IEC and SAE Standards.

**Text Books:**

1 Williams B. Ribbens, **"Understanding Automotive Electronics**", *Newnes*, (7thEdition), (2003).
2 Robert Bosch, **"Automotive Electronics Handbook"**, *John Wiley and Sons*, (1stEdition), (2004).

**Reference Books:**

1 Ronald K Jurgen, **"Automotive Electronics Handbook",** *McGraw-Hill*, (2nd Edition), (1999).
2 James D Halderman, **"Automotive Electricity and Electronics",** *PHI Publication* , (1st Edition), (2005).
3 Tom Denton, **"Automobile Electrical & Electronic Systems",** *Routledge*, (4thEdition), (2002).
4 Tom Denton, **"Advanced Automotive Diagnosis",** *Elsevier*,(2"d Edition), (2006).
5 V.A.W. Hillier, **"Fundamentals Automotive Electronics",** *Oxford University Press*, (6th Edition), (2014).
6 Mehrdad Ehsani, Ali Emadi, Yimin Gao, **"Modern Electronic, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press*, (2nd Edition), (2009).
7 Terence Rybak, Mark Steffka, **"Automotive Electromagnetic Compatibility (EMC)"**, *Springer*, (2004).

**Online Resources:**

1 **NPTEL Course "Fundamentals of Automotive Systems"** https://onlinecourses.nptel.ac.in › noc20_de06 › preview

## 20OE601C Avionics

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Control Systems, Basics of Communication System

**Course Objectives:**
1 To integrate the digital electronics with cockpit equipment
2 To understand the various principles in flight desk and cockpit panels.
3 To understand the communication techniques used in aircraft.
4 To explain the modern era of flight control system

**Course Outcomes:** The student will be able to
1 Identify the mechanical and electronic hardware required for aircraft.
2 Compare the communication and navigation techniques used in aircrafts.
3 Disseminate the autopilot and cockpit display related concepts.
4 Compare and identify different actuators in avionics.

**Unit 1: Introduction to Avionics (08)**
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

**Unit 2: Digital Avionics Bus Architecture (07)**
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies.

**Unit 3: Flight Deck and Cockpit (07)**
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

**Unit 4: Avionics Systems (06)**
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals- Certification-Military and civil aircrafts.

**Unit 5: On Board Navigation Systems (07)**
Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.

**Unit 6: Basics of Final Control Element (06)**

Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

**Text Books:**

1 R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.

2 N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

**Reference Books:**

1 Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2 Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3 Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4 Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

## 20OE601D Bioinformatics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2 To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3 To understand the concepts and types of Phylogeny.

**Course Outcomes:** Students will be able

1 Apply basic concepts of bioinformatics to biological data analysis.
2 Classify different types of biological databases.
3 Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4 Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

**Unit 1: Introduction to Bioinformatics (06)**

Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

**Unit 2: Bioinformatics Databases (08)**

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

**Unit 3: Algorithms for bioinformatics (08)**

Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

**Unit 4: Sequence Analysis (08)**

Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms

**Unit 5: Sequence Alignment (06)**

Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

**Unit 6: Phylogeny (06)**

Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

**Text Books/Reference Books:**

1 Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2 Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3 N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4 Bioinformatics: Databases and Systems, by Stanley I. Letovsky
5 Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6 Mathematical Biology & Medicine), by SorinDraghici
7 Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8 Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

## 20OE601E COMPUTER VISION

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:**20EC501 Digital Signal Processing

**Course Objectives:**

1 To introduce major ideas, methods and techniques of Computer Vision algorithms
2 To introduce fundamentals of Image formation
3 To explain concepts of Camera Calibration and Stereo Imaging
4 To explain different Background Subtraction techniques and Motion tracking algorithms

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the fundamentals of Image formation, Camera calibration parameters and Stereo Imaging |
| CO2 | Apply camera calibration concepts to calculate intrinsic and extrinsic parameters of camera |
| CO3 | Explain different Background Subtraction techniques and Calculate the Performance measures of it. |
| CO4 | Select the appropriate feature extraction techniques according to the requirement of the applications |
| CO5 | Analyze the appropriate Background Subtraction techniques and Object tracking algorithms according to the requirement of the applications |

**Unit I: Camera Calibration (07)**

Geometrical primitives and transformations, 3D to 2D projections, Image Formation, Capture and Representation, Camera Calibration and parameters, Digital camera.

**Unit II: Stereo Imaging (08)**

Stereo Vision: Epipolar geometry, Rectification, Correspondence, triangulation, RANSAC algorithm, Dynamic programming.

**Unit III: Visual Features and Representations (09)**

Edge, Blobs, Corner Detection, SIFT, SURF, HoG.

**Unit IV: Background Subtraction Techniques for Moving Object Detection (09)**

Frame differencing, Mean and Median filtering, Gaussian Mixture Model (GMM), Kernel density estimation, Applications.

**Unit V: Motion Tracking (09)**

Motion tracking using Optical flow, blob tracking, Colour feature based mean shift, Kalman tracking, Applications.

**Text Books:**

1 D. Forsyth, J. Ponce, **"Computer Vision, A Modern Approach"**, *Prentice Hall*, (2nd Edition), (2003).
2 R. Szeliski, **"Computer vision algorithms and applications",** *Springer-Verlag*, (2nd Edition), (2010).

**Reference Books:**

1 L. G. Shapiro, George C. Stockman**, "Computer Vision"**, *Prentice Hall*, (1st Edition), (2001
2 E. Trucco, A. Verri, **"Introductory Techniques for 3-D Computer Vision"**, *Prentice Hall*, (1st Edition), (1998)
3 D. H. Ballard, C. M. Brown, **"Computer Vision"**, Prentice Hall, (1st Edition), (1982).
4 M. Sonka, V. Hlavac, R. Boyle, **"Image Processing, Analysis, and Machine Vision",** *Thomson Press*, (3rd Edition), (2011).

**Online Resources:**

NPTEL Course **"Computer Vision"**

1 https://nptel.ac.in/courses/106/105/106105216/
2 http://www.ai.mit.edu/projects/vsam/Publications/stauffer_cvpr98_track.pdf
3 https://people.cs.rutgers.edu/~elgammal/pub/ieeeproc-paper-final.pdf
4 http://www.cs.cmu.edu/~16385/s15/lectures/Lecture24.pdf

## 20OE 601F Design Thinking

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| Tutorial: - | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:**

**Course Objectives:**

Familiarize students with

1 Design thinking process
2 User centric approach for designing a solution
3 Problem analysis with various methods
4 Applications of Design Thinking

**Course Outcomes:**

Students should be able to

1 Analyze problems with various methods
2 Recommend a solution based on empathy, ideation, prototyping, and playful testing
3 Apply design thinking methods to generate innovative and user centric solutions
4 Test designed prototypes to reduce risks and accelerate organizational learning

**Unit I: Design and Design Problems 8 Hours**

What is Design? The components of design problems; measurement, criteria and judgement in design

A model of design problems – Defining problems: Selecting goals and diverse teams, creating a unified vision and scope, mapping stakeholders and personas; Analysing design problems, generators of design problems, roles of generators, design constraints

**Unit II: Design Solutions 8 Hours**

Solutions to Design Problems: Designer's response: procrastination, non-committal design and throw away design, design problems and solutions
Design Process: define, search, ideate, prototype, select, implement, learn, Refresher and restate the challenge, getting inspiration, understanding innovation ambition, Solution ideation, Narrowing solution choice, Solution evaluation, Road map

**Unit III: Design Thinking 9 Hours**

Types and Styles of Thinking – theories of design, types of thinking; creative thinking - what is creativity? creativity in design, Principles of design thinking

**Unit IV: Design Philosophies and Strategies 9 Hours**

Theory and practice, three early phases of working on the same problem

Prototype Creation: Choosing a prototype approach, user interface prototypes, applications vs custom build, reference architectures, prototype and solution evaluation

**Unit V: Design Tactics and Traps 8 Hours**

Methods and Tactics, understanding the problem, the model of problems, One or many solutions? Common traps and ways of avoiding them

**Text Books:**

1 Bryan Lawson, "How designers think: The design process demystified", 2nd Edition, Butterworth Architecture
2 Nigel Cross, "Design Thinking", Berg Publishers - 2011

**Reference Books:**

1 Ben Crothers, "Design Thinking Fundamentals", O'Reily
2 Tim Brown, "Change by Design: How Design Thinking Transforms Organizations", HarperCollins – 2009
3 Susan Weins Chenk, "Hundred things every designer needs to know about people", New Riders Publication
4 Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley Publication
5 Roger L. Martin, "Design of Business: Why Design Thinking is the Next Competitive Advantage" Harvard Business Press
6 Karl Ulrich, "Design: Creation of Artifacts in Society" - 2011
7 Bala Ramadurai, "Karmic Design Thinking"
8 T. Amabile, "How to kill creativity", SAGE Publication - 2006
9 William Lidwell, Kritina Holden, Jill Butler, "Universal principles of Design ", Rockport Publishers
10 Bella Martin, Bruce Hanignton, Bruce M Hanington "Universal methods of design", Rockport Publishers - 2012
11 Roman Kizanie, "Empathy: Why it matters, how to get it", TarcherPerigee Publishers
12 Karla McLaren, "The Art of Empathy: A complete Guide to life's most essential skill", Sounds True Publishers

# 20OE601G e-Business

**Teaching Scheme**
**Lectures:** 3 Hours / Week

**Examination scheme:**
In Semester**:** 50 Marks
End Semester**:** 50 Marks
Credits: 3

**Prerequisite:** No Prerequisites

**Course Objectives:**

To facilitate the learners to-

1. Understand the technological, economic and social phenomena behind rapid changes in the e-businesses.
2. Have a good working knowledge of e-business concepts, applications and technologies.
3. Understand the e-business models and infrastructure.
4. Learn how e-business concepts are applied to different fields, such as: education, banking, tourism and so on.
5. Inspire with online business ideas and motivate them to apply in the real life.
6. Study the new trends in e-business, e-commerce

**Course Outcomes:**

By the end of this course, students will be able to

CO1 Explain the concepts of e-business and e-business models
CO2 Apply suitable principles and practices of designing and developing e-business website
CO3 Apply necessary back end system components required for successful e-business implementations
CO4 Outline the meaning of e-business security and how it impacts the business
CO5 Relate e-business, BI and KM to fulfil modern e-business trends

**Unit I: Introduction (07)**

E-commerce and e-business, advantages of e-business in growth of a business, Transition from traditional business to e-business, features of e-business technology, e-business models, IT Infrastructure requirements of e-business Case Study : Various e-business models

**Unit II: Building e-business Websites (07)**

Issues involved in designing a website, designing in-house websites, steps involved in website development, e-business and website development solutions, Advantages of using an e-business solution, selection of a suitable e-business solution, security issues involved in websites, tracking and analysing website traffic data. Digital Marketing Case Study

**Unit III: e-Business Infrastruture / Back end Systems (07)**

Back end system support requirements - security, scalability, availability, adaptability, manageability, maintainability, assurance, interoperability, load balancing; internet technology, World Wide Web, Internet software; Content management, Case Study

**Unit IV: e-security & online payment systems (07)**

e-Business security policy, risks and risk assessment, practice guidelines to e-security, legal framework and enforcement, ethical, social and political issues in e-business

Performance characteristics of online payment systems, online payment methods, security and risk handling in online payments, fraud detection in online payments, IT Act 2000, digital signatures, digital certificates, and PKI; Case Study

**Unit V: Knowledge management & BI for strategic e-business (08)**

From information processing to knowledge world, aligning knowledge with business, knowledge management platforms, state of knowledge and measuring parameters; knowledge industry, knowledge strategy, and knowledge workers

Business and Intelligence - applications and importance of business intelligence, implementation of intelligence, building BI systems, selecting BI tools, integrating BI and KM, decision-making and BI, Case Study

**Unit V: Launching an e-Business and e-business trends (06)**

Launching a successful e-business – requirement analysis, managing Web site development, search engine optimization, Evaluate Web sites on design criteria.

Future and next generation of enterprise e-business, challenges and new trends, ethical and regulatory issues

**Text Books:**

1. Papazoglou, Michael and Pieter Ribbers, "E-Business : Organizational and Technical Foundations", John Wiley, 2nd Edition (Sept 2011).
2. Parag Kulkarni, Sunita Jahirabadkar, Pradeep Chande, "E-Business", Oxford University Press (May 2012)

**Reference Book:**

1. Daniel Amor, "The E-business (R)evolution", Prentice Hall PTR (2000)
2. Kenneth Laudon, Carol Guercio, "E-commerce : Business, Technology, Society", Prentice Hall, 4th Edition (January 2008).
3. Kalakota Ravi, Marcia Robinson, "E-Business 2.0 – Roadmap for Success", Pearson Education, 2nd Edition (2004).

## 20OE601H - Electric Vehicles

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| Tutorial: - | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**

1 Understand and identify and integrate EV subsystems
2 Learn and find energy storage requirements for vehicle application
3 Comprehend design of battery thermal management system
4 Undestand calculations of motor power ratings for an EV application
5 Study suitable type of sensors for EV applications
6 Study appropriate control strategy for EV

**Course Outcomes:**
Students should be able to
1 To identify and integrate EV subsystems
2 To calculate energy storage requirements for vehicle application
3 To select and design battery thermal management system
4 To calculate motor power ratings for an EV application
5 To select a suitable type of sensors for EV applications
6 To select appropriate control strategy for EV

**Unit 1: Introduction to hybrid and electric vehicles:** (6)
Engineering case, legislative push, incentives, market pull. EV : micro to mild to PHEV to HEV to REEV to EV - Hybrid-Electric Vehicle Power trains, Vehicle Energy Storage System Design, System and sub-systems, Modelling and design of EVs as a system, Motors & motive power spilting concepts, and interface within power train system

**Unit 2: Power train architecture:** (6)
Parallel, Series and Combined, Types of EVs, Vehicle layout and packaging options, Duty Cycles in Indian cities; performance, Components of Power Train**,** Auxiliary Inverter, HV-LV DC-DC converter, Traction Inverter, Gear Trains, Integration of power train components, regenerative brakes

**Unit 3: Introduction to Energy Storage** (6)
Energy storage requirements for vehicle applications, Storage technologies and metrics for comparison, Distribution of Energy, Storage Form of Energy, Intermediary Conversion, Control and Diagnostic, Ragone Chart, Theory of Ragone Plots. Ragone Plot of a Battery

**Unit 4: BMS, Packing and Charging:** (6)

Battery Management Systems (BMS), Lithium-Ion Batteries Aging Effects. Battery characterization and testing systems, Thermal management & Battery life cycle, Modular battery packs, packaging, thermal control, Changing Systems and Infrastructure

**Unit 5: Electric Drives** (6)

DC motors, induction motors and synchronous motors, permanent magnet motors, BLDC, switched reluctance motors, Switched Reluctance Motors (SRM),Permanent Magnet Synchronous Motor (PMSM)

**Unit 6: Sensors in Electric Vehicles:** (6)

MEMS Sensors for Engine Management, Battery Monitoring Sensors, State of the Charge Sensing, Sensors for Passenger Safety, Sensors for Skidding and Rollover Detection, Tire Pressure Sensors, Electronic Stability Control of Vehicles, Sensors for Antitheft, Vehicle Navigation Sensors. EV sensors of Texas Instruments, STM, NXP, etc.

**Books:**

1 Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Celll vehicles-Fundamentals - Theory and Design", CRC Press
2 Energy Storage by Robert A. Huggins, Springer Publication
3 Chang Liang Xia,Permanent Magnet Brushless Dc Motor Drives and Controls, Wiley 2012.
4 Katsuhiko Ogata, "Modern Control Engineering" 5th edition, Prentice Hall of India Private Ltd., New Delhi, 2010.
5 Cooper W.D & Hlefrick A.D., Electronic Instrumentation Measurement Technique, III Edition, Prentice Hall of India – 1999

## 20OE 601I Gamification

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 To develop problem solving abilities using gamification.
2 To identify the various methods of gamification.
3 To apply gamification mechanics to solve a problem.
4 To make use of gamification tools to solve a problem.

**Course Outcomes:**
After completion of the course, students will be able to
1 To apply steps of problem solving using gamification.
2 To analyze player motivation and counter gamification.
3 To develop game using game mechanics.
4 To apply tools of gamification to real life applications.

Gamification is about applying game concepts, driving engagement into non game environments/contexts like a website designing, online community for interactive discussion, a fun way of learning management system for engagement of stakeholders etc.

Gamification is NOT about designing fancy games, video games, virtual reality games etc. Therefore this course does NOT cover games and game design aspects. Course will also discuss the negative impact and influence of games (when played in excess) on young minds like addiction to video games, over spending time for games.

**Unit I: Gaming Foundations (6)**
Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

**Unit II: Player Motivation (7)**
Powerful Human Motivators, Why People Play, Player types, Social Games, Intrinsic verses Extrinsic Motivation, Progression to Mastery, Case studies for Thinking: Tower of Hanoi,Concepts Applied to Video games and Gamification.

**Unit III: Counter Moves in Gamification (8)**
Reclaiming Opposition: Counter gamification, Gamed Agencies: Affectively Modulating Our Screen-and App-Based Digital Futures, Remodeling design, Designing for Engagement, Case study of Maze Problem.

**Unit IV: Game Design (8)**

Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, Putting it together, Case study of 8 queens problem.

**Unit V: Game Mechanics and Applications (7)**

Gamification case Studies, Coding basic game Mechanics,Gamification Applications : Education,Healthcare,Marketing,Gamification for Machine Learning.

**Unit VI: Gamification Platforms (6)**

Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server
(ref: https://github.com/ngageoint/gamification-server).

**Text Books:**

1 Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press,2014, ISBN: 978-3-95796-000.
2 Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly,August 2015, ISBN: 978-1-449-397678.

**Reference Books:**

1 B. Burke, Gamify: How Gamification Motivates People to Do Extraordinary Things, Gartner 2014,ISBN:1937134857.
2 **Stieglitz**, S.**Lattemann**, C.**Robra-Bissantz**, S.**Zarnekow**, R.**Brockmann**,Gamification :Using Game Elements in Serious Contexts,2016,ISBN: 978-3-319-45557.

## 20OE 601J Geographical Information Systems

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**
To facilitate the learner to
1 Learn basics of GIS
2 Understand representation of GIS models
3 Relate GIS and DBMS for various applications, analyze and visualize the spatial data
4 apply GIS to supply chain management

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basics of GIS to database design
2 Make use of various data models to given data
3 Apply data editing techniques to spatial data
4 Apply spatial data analysis to GIS data
5 Create maps using ArcGIS
6 Apply GIS in supply chain management

**Unit I: Introduction to GIS (05)**
Define GIS, GISystems, GIScience, Spatial and Geoinformation, Components of GIS, Recent trends and applications of GIS; Data structure and formats, Spatial data models – Raster and vector, Database design- editing and topology creation in GIS, Linkage between spatial and non-spatial data, Data inputting in GIS. Rectification, Transformation Methods; Root Mean Square (RMS) Error

**Unit II: Data Types and data models (05)**
Data Types; Spatial Data; Non-Spatial Data, Data Input; Existing GIS Data, Metadata; Conversion of Existing Data, Creating New Data, Data Models; Vector Data Model; Raster Data Model; Integration and Comparison of Vector and Raster Data Models.

**Unit III: Data Exploration and spatial data editing (08)**
Attribute Data in GIS, Attribute Data Entry, Manipulation of Fields and Attribute Data, Data Exploration; Attribute Data Query, Raster Data Query, Map- Based Data Manipulation, Types of of Digitizing Errors, Causes for Digitizing Errors; Topological Editing and Non-topological Editing; Other Editing Operations; Editing Using Topological Rules.

**Unit IV: Spatial data Analysis (08)**

Spatial Data: Definition, Analysis, Processes & Steps, Software and Tools, Geodatabase Model, Role of Databases in GIS, Creating, Editing and Managing, Classification scheme of Vector-Based and Raster- Based GIS Operation Raster- Based Techniques: Methods of reclassification, overlay analysis, Digital Terrain Analysis and Modeling- TIN and DEM, Surface representation and analysis, Slope and Aspect, Geographic Visualization Data Classification

**Unit V: ArcGIS (08)**

Introduction, Geographical terms, ArcMap main window, Coordinate system, Georeferencing, Generation of vector referencing, Table administration, Geoprocessing tools, spatial analysis, Design and publication, API for ArcGIS

**Unit VI: Trends and applications (08)**

Need for GIS network analysis in SCM, data for GIS logistic service, understanding logistic management, types of GIS services, supply chain audit, ISRO-Bhuvan, Web GIS

**Text Books:**

1 "Fundamentals of GIS", Franz Pucha et al, 2018
2 "Principles of Geographic Information Systems",Kang-tsung chang, 2017

**Reference Books:**

1 "Essentials of Geographic Information Systems",Jonathan E. Campbell Michael Shin, 2018
2 "Introduction to GIS",Víctor Olaya

## 20OE601K MULTIMEDIA SYSTEMS

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**20EC402 Analog and Digital Communication

**Course Objectives:**

1 To introduce basic concepts and design of Colour TV and Digital TV
2 To explain advanced TV technologies like HDTV, CATV, CCTV, DTH, CAS and case study for live telecast
3 To introduce multimedia compression techniques, standards and multimedia over the internet
4 To familiarize the students with digital recording and playback systems, acoustic design, microphones and loudspeakers

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the concepts of colour TV design, systems and Digital TV |
| CO2 | Discuss and compare advanced TV systems like CATV, CCTV, DTH, HDTV, CAS, Wi-fi TV, 3DTV and different display technologies |
| CO3 | Apply and analyze multimedia compression standards for text, audio, image and video and explain multimedia over the internet |
| CO4 | Compare optical recording techniques, microphones and loudspeakers |
| CO5 | Design acoustics and PA system for auditorium, public meeting, debating hall, football stadium and college classrooms |

**Unit I: Colour and Digital TV (11)**

Resolution, interlaced scanning, BW, CVS, Color TV systems, frequency interleaving, colour difference signals, colour TV receiver, NTSC, PAL, SECAM encoders and decoders, Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters and receivers.

**Unit II: Advanced TV Systems (10)**

HDTV standards and systems, HDTV transmitter and receiver, CCTV, CATV, Direct to Home TV (DTH), Set top box, Conditional Access System (CAS), 3D TV systems, Case study (Cricket match, Marathon, Football match), Wi-Fi TV, Video door phone systems, Display devices: LED, LCD, Plasma.

**Unit III: Multimedia Compression and Multimedia over Internet (11)**

Introduction, Overview, Concept of Multimedia, Multimedia Applications, Text: Types, Compression, Hypertext, Image Compression techniques: JPEG, Multimedia Audio: MIDI, MP3, Video: MPEG, Animation: Introduction, types, 3D animation, Virtual reality, Multimedia over Internet**:** Introduction to Multimedia Services, Transmission of Multimedia over the Internet, IP Multicasting, Explaining VOIP

**Unit IV: Acoustics and Digital Audio Video (10)**

Optical recording, noise, CD, DVD, dual layer DVD, rewritable DVD, Blu Ray DVD, Studio acoustics and reverberation, acoustic chambers, PA system for : auditorium, public meeting, debating hall, football stadium, college hall, Advanced PA systems, Different types of speakers and microphones.

**Text Books:**

1 R. R. Gulati, **"Modern Television Practice",** *New Age International*, ($5^{th}$ Edition), (2015).
2 Ralf Steinmetz, Klara Nahrstedt, **"Multimedia: Computing, Communication and Applications"**, *Pearson Publication*, ($8^{th}$ Edition), (2011).
3 R.G. Gupta, **"Audio and Video Systems"**, *Tata Mcgraw Hills*, ($2^{nd}$ Edition), (2020).
4 Robert D. Finch, **"Introduction To Acoustics",** *PHI*, (2nd Edition), (2007).
5 Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, "**Advance Computer Network"**, *Wiley*, ($2^{nd}$ Edition), (2014).

**Reference Books:**

1 A. M. Dhake, "**Television and Video Engineering**", *Tata Mcgraw Hills*, ($2^{nd}$ Edition), (2003).
2 Ranjan Parekh, **"Principles of Multimedia**", *Tata Mcgraw Hills*, (2nd Edition), (2013).
3 Alec Nisbett , "**The Sound Studio**", *Focal Press*, ($5^{th}$ Edition) , (1993).

**Online Resources:**

**NPTEL Course " Multimedia Systems"**

1 https://nptel.ac.in/courses/117/105/117105083/

## 20OE 801A Big Data And Analytics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Understand the concepts, challenges and techniques of Big data and Big data analytics
2 Understand the concepts of Hadoop, Map Reduce framework , Spark for Big data analytics
3 Apply skills and tools to manage and analyze the big data
4 Understand latest big data trends and applications.

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basic concepts of big data for the various applications.
2 Apply data analytics life cycle to real-world big data applications
3 Choose Hadoop ecosystem components based on requirement of application
4 Compare Spark and Hadoop architecture
5 Compare various methods used in data Analytics and big data trends.

**Unit I: Introduction (6)**
Database Management Systems, Structured Data, SQL. Unstructured data, NOSQL, Advantages of NOSQL, Comparative study of SQL and NOSQL. Big data overview, characteristics of Big Data, Case study- SAP HANA.

**Unit II: Data Analytic Life Cycle (6)**
Data Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach. Data Analytic Life Cycle: Discovery, Data preparation, Model Planning, Model Building, Communicate Results, Opearationalize. Case Study: GINA

**Unit III: Big Data Architectures, Hadoop (8)**
Introduction to Big Data and Hadoop, Building blocks of hadoop: Ecosystem, HDFS, HBASE, YARN, Map Reduce working.

**Unit IV: Introduction to Spark (7)**
Spark Framework, Architecture of Spark, Resilient Distributed Datasets, Data Sharing using Spark RDD, Operations in Spark;
Introduction to Kafka: need, use cases, components.

**Unit V: Machine learning** **(8)**

Supervised, unsupervised learning; Classification, Clustering; Time series analysis, basic data analysis using python: libraries,functions.

Text Analysis: Text Pre-processing, Topic modelling algorithms, Text Similarity measure.

**Unit VI: Big Data Trends and applications** **(7)**

Exploratory data analysis, Big data Visualization using python;

IoT and big data, Edge computing, Hybrid cloud.

Applications of Big data, Case study: E-commerce, healthcare.

**Text Books:**

1 "Data Science and Big Data Analytics", Wiley, 1stEdition (January 2015)
2 "Big Data, Black Book" ,Dreamtech Press (27 May 2015),ISBN-13-978-9351197577

**Reference Books:**

1 Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game",MC Press(November 2012)
2 J.Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "Big Data for Dummies", 1st Edition (April 2013)
3 Tom White, "Hadoop: The Definitive Guide", O′Reilly, 3rdedition (June 2012)
4 Abraham Silberschatz, Henry Korth, S. Sudarshan, "Database System concepts",McGraw Hill Education, 6th Edition (December 2013).
5 Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing (November 2013)
6 Shiva Achari ,"Hadoop Essentials - Tackling the Challenges of Big Data with Hadoop" ,Packt Publishing(April 2015), ISBN:978-1-78439-668-8

**Online/Web/Other References:**

1 https://nptel.ac.in/courses/106/104/106104189/
2 https://hadoop.apache.org/docs/stable/
3 https://kafka.apache.org/documentation/
4 https://spark.apache.org/

## 20OE801B Cyber Physical System

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20EC404 Embedded System, 20EC603 Control Systems

**Course Objectives:**

1 To introduce modeling of the Cyber Physical System (CPS).
2 To analyze the CPS.
3 To explain the software modules.

**Course Outcomes:**

After completion of the course, students will be able to

1 Categorize the essential modeling formalism of CPS
2 Analyze the functional behavior of CPS based on standard modeling formalisms
3 Apply specific software for the CPS using existing synthesis tools
4 Design CPS requirements based on operating system and hardware architecture constraints

**Unit I: Cyber Physical Systems (CPS) applications and Characteristics (07)**

CPS in the real world, Basic principles of design and validation of CPS, CPS: From features to software components, Mapping software components to Electronic Control Unit (ECU), CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal methods for Safety Assurance of CPS.

**Unit II: CPS physical systems modeling (07)**

Stability Analysis: CLF (Common Lyapunov function), MLF (Multiple Lyapunov function), stability under slow switching, Performance under Packet drop and Noise.

**Unit III: CPS computer systems modeling (07)**

CPS SW Verification: Frama-C, C Bounded Model Checker (CBMC), Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Hybrid Automata Modelling: Flow pipe construction using Flowstar (Flow*), Polyhedral Hybrid Automaton Verifier (Phaver) tools (Reliability testing).

**Unit IV: Operating systems and hardware architecture support for CPS (07)**

CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques, CPS HW platforms: Processors, Sensors, Actuators, CPS Network.

**Unit V: Analysis and verification of CPS (07)**

Advanced Automata based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, Reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

**Unit VI: CPS case studies (07)**

Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

**Text Books:**

1 Lee, Edward Ashford, and SanjitArunkumarSeshia, "Introduction to embedded systems: A cyber physical systems approach", MIT Press, (2nd Edition), (2017).
2 Rajeev Alur, "Principles of Cyber-Physical Systems". MIT Press, (1st Edition), (2015).
3 Wolf, Marilyn, "High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing". Elsevier, (1st Edition), (2014).

**Reference Books:**

1 P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag, (1st Edition), (2009).
2 Raj Rajkumar, Dionisio De Niz , and Mark Klein, "Cyber-Physical Systems", *SEI Series in Software Engineering*, (1st Edition), (2018).
3 André Platzer, "Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics", *Springer*, (1st Edition), (2010).
4 Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", *CRC Press*, (2nd edition), (2011).

**Online/Web/Other References:**

1 Coursera course, Cyber Physical system modelling
https://www.coursera.org/learn/cyber-physical-systems

## 20OE801C Digital Control

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Basics of Control Systems

**Course Objectives:** To
1 Understand the basic components of a digital control system.
2 Design various Digital Controllers and Study response of those controllers.
3 Learn and understand the stability of the system in the Z plane.
4 Introduce Optimal Control Design and Its need.

**Course Outcomes:** Students will be able to

1. Analyse system design in various planes S-W-Z and its mapping.
2. Analyse system stability in the S and Z plane.
3. Design and analyse systems using classical methods and State Space.
4. Design Optimal Control for a Discrete System.

**Unit 1: Introduction to Discrete Time Control System (08)**
Basic building blocks of Discrete Time Control System, Sampling Theorem, Choice of Sampling Rate, Z Transform and Inverse Z Transform for applications of solving Differential Equations, Impulse Sampling, Reconstruction – Zero Order Hold

**Unit 2: Pulse Transfer Function and Digital Controllers (08)**
Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop System, Pulse Transfer Function of Digital PID Controller, Design of Deadbeat Controller

**Unit 3: Stability Analysis of Discrete Control System (08)**
Stability regions in S plane W plane and Z plane, Mapping between three planes, Stability Tests for Discrete Systems

**Unit 4: Design of Discrete Control System by State Space Approach (07)**
Different Canonical Forms, Relation between Pulse Transfer Function and State Equation, Solution of Discrete Time State Space Equations, Eigen Values, Eigen Vectors

**Unit 5: Pole Placement and Observer Design (07)**

Concept of Controllability and Observability, Pole Placement Design by State Feedback, Design of Feedback Gain Matrix by Ackerman's Formula, State Observer Types.

**Unit 6: Introduction to Optimal Control (05)**

Basics of Optimal Control, Quadratic Optimal Control, Performance Index.

**Text Books:**

1 K. Ogata, "Discrete Time Control Systems", Prentice Hall, Second Edition.
2 M. Gopal, "Discrete Control and State Variable Methods", Tata McGraw Hill.
3 Kannan Moudgalya, "Digital Control", John Wiley and Sons.

**Reference Books:**

1 G. F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, Third Edition.
2 M. Gopal, "Digital Control Engineering", Wiley Eastern LTD.
3 Forsytheand W, Goodall R, "Digital Control".
4 Contantine H. Houpis, Gary B. Lamount, "Digital Control Systems", McGraw Hill International, Second Edition.

## 20OE801D Industrial Engineering and Management

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
The Industrial Engineering course prepares students to…
1 Understand type of organisation and calculate partial and total productivity
2 Learn the fundamental knowledge, skills, tools and techniques of methods study and work measurement.
3 Understand type of production environments, resource planning and control methods.
4 Learn basic resource scheduling techniques, human resource management and industrial safety norms.

**Course Outcomes:**
Students will be able to
1 Identify type of organisation and analyze partial and total productivity
2 Manage and implement different techniques of methods study and work measurement of process under consideration for improvement.
3 Analyze production environment under consideration w.r.to its resource planning and control.
4 Apply basic resource scheduling and human resource management techniques.

**1 Introduction to Industrial Management and Productivity Analysis 6**

1 Industrial management: Functions and principles of management; Organisation: Concept, characteristics, structures and types of organisation- (formal line, military, functional, line and staff organisation);
2 Productivity analysis: Definition, measurement of productivity: productivity models and index (numerical); factors affecting the productivity; productivity improvement techniques;
3 Definition and scope of Industrial Engineering.

**2 Method Study 7**

1 Work Study: Definition, objective and scope of work-study.
2 Method Study : Definition, objective and scope of method study, activity recording and exam aids, Charts to record moments in shop - operation process charts, flow process charts, travel chart, two handed chart and multiple activity charts. Charts to record movement at work place - principles of motion economy, classification of moments, SIMO chart, and micro motion study. Definition and installation of the improved method;
3 Human factors in Work-Study;
4 Value Engineering and Value Analysis.

| | | |
|---|---|---|
| **3** | **Work Measurements** | **6** |
| 1 | Introduction: Definition, objectives and uses; Work measurement techniques: | |
| 2 | Time study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination(numerical); | |
| 3 | Work sampling: Need and procedure, sample size determinations (numerical); | |
| 4 | Synthetic motion studies: PMTS and MTM. Introduction to MOST (numerical). | |
| **4** | **Production Management** | **7** |
| 1 | Production Planning and Control: Types of production systems, functions of PPC, Aggregate production planning; Master Production Schedule; ERP | |
| 2 | Forecasting techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality; (Numerical). | |
| 3 | Supply Chain Management: Concept, Strategies, Supply Chain Network, Push and Pull Systems, Logistics, Distribution; Order Control strategies: MTO, MTA, MTS. | |
| **5** | **Facility Management** | 6 |
| 1 | Facility Layout: Factors affecting facility location; Types of Plant Layout; Computer Aided Layout Design Techniques; Assembly Line Balancing (Numerical); | |
| 2 | Material Handling and Inventory Control: Principles, Types of Material Handling Devices; Stores Management, Inventory costs, Types of inventory models - Deterministic and Probabilistic, Concept of EOQ, purchase model without shortages (Numerical); ABC and VED Analysis (Numerical). | |
| **6** | **Project Scheduling, Human Resource and Industrial Safety** | 6 |
| 1 | Scheduling Techniques: CPM and PERT(Numerical); | |
| 2 | Human Resource Development: Functions: Manpower Planning, Recruitment, Selection, Training; Concept of KRA (Key Result Areas); Performance Appraisal (Self, Superior, Peer, $360^0$); | |

**Text Books:**

1 Industrial Engineering and Production Management, M Mahajan, Dhanpat Rai and Co.
2 Industrial engineering and management by O. P. Khanna, Dhanpatrai publication
3 Industrial Engineering , Martend Telsang, S. Chand Publication.
4 Industrial Organisation & Engineering Economics by Banga and Sharma, Khanna publication.
5 Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
6 J. K. Sharma, Operations Research : Theory And Application, Laxmi pub. India.

**Reference Books:**

1 Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008
2 Maynard's Industrial Engineering Hand Book By H.B. Maynard, KJell, McGraw Hill Education, 2001
3 Zandin K.B. - Most Work Measurement Systems, ISBN 0824709535, CRC Press, 2002.

Assignment based evaluations are designed. **This evaluation is treated as T1-Marks**. Marks will be calculated (at the end of semester) on the basis of successful completion / submission of assignments explained to you time to time on the basis of syllabus content. [Note: these assignments are part of activity based learning. Hence, students are to work in a group to complete following assignments].

| **Assignment Details** | **Mapped COs** |
|---|---|
| 1. Case study based Assignment on Method Study. [Data may be collected from: 1) Day to day activity : Workshop, Library, Admin area, Canteen, Parking 2) Students visiting industrial area for project 3) Quality concept Assignments in a Group.] | **CO1** |
| 2. Hands on Assignment on application of Work Measurement technique(s). [1) Using stopwatch work measurement can be completed. (E.g. in workshop)] | **CO1, CO1** |
| 3. Simulation / Assignment on Routing & Scheduling Model. [Open Source Softwares 1) Flexsim (Videos are available online) 2) Arena - Student Version 3) Pro model – Student Version 4) Excel templates available online. Note: Backward / Forward Scheduling concepts are to be included.] | **CO1, CO4** |
| 4. Assignment on simulation of Manufacturing System / Service System Operations for demand forecasting of the given product using any two methods. [1) Data from shops malls, manufacturing company, etc.] | **CO1, CO4** |
| 5. Assignment on simulation determination of EOQ and plot the graphs. [1) Use of any freeware available.] | **CO1, CO4** |
| 6. Assignment on analysis of Manufacturing / Service Operation for Capacity Planning. [1) Define capacity term for the real life environment you are working for (e.g. foundry= tons of casting, hospital = no. of bed, etc.) 2) Study and collect the data of Variation in demand and capacity planning. 3) Analysis the pattern of data set and report… how they manage the change in capacity.] | **CO1, CO4** |
| 7. Case study based assignment on supply chain model. [1) Select any real life supply chain (any engineering product processing, vendors for vegetable grocery, etc.) 2) Identify all major supply chain elements and prepare supply chain diagram and report.] | **CO1, CO4** |
| 8. Assignment on analysis of (selected) plant layout modeling / Simulation for bottleneck / line balancing. [Plant layout with its detail (with Scale) and identify the type.] | **CO1, CO4** |
| 9. Assignment on analysis of material handling system - for the selected plant layout. [This assignment must be completed with the help of plant layout visited in earlier assignment.] | **CO1, CO4** |
| 10. Case study based assignment on identification of Key Result Areas for performance appraisal for selected company (3600 feedback). [Real life case studies.] | **CO1, CO4** |
| 11. Assignment on industrial safety audit of selected work environment. [Download standard questionnaire and visit any work environment and submit it as assignment.] | **CO1, CO4** |
| **Note**: If student groups working with industry for their project, they are advised to collect data related to above mentioned assignments for submission. | |

## 20OE 801E Introduction to Cyber Crime and Forensics

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**
**To facilitate the learners to-**

1 Learn fundamental concepts of cyber security
2 Understand Security challenges presented by mobile devices and information system access in cybercrime world
3 Learn tools used in Computer forensics and Cyber Applications
4 Understand risks associated with social media networking

**Course Outcomes:**
**By taking this course the learner will be able to-**

1 Classify Cyber Crimes
2 Identify threats and risks within context of Cyber Security
3 Outline Relevant laws and Acts in Cyber Security
4 Appraise various roles and tools used in Cyber Security/ Digital forensics

**Unit I: Introduction to Cybercrime: (7)**
Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Ethical dimensions of cybercrime,Ethics and Morality,Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes

**Unit II: Cyber Offenses**: **(7)**
How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Typical Cyber Crimes like Social Engineering, Cyber stalking, Cyber Defamation, Intellectual property Infringement Botnets: The Fuel for Cybercrime, Dark net

**Unit III: Cybercrime:Mobile and Wireless Devices** : **(8)**
Introduction, Trends in Mobility, Financial Frauds in Mobile and Wireless Computing, Security Challenges Posed by Mobile Devices, structure of Sim card, Sim card forensics, Sim card cloning, Organizational Measures for Handling Mobile,Mobile Apps and cybercrime, Whats app forward frauds, End point detection systems, End point detection systems in devices in organisation

**Unit IV: Methods Used in Cybercrime: (8)**
Introduction, Proxy Servers and Anonymizers,Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow

**Unit V: Digital Forensics- (6)**
Introduction to Digital Forensics, Forensics Software and Hardware, Evaluating computer forensic tools , Software tools and Hardware Tools, New Trends, Mobile forensics for android, Sample Case studies.

**Unit VI: Cyber Security Tools- (6)**
wireshark, Nmap, Nessus, Ncat, Burp Suite, Snort, Nikto Carer Opprtunities and trends in Cyber Security.

**Text Books:**

1 Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA. ISBN 978-81-265-2179-1
2 Information Security & Cyber Laws By Sarika Gupta, Gaurav Gupta,Khanna Publication ISBN: 978-93-810-6824-3 2019
3 Computer Forensics and Investigations Bill Nelson, Amelia Phillips and Christopher Stuart Cengage learning. ISBN 978-81-315-1946-2

**Reference Books:**

1 Intoduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group
2 Eoghan Casey,"Digital evidence and computer crime Forensic Science,Computers and the Internet , ELSVIER,2011 ISBN 978-0-12-374268-1

## 20OE801F Instrumentation in Food and Agriculture

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Basics of sensors and transducers, knowledge of Unit operations and basics of process control, PLC and pneumatic and hydraulic instrumentation

**Course Objectives:**
1 To know the scope of Instrumentation in agriculture field
2 To know greenhouse, food packaging automation schemes
3 Understand sensors used in agriculture field and weather monitoring stations
4 To get acquainted with food quality standards

**Course Outcomes:** The student will be able to
1. Identify the different unit operations, process control equipments involved in different types of process industries
2. Select appropriate measurement techniques for measurement of various process parameters related to soil, green house, Dam and agro-metrology
3. Analyse and develop various control loops for processes involved in various food processing plants
4. Assess various automation tools to develop automation strategy to Dam, Green house, food processing and packaging in accordance to various food standards

**Unit 1: Process Control in Agriculture and Food Industries (08)**
Sensors in Agriculture (Hygrometers, Anemometers, fine wire thermocouple, etc), Sensors in Food (ph, temperature sensor for pasteurization, brix sensor, etc), Flow diagram of some continuous processes like sugar plant, dairy, juice extraction, etc & batch process (Fermentation)

**Unit 2: Instrumentation in Irrigation and Green House (09)**
SCADA for DAM parameters & control, irrigation canal management systems, Auto drip & sprinkler irrigation systems
Green House Automation: Construction of green houses, Sensors for greenhouse, Control of ventilation, cooling & heating, wind speed, temperature & humidity

**Unit 3: Instrumentation in Farm equipments, Food Safety and Sanitation (09)**
Instrumentation for farm equipment: Implementation of hydraulic, pneumatic and electronic control circuits in harvesters cotton pickers, tractors, etc; Classification of pumps, pump characteristics, selection and installation.
Food safety standards (Food safety and standards bill 2005, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products)
Sanitation regulatory requirements: Sanitation standards operating procedure (SSOP's), Sanitation performance standards (SPS), 11 principles of sanitary facility design, Sanitation best practices.

**Unit 4: Automation in Food Packaging (08)**

Ware house management, Cold Storage Units, PLC and SCADA in food packaging

**Unit 5: Smart Instrumentation in Agriculture and Food Industries (08)**

Wireless sensors, Application of IOT in agriculture and food industries, application of Image processing in agriculture and food industries, application of robots in agriculture and food industries, Case studies.

**Text Books:**

1 D. Patranabis, "Principles of Industrial instrumentation", TMH (2010), ISBN-13: 978-0070699717
2 Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3 Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015,Person, ISBN: 9789332549456, 9332549451
4 Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584

**Reference Books:**

1 Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812
2 Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
3 Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-084933862

## 20OE801G Medical IoT

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:**

**Course Objectives:**
1 To understand smart Objects and IoT Architecture
2 To learn sensor Interfacing
3 To learn IoT Protocols
4 To build simple IoT based Health care system

**Course Outcomes:**
1 Ascent the basic concepts of IOT in healthcare
2 Relate the existing hardware platforms and sensor interfaces for various healthcare-based Applications
3 Comprehend the ways of communication between the client and the server in IOT
4 Build various applications in healthcare using IOT based approach with appropriate case studies.

**Unit 1: Medical Measurements (06)**
Cardiovascular system, respiratory system, nervous system etc. Measurement of Heart, Brain and Muscle activity using wearable sensors. Monitor health parameters like Blood Pressure, ECG, EMG, EEG, HR, RR, SPO2 etc.

**Unit 2: Sensors & Smart Patient Devices (08)**
Role of Wearables, Challenges and Opportunities, Future of Wearables, Social Aspects, Wearable Haptics, Intelligent Clothing, Industry Sectors' Overview – Sports, Healthcare, Military, Environment Monitoring, Mining Industry, Public Sector and Safety.

**Unit 3: Wearable mechatronics device (08)**
Accelerometers, Gyroscopic Sensors; In – Shoe Force and Pressure Measurement its applications. Physical Activity Monitoring: Human Kinetics, Cardiac Activity.
Cuffless Blood Pressure Monitor, Study of Flexible and Wearable Piezo resistive Sensors for Cuffless Blood Pressure Measurement, Wearable Pulse Oximeter, Wearable Sweat Analysis, Wearable Heart Rate Measurement**.**

**Unit 4: Device Connectivity and Security / Biomedical Sensors with Internet connectivity (08)**
Gateway, Embedded Systems for devices like RPi, Arduino, etc, Protocols as applied to medical devices.
Sensor interface: Temperature sensor, pressure sensor, optical sensor etc. Wireless body area network. IoT Privacy and Security.

**Unit 5: Data Analytics for Medical Applications (06)**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit 6: IoT in Biomedical Applications - Case Studies (06)**

Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application development in mobile and cloud Environments.

Case Study1: Wireless Patient Monitor system; Design an IoT System for Vital Sign Monitors Weight measuring device, Blood pressure measuring device, ECG, Blood glucose measuring Heart rates measuring devices and Pulse Oximeters etc.

Case Study2: Wearable Fitness & Activity Monitor; Walking time measuring device ii. Step counting device iii. Speed measuring device iv. Calorie spent measuring device v. Time spent in rest or sleeping measuring device.

**Text Books:**

1 Joseph D. Bronzino, "Handbook of Biomedical Engineering", 2nd edition –Volume II, CRC press, 2010.
2 Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications", Elsevier Inc., 2014.
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
4 Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

**Reference Books:**

1 Subhas Chandra Mukhopadhyay and Tarikul Islam, "Wearable Sensors - Applications, design and implementation" IOP Publishing Ltd 2017.
2 Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors", Springer Nature Singapore Pte Ltd. 2018.
3 Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
4 "The Internet of Things: Key Applications and Protocols", by, Wiley
5 Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

# 20OE801H QUANTUM COMPUTING

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS04 Physics, 20BS01 Linear Algebra & Univariate Calculus,20BS03 Multivariate Calculus

**Course Objectives:**
1 To give an introduction to quantum computation
2 To explain the basics of quantum mechanics
3 To analyze quantum circuits using qubit gates
4 To elaborate difference between classical and quantum information theory
5 To explain quantum algorithms
6 To explain noise and error correction

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Describe the basics of quantum computation |
| CO2 | Apply the concepts of quantum mechanics |
| CO3 | Design of quantum circuits using qubit gates |
| CO4 | Comparison between classical and quantum information theory |
| CO5 | Utilize quantum algorithms |
| CO6 | Apply noise and quantum error correction |

**Unit I: Introduction to Quantum Computation (03)**
Quantum bits, Bloch sphere representation of a qubit, multiple qubits.

**Unit II: Background Mathematics and Physics (08)**
Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics, Measurements in bases other than computational basis.

**Unit III: Quantum Circuits (08)**
Single qubit gates, Multiple qubit gates, Design of quantum circuits.

**Unit IV: Quantum Information and Cryptography**
Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Quantum Cryptography, No cloning theorem.

**Unit V: Quantum Algorithms**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit VI: Noise and error correction**

Graph states and codes, Quantum error correction, fault-tolerant computation.

**Text Books:**

1 Michael Nielsen and Isaac Chuang, **“Quantum Computation and Quantum Information”**, *CambridgeUniversity Press, UK*, (10th Edition), (2012).
2 Phillip Kaye, Raymond Laflamme and Michele Mosca,**“An Introduction to Quantum Computing”**, *Oxford University Press, UK*, (1st Edition), (2007).

**Reference Books:**

1 N. David Mermin, **“Quantum Computer Science An Introduction”**,*Cambridge University Press*, UK, (1st Edition), (2007).
2 NosonYanofsky and MircoMannucci, **“Quantum Computing for Computer Scientists”**, *Cambridge University Press*, (1st edition), (2008).

**Online Resources:**

1 NPTEL Course **“Quantum Computing”**
https://onlinecourses.nptel.ac.in/noc19_cy31/

## 20OE801I RENEWABLE ENERGY SOURCES

**Teaching Scheme** | **Examination scheme:**
Lectures: 3 Hours / Week | ISE: 50 Marks
ESE: 50 Marks
**Credits: 3**

**Course Objectives:**
**To make students**

1 Understanding basic characteristics of renewable sources of energy and technologies for their utilization.
2 Learning engineering approach for renewable energy projects.
3 For analyze energy potential of renewable sources of energy.

**Course Outcomes:**
**Students will be able to**

1 Understand of different renewable sources of energy and technologies for their utilization.
2 Select engineering approach to problem solving when implementing the projects on renewable sources of energy.
3 Undertake simple analysis of energy potential of renewable sources of energy.
4 Describe main elements of technical systems designed for utilisation of renewable sources of energy.

**Unit/Module: 1 Solar Energy 8 hours CO: 1**
Solar potential, Solar radiation geometry, Solar radiation data, radiation measurement, Types of Solar Collectors, Collection efficiency, Applications of Solar Energy, Solar Desalination system, Solar dryer, Solar Energy storage. Solar PV Principle, Photo-cell materials, Applications.

**Unit/Module: 2 Wind Energy 7 hours CO: 2,3**
Wind parameters and wind data, Power from wind, Site selection, selection of components, Blade material, Wind energy conversion systems and their classification, Construction and working of typical wind mill, wind farms, present status.

**Unit/Module: 3 Biomass Technology 7 hours CO: 2,3**
Introduction to biomass technology, Combustion and fermentation, Biomass gasification, types of gasifire, Pyrolysis, various applications of Biomass energy, Bio-fuel types, and applications.

**Unit/Module: 4 Ocean – Tidal – Geothermal Energy 6 hours CO: 3**
Introduction to OTEC, open and closed cycle OTEC systems, Energy through waves and tides. Geothermal Energy, Energy generation through geothermal system, types of geothermal resources, Introduction of tidal systems, Environmental impact.

**Unit/Module: 5 Hydrogen - Fuel Cell – Hybrid Energy System 7 hours CO: 4**
Introduction to hydrogen and fuel cell technology, applications of hydrogen and fuel cell technology. Need for hybrid energy systems, Case studies of hybrid energy system such as Solar-PV, Wind-PV, Micro hydel- PV, Biomass-Diesel systems.

**Total Theory hours: 35 hours**

**Text Books:**

1 Solar Energy by Dr. S.P.Sukhatme Tata McGraw Hill.
2 Non Conventional Energy Sources by G.D.Rai.- Khanna Publishers.
3 Energy Technology by S. Rao, Dr. B.B.Parulekar Khanna Publishers.

**Reference Books:**

1 Fan Lin You,Hong ye (2012), Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press
2 John. A. Duffie, William A.Beckman (2013) Solar Engineering of Thermal processes, Wiley
3 Godfrey Boyle (2017), Renewable Energy, power for sustainable future, Oxford University Press.
4 A.R.Jha (2010), Wind turbine technology, CRC Press.

## 20OE 801J Soft Computing

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

1. To understand basics in soft computing
2. To understand concepts of fuzzy logic and fuzzy sets
3. To understand supervised neural network architecture, training and testing algorithms and tools for the same
4. To understand unsupervised neural network architecture, training and testing algorithms
5. To understand concept for optimization, evolutionary programming and genetic algorithm and tools for the same
6. To understand concept swarm intelligent systems and tools for the same

**Course Outcomes:**

After completion of the course, students will be able to

1 Identify various soft computing and artificial neural network constituents to solve the problems in engineering domain
2 Experiment with fuzzy logic principles
3 Apply Supervised learning algorithms in artificial neural networks to simple real life problems
4 Apply Unsupervised learning algorithms in artificial neural networks to simple real life problems
5 Apply principles of genetic algorithm in solving engineering optimization problems
6 Apply principles of swarm intelligence in solving engineering optimization problems

**Unit I: Introduction to Intelligent systems, soft tools and Artificial Neural network (07)**

Soft computing constituents and conventional Artificial Intelligence, Artificial Neural network: definition, advantages of artificial neural network, Fuzzy Set Theory, Genetic algorithm, hybrid systems: neuro fuzzy, neuro genetic, fuzzy genetic, soft computing, Introduction to Artificial Neural Network: Fundamental concepts, basic models of artificial neural network, important terminologies of ANNs, McCulloch- Pitts Neuron, linear separability.

**Unit II: Fuzzy logic and fuzzy sets (07)**

Introduction to fuzzy logic, fuzzy sets, fuzzy set operations, properties of fuzzy sets, classical relation, fuzzy relation, membership function, fuzzification, Methods of membership value assignments, lambda-cuts for fuzzy set, lambda-cuts for fuzzy relations, defuzzification. Introduction to tools for fuzzy logic using MATLAB/ Python

**Unit III: Supervised Learning Networks (07)**

Introduction, Perceptron Networks: Perceptron learning rule, Architecture, perceptron training algorithm for single output classes, perceptron training algorithm for multiple output classes, perceptron network testing algorithm, Back Propagation Network: flowchart for training process, training algorithm, linear factors of back- propagation networks, number of training data, number of hidden layer nodes, testing algorithm of back- propagation networks. Introduction to tools for Supervised Learning Networks using MATLAB/ Python

**Unit IV: Associative Memory Networks and Unsupervised Learning Networks (07)**

Associative Memory Networks: Introduction, Training algorithm for pattern association: Hebb rule, Auto-associative Memory networks, Bidirectional associative memory: architecture, discrete bidirectional associative memory, Unsupervised Learning Networks: Introduction, Fixed wright competitive nets: max net, Kohonen Self organizing feature maps

**Unit V: Genetic Algorithm (07)**

Introduction, Traditional Optimization and Search Techniques, biological background, genetic algorithms and search space, genetic algorithm vs. traditional algorithms, basic terminologies in in genetic algorithm, simple GA, operations in genetic algorithm: encoding- binary, octal, selection- Roulette wheel selection, random selection, crossover- single point cross over, two point crossover, mutation- flipping, interchanging, stopping condition for genetic algorithm flow, constraints in genetic algorithm. Introduction to tools for Genetic Algorithm using MATLAB/ Python

**Unit VI: Swarm Intelligent Systems (07)**

Introduction, background of Ant Intelligent systems, Importance of the Ant Colony Paradigm, Ant colony systems, Development of Ant colony systems, Applications of Ant Colony Intelligence, the working of ant colony systems, practical swarm intelligent systems: The basic of PSO method, Characteristic features. Introduction to tools for Swarm Intelligent Systems using MATLAB/ Python

**Text Books:**

1. S.N. Sivanandam- **“Principles of Soft Computing”,** Third Edition, Wiley India- ISBN 9788126577132, 20018
2. B K Tripathy, J Anuradha, “Soft Computing- Advances and Applications”, Cengage India, ISBN: 78-8131526194, 1st, 2018
3. P.Padhy, **“Artificial Intelligence and Intelligent Systems”** Oxford University Press, ISBN 10: 0195671546, 2005

**Reference Books:**

1 De Jong, **"Evolutionary Computation: A Unified Approach",** Cambridge (Massachusetts): MIT Press. ISBN: 0-262-04194-4. 2006

2 J. S. R. Jang, CT Sun and E.Mizutani, **"Neuro-Fuzzy and Soft Computing" ,** PHI PVT LTD, ISBN 0-13-261066-3. 2015

3 S. Rajsekaran and G.A. Vijayalakshmi Pai, **"Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications"** , Prentice Hall of India, ISBN: 0451211243, 2003

4 1. Sinha N.K., **" Soft Computing And Intelligent Systems: Theory And Applications"**, ISBN-13: 978-0126464900, Elsevier. 2007.

# 20OE 801K Software Testing and Quality Assurance

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures : 3 hours/week | In-Semester : 50 Marks |
| Tutorial : -- | End-Semester : 50 Marks |
| | Credit : 3 |

**Prerequisites:**

**Course Objectives:**
Familiarize students with
1. Testing strategies in projects.
2. Levels of testing strategies
3. Various quality assurance models
4. Automated Testing Tools

**Course Outcomes:**
Students should be able to
1. Explain different terminologies in software testing.
2. Apply appropriate testing technique based on the project scenario
3. Choose quality assurance models for the project
4. Make use of modern testing tools suitable for the project

**Unit – I Fundamentals 7 Hours**
Testing as a Process, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, Testing fundamentals, the defect repository and test design, Defect examples, Developer /Tester support for developing a defect repository. Process model to represent Different phases, Lifecycle models

**Unit – II Levels of testing 7 Hours**
Need for levels of testing, Unit testing, Integration testing, System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing, Stress testing, Regression testing, Alpha, Beta and Acceptance testing.

**Unit – III Testing techniques 7 Hours**
Using White Box Approach to Test design - Static Testing, Structural Testing, Unit Functional Testing, Challenges in White box testing, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing.

**Unit – IV Fundamentals of software quality assurance 7 Hours**
SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

**Unit – V Quality assurance models 7 Hours**
Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM, Clean-room software engineering, Defect Injection and prevention, Inspections & Walkthroughs, Case Tools and their effect on Software Quality.

**Unit – VI Software test automation 7 Hours**

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug. Combining Manual and Automated Testing

**Text Books**

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson
2. Ilene Burnstein, "Practical Software Testing", Springer International edition

**Reference Books**

1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications
2. William Perry, "Effective Methods of Software Testing", Wiley Publishing, Third Edition
3. Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition
4. Watts S Humphrey, "Managing the Software Process", Pearson Education Inc.

## 20OE 802A Applied Statistics with R programming

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Mathematics

**Course Objectives:**

Familiarize students with
1 Fundamentals in Statistics
2 Evaluation and Interpretation of applied statistics
3 Hypothesis Test
4 R programming used in statistical analysis

**Course Outcomes:**

Students should be able to
1 Apply probability for statistical analysis.
2 Draw inferences from statistical analysis of data
3 Apply statistical methods and hypothesis tests on data
4 Explain Multivariate Analysis

**Unit I: Probability** **7 Hours**

Introduction, conditional probability, Bayes Theorem and independence, random variable and Probability distribution, normal distribution.

**Unit II: Basic statistical measures** **9 Hours**

Introduction to statistics, type of data, processing the data, classification, graphical representation. Introduction Measures of central Tendency: Arithmetic Mean, Weighted Arithmetic Mean, Median, mode, Measurement of variation: Quartile, Average and Standard Deviations, Coefficient Variation, Measurement of skewness
Case Study with R programming

**Unit III: Analysis of Variance** **8 Hours**

Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, ANOVA, Completely randomized design, Latin square Design, Duncan's Multiple Range Test
Case Study with R programming

**Unit IV: Types of hypothesis** **9 Hours**

Introduction , types of hypothesis, Tests of hypothesis concerning means, hypothesis concerning proportions, Hypothesis concerning variations (Chi-square and F-tests), Chi square test for checking independence of categorized data, goodness of Fit Test
Case Study with R programming

**Unit V: Multivariate Analysis 9 Hours**

Correlation: Introduction , types of correlations, Correlation Analysis, correlation coefficients,
Regression: Introduction, Linear Regression, Regression analysis, regression coefficients.
MANOVA, Discrimination Analysis, Factor Analysis, Principle Component Analysis and Independent Component Analysis
Case Study with R programming

**Text Books:**

1 S.P. Gupta, "Statistical Methods", Sultan Chand and sons Publication, 41st Edition.

2 B.L. Agarwal, "Basic Statistics", New Age Publication, 9th Edition

3 A. Papoulis, S.U. Pillai, "Probability Random Variables and Stochastic Processes", Tata McGraw Hill, (4th Edition)

**Reference Books:**

1 S. M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier Publication, 5th Edition

2 Piegorsch W.W, "Statistical Data Analytics", Wiley Publication.

3 E. Rukmangadchari, E.K.Reddy, "Probability and Statistics", Pearson India Pvt.Ltd.,1st Edition

4 Rohatgi A.K. Md e. Saleh, "Introduction to Probability and Statistics", Wiley Publication Pvt. Ltd. 3rd Edition.

**Web References**

1 NPTEL NOC: Descriptive Statistics with R software, Prof. Shalabh, IIT Kanpur,

2 NPTEL NOC: Applied Statistics and Econometrics, Prof. Mukherjee, IIT Kanpur

## 20OE802-B Automobile Engineering (AE)

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
ISE**:** 50 Marks
ESE**:** 50 Marks
**Credits: 3**

**Course Objectives:**
**To make students**

1 To study layout of the vehicles.
2 To understand function of various components of automotive systems
3 To understand use of alternative fuels for vehicle.

**Course Outcomes:**
**Students will be able to**

1 Identify different layouts of automobile vehicle and engine auxiliary systems.
2 Explain latest transmission, steering, braking and suspension systems in vehicle.
3 Explain EV, HEV, latest trends in AI technologies
4 Understand energy sources, current emission norms and emission control systems.

**Unit/Module: 1 Vehicle Structure and Engine auxiliary systems 6 hours CO: 1**
Vehicle construction and different layouts, chassis, frame and body, components of engine. Electronically controlled gasoline injection system for SI engines. Electronically controlled diesel injection system, electronic ignition system. Introduction to Vehicle Maintenance and Servicing.

**Unit/Module: 2 Transmission Systems 6 hours CO: 2**
Introduction to transmission system, Automatic transmission system (fluid coupling, clutch less drive, fluid flywheel – torque converter), Semi-automatic transmission, continuously variable transmission (CVT), dual clutch hybrid transmission

**Unit/Module: 3 Steering, Brakes and Suspension Systems 6 hours CO: 2**
Introduction to Steering geometry and its function, Power Steering. Introduction to suspension system, Active and passive Suspension. Introduction to Braking Systems, Regenerative breaking, Anti-lock Braking System (ABS), EBS and Traction Control.

**Unit/Module: 4 Electric and hybrid vehicles 6 hours CO: 3**

Concept of electric and hybrid vehicle, EV and HEV fundamentals, architecture of EV and HEV power train, drives and energy sources in EV and HEV, Artificial intelligence technologies such as Autonomous Vehicles, computer vision assist drivers to improve safety, improve services such as vehicle inspection or insurance. Role of IoT to secure communication between vehicles as well as vehicles and infrastructure components

**Unit/Module: 5 Modern Energy Sources and optimizing supply chain 6 hours CO: 4**

Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LNG), Bio-fuels, lithium-ion battery, hydrogen fuel cell in Automobiles, Introduction to Optimization of Supply Chain in Automotive Industry

**Unit/Module: 6 Emission control in automobiles 6 hours CO: 4**

Emission and Fuel Roadmap Euro 6 / BS V norms (proposed 2020-21), Effect of car emissions on human health and the environment. Exhaust gas re-circulation (EGR) and Engine emission control (three-way catalytic converter system SCR and particulate filter).

**Text Books:**

1 Kirpal Singh, Automobile Engineering Vol 1 and 2, Standard Publishers, 7th Edition, 1997
2 M. Chris and M. A. Masrur, Hybrid Electric Vehicles, Wiley Publications, 2nd Edition, 2017
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press

**Reference Books:**

1 K. K. Jain and R. B. Asthana, Automobile Engineering, Tata McGraw Hill Publishers, New Delhi, 1999.
2 Barry Hollembeak, "Automotive Electricity and Electronics" Cengage Learning, Cliftorn Park, USA 2007.
3 Dr. K. R. Govindan, Automobile Engineering, Anuradha Publications, Chennai, 2013.
4 Joseph Heiner, Automotive Mechanics, Litton Education Publishing Ins., New York, 1999.
5 Angelin, Automotive Mechanics, Tata McGraw Hill Pub. Comp. Ltd., 10th Edition, 2004.
6 Josep Aulinas, Hanky Sjafrie, AI for Cars, Chapman and Hall/CRC Press, 1st Edition.

# 20OE802C AUTONOMOUS ROBOTS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1 To explain fundamentals of robotic system
2 To introduce kinematics, dynamics and control for robotics systems
3 To introduce trajectory planning for motion
4 To describe application of robots in automation

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain and classify different components used in developing autonomous robot |
| CO2 | Select sensors, actuators and grippers for autonomous robot |
| CO3 | Apply formulations to obtain kinematics, dynamics and trajectory planning of autonomous robot |
| CO4 | Develop path planning and navigation algorithm for autonomous robot |
| CO5 | Design robot for automation |

**Unit I: Introduction to Robotics (10 )**
Definition of robotics, Types of robots, Components of Robot system, Classification of robots , Robot architecture, Robot locomotion, Specification of robot, Robot sensors for position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and robot vision, Actuators and end effectors.

**Unit II: Introduction to Mechanics of Robotic Arm (10)**
Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and inverse kinematic analysis, Dynamics and inverse Dynamics of robots, Newton–Eller formulation, Trajectory and Path planning, Application of robotic arm.

**Unit III: Mobile robot Kinematics and Dynamics (08)**
Forward and inverse kinematics, holonomic and nonholonomic constraints, Kinematic models of simple car and legged robots, Dynamic simulation of mobile robots.

**Unit IV: Localization (06)**
Odometric position estimation, Belief representation, Probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, Positioning beacon systems.

**Unit V: Introduction to Planning and Navigation (08)**
Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm, A-star, D-star, Voronoi diagrams, Probabilistic Road Maps (PRM), Rapidly exploring Random Trees (RRT), Markov Decision Processes (MDP), Stochastic Dynamic Programming (SDP).

**Text Books:**

1 R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).
2 Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).
3 Robin R. Murphy, **"Introduction to Artificial Intelligence for Robotics"**, *The MIT Press*,(2nd Edition), (2000).
4 S. K. Saha, **"Introduction to Robotics"**, *Tata McGraw Hill*, (2nd Edition), (2014).

**Reference Books:**

1 K. S.Fu, R. C. Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence" ,** *Tata McGraw Hill* **,** (2nd Edition), (2008).
2 Robert J. Schilling, **"Fundamentals of Robotics- Analysis and Control",***Prentices Hall India*, (1st Edition), (2008).

**Online Resources:**

1 NPTEL Course **"Wheeled Mobile Robot"**
https://nptel.ac.in/courses/112/106/112106298/

## 20OE802D Building Automation and Energy Audit

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**

1 To understand Need and Applications Building automation systems.
2 To understand the working of various Building automation components.
3 To Select and Implement Building automation with various applications.

**Course Outcomes:** The student will be able to

1 Investigate the system requirements for developing building automation systems
2 Compare and choose the suitable building automation systems for the applications
3 Design building automation system for required application
4 Evaluate the performance of the designed building automation system

**Unit 1: Fire Alarm Systems I (08)**

Introduction: to BAS, Need and Applications of BAS, Block diagram of BAS.FAS: Need and Applications of FAS, Types of FAS, Block diagram of FAS, Fire, Fire Development Stages, Fire Signatures, Initiation Devices, Notification Appliances, IDC Placements, NAC Placements, Fire Suppression: Fire Extinguishers & Its Classification, Fire Suppression Systems.

**Unit 2: Fire Alarm Systems II (08)**

IDC, NAC, SLC, FAS Wiring Standards, FAS Communication Protocols, Voltage Drop Analysis, Battery Capacity Analysis, Cause & Effect Matrix.

**Unit 3: Access Control Systems (06)**

Introduction to Security Systems, Types of Security systems, Access Control Systems: Introduction, Applications, Concept, Generic Model, Components, Card Technologies, Communication Protocols for ACS, Biometrics for ACS, CCTV System Types: CCTV Components, Digital Video Management System

**Unit 4: HVAC- Air Systems (06)**

Human Comfort Parameters and Air Properties Need of HVAC System, HVAC Block Diagram. AHU: Concept, Working, AHU Functions, AHU Components: Dampers, Filters, Cooling coil, Heating coil, etc., AHU Configurations, AHU Locations, AHU Terminal Units: CAV, VAV, Measurement and Control Loops for Air Systems.

**Unit 5: HVAC- Water Systems (07)**

Cold Water System: Refrigeration Cycles, Chillers, Cooling Towers, Types of chilled water system, Concept of Free Cooling : Direct Waterside, Series Waterside, Parallel Waterside. Hot Water Systems: Heating Circuits, Boilers, Types of Boilers, Heat Exchangers: Steam Input and Hot Water Input, Solar Hot Water System, Measurement and Control Loops for Water Systems.

**Unit 6: Building Energy Management System (07)**

Overview of Building Energy Management Systems, BEMS Control systems overview, Benefits of BEMS, Energy System Monitoring, Application of Energy Efficient Strategies, Effective Energy management, Computerized Energy Management Systems.

**Text Books:**

1 Robert Gagnon, Design of Special Hazards and Fire Alarm Systems
2 Damjanovski, Vlado, CCTV, Butterworth-Heinemann, 3rd ed
3 Benantar M., Access Control System
4 Montgomery R, Fundamentals of HVAC Control Systems, Elsevier Publications
5 Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6 James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7 "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1 "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2 "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
3 "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4 "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

## 20OE 802E Data Analysis and Visualization

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data analysis and the statistical tools used for analysis
2 Identify the relevant data analysis method for a real time application
3 Select the appropriate data visualization method for the application in hand
4 Understand recent trends in data analysis and visualization

**Unit 1: INTRODUCTION TO DATA ANALYTICS (06)**
Introduction to Data, Data types and their relationships, Data Analytics workflow, Types of analysis Applications.

**Unit 2: BASIC DATA ANALYTICS (08)**
Statistical analysis, Attribute correlation, Regression analysis, Dimensionality reduction, Feature extraction and selection, Time series prediction, Hypothesis Analysis
Case study, Python based examples

**Unit 3: MACHINE LEARNING FOR DATA ANALYTICS (10)**
Data analysis methods used for Clustering, Classification, Regression, Outlier Detection, Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 4: DATA VISUALIZATION (10)**
Purpose and types of Visualization, Graphical Representation, Multidimensional Visualization, Handling data Cleaning, data reduction for visualization, Sorting and Scaling, Multivariate Glyphs
Case study, Python based examples

**Unit 5: RENDS IN DATA ANALYSIS AND VISUALIZATION (08)**

Deep Learning for Data Analysis, handling of small and Big Data,
Storytelling and Data Visualization Dashboards
Case study, Python based examples, Demo with tool like Tableau.

**Text Books:**

1 Dr. Anil Maheshwari, '**Data Analytics'**, McGraw Hill Education (India) Pvt. Ltd. (2017)
2 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching
2 NPTEL Courses
  a Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/
  b Data Analytics with Python https://nptel.ac.in/courses/106/107/106107220/
  c Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
  d Introduction to Learning Analytics https://nptel.ac.in/courses/127/101/127101012/
  e Data Analytics with Python https://onlinecourses.nptel.ac.in/noc20_cs46/preview

## 20OE 802F Data Science Using Python

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data science.
2 Identify the relevant Python method used in data science.
3 Select the appropriate data operation method for the application in hand.
4 Understand recent trends in data science and analysis.

**Unit 1: INTRODUCTION TO DATA (06)**
Introduction to Data, Data types and their relationships, Handling different types of data using Python, Handling numeric and categorical data using Python

**Unit 2: BASIC DATA Processing using NumPy, Pandas (08)**
Statistical operations, data cleaning, missing data, indexing, slicing, iterating, attribute selection, dimensionality reduction, Handling tabular data, time series
Case study, Python based examples

**Unit 3: MACHINE LEARNING using Sci-Kit, Tensorflow - I (08)**
Clustering, Classification, Regression, Outlier Detection
Case study, Python based examples

**Unit 4: MACHINE LEARNING using Sci-Kit, Tensorflow- II (08)**
Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 5: REGRESSION ANALYSIS AND PREDICTIVE ANALYSIS (06)**

Introduction to types of analysis - Predictive, descriptive and decision based, Regression analysis, types - linear, logistic, ridge, lasso

**Unit 6: DATA VISUALIZATION AND GRAPHICS USING Matplotlib / Seaborn (06)**

Basic visualization plots - Area, histogram, bar, Specialized plots - pie, box, scatter, bibble, Waffle, Word clouds, Seaborn, Regression plots
Introduction to Folium, maps with markers, choropleth maps, dashboards

**Text Books:**

1 Aurélien Géron, '**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems'**, O'Reilly Media (2017)
2 Samir Madhavan, '**Mastering Python for data science'**, Packt (2015)
3 David Beazley, '**Python CookBook**', O'reilly (2013)
4 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching
2 NPTEL Courses
   a Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
   b Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/

## 20OE802G Industrial Drives and Control

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 To evaluate and select a suitable drive for a particular application.
2 To analyse the basic drive system dynamics
3 To develop the basic design of an electric drive system.

**Course Outcomes:**

1 Selection of appropriate drive for the given application
2 Selection of suitable control system scheme along with the interlocking for given application
3 Analysis of the control drive dynamics for the desired drive system
4 Design of the total electric drive system based on desired application

**Unit 1: Introduction to Industrial Drives (07)**
Concept of electric drive, Power modulators, Motors used in drives, types of loads choice of drives, classification of drives Multi quadrant operation of Drives.

**Unit 2: Introduction to Control Systems (07)**
Open and closed loop systems with examples, automatic control, speed control of motors

**Unit 3: Electrical Control of Machines (08)**
Manual control – Magnetic control – Semi-automatic and Automatic control of Modern machinery – Development of Control circuits–Two wire and Three wire control – Remote control –

**Unit 4: Interlocking of drives (08)**
Control circuit components –Symbols for control components–Fuses, Switches and Fuse Switch units.

**Unit 5: Dynamics and Control of Electric Drives (06)**
D.C. motor drives, Induction motor drives, Synchronous and Brushless D.C. motor drives.

**Unit 6: Industrial process and drives (06)**

Process flow diagram of paper mill, cement mill, sugar mill, steel mill, Hoists and cranes, centrifugal pumps and compressors, solar powered pump drives, selection of drives for the above processes

**Text Books:**

1 Electrical Motor Drives, R. Krishnan [PHI-2003]

2 Electric Drives, Vedam Subrahmaniam [TMH-1994]

3 Industrial Drives and Control, Sandeep M. Chaudhari, Nilesh R. Ahire [Nirali Prakashan]

**Reference Books:**

1 Control of Electric Drives,W. Leonard, [Springer- 2001]

2 Electrical Drives, Second Edition, S.A. Nasar, Boldea [CRC Press - 2006]

## 20OE802H Smart Sensors and Systems

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 Theoretical understanding of various physical phenomena behind the operation of different types of sensors and microsystems
2 Overview of micro/nano fabrication process
3 Develop a complete sensor or sensor system, MEMS device or microsystem

**Course Outcomes:**

1 Selection of suitable sensor along with the associated electronics and fabrication process for given application
2 Selection of appropriate smart sensors for the desired application in the field of Automobile, Biomedical, Military, Space and Défense.
3 Design of application-based sensors in the field of Military, Défense, Spacecraft and environment
4 Analysis of the system designed for applications in the field of Biomedical and Automobile

**Unit 1: Introduction to Smart Sensors and Systems (07)**

Principles of Sensing, Classification and Terminology of Sensors. Introduction to micromachining - Fabrication and miniaturization techniques
Digital Signal Controllers (Microcontrollers and Digital Signal Processors) for Smart sensors
Key features, Certain case studies - for eg: temperature, fingerprint recognition

**Unit 2: Microfabrication process (08)**

Fabrication and miniaturization techniques, Steps involved in fabrication

**Unit 3: Smart sensors in Biomedical field (08)**

Bio-analytical [sample preparation and detection of compound] sensors & systems, Transduction modes & classifications,
Hall Effect sensors and associated signal conditioning circuits, Sensors for displacement (linear and angular), velocity, acceleration, force, torque, vibration and shock measurements. Sensor measurements for conductivity and viscosity. Electrochemical transducer in Biology and medicine Biochemical Transducer, Enzyme-based electrochemical biosensors, electronic tongue, few related Case studies

**Unit 4: Smart sensors in Automobile industry (07)**

Introduction to Modern Automotive Systems and need for electronics in Automobiles, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Sensors for chassis management, Powertrain sensors, Air Bag and Seat Belt Pre tensioner Systems, Case studies explaining the Modern Trends and Technical Solutions, Related communication systems

**Unit 5: Smart sensors related to Environment and in Spacecraft (06)**

Human Toxicology Ecotoxicology, W ater and air pollution sources
E-nose for Sensitive and Selective Chemical Sensing, Chemical sensors, Ocean environment
Smart sensors in spacecraft - in monitoring applications, Smart Instrumentation Point Bus (SIP), Solid state micro-gyroscopes, related Case studies

**Unit 6: Smart sensors in Military and Defence (06)**

Types of sensors (Accelerometers, Inertial Sensors, Pressure Sensors, Force Sensors, Motion Sensors, Gyroscopes, Temperature Sensor and Others), Device-based Sensor, Clothing-based Sensor, Application based sensors - Wrist Wear, Foot Wear, Eye Wear, Body Wear and Neck Wear, intelligent sensor technology for surveillance and electronic intelligence, Case studies, related communication systems

**Text Books:**

1 Understanding Smart Sensors, Randy Frank [Artech House, Boston London]
2 Smart Sensors for Environmental and Medical Applications, Hamida Halilil, Hadi Heidari [Wiley]
3 Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, S Nihtianov, Antonio Luque [Science Direct]

**Reference Books:**

1 Smart Sensors and Systems, Lin, Y.-L., Kyung, C.-M., Yasuura, H., Liu, Y. [Springer]
2 Smart Sensor Systems, Gerard Miejer [Wiley]

## 20OE802I Wireless Networks

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Nil

**Course Objectives:**

1 To explain the importance of wireless communication and multiple access techniques
2 To elaborate the behavior of communication system for indoor and outdoor wireless networks
3 To introduce 3G, 4G cellular network components and 5G future wireless network
4 To explain MIMO technology
5 To introduce visible light communications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain fundamentals of wireless communication and multiple access techniques |
| CO2 | Analyze the behavior of communication system for indoor and outdoor wireless networks |
| CO3 | Apply 3G, 4G cellular network standards and describe 5G future wireless network |
| CO4 | Interpret MIMO technology its advantages and limitations |
| CO5 | Explain LiFi networking and technology for indoor network access |

**Unit I: Introduction to wireless communication (08)**
Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Media, Spread spectrum, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA.

**Unit II: Wireless indoor and outdoor networks (08)**
WLAN, WiFi, Bluetooth, Zigbee, Ultra Wideband communication, Infrared, UHF narrowband, WiMax, Limitation of indoor networks.

**Unit III: Cellular Network (08)**
Spectrum reuse and re-framing, Cell cluster concept, Co-channel and adjacent channel interference, Cell site, call blocking and delay, Channel allocation strategies, 3G and 4G standard.

**Unit IV: Future Wireless networks (10)**
Introduction to 5G, Modulation techniques for 5G, Architecture, MIMO, Massive MIMO, Limitations and applications.

**Unit V: Visible Light Communications (08)**

LiFi Technology, LiFi Networking, LiFi technology for indoor network access, Applications.

**Text Books:**

1 T. Rappaport, "**Wireless Communications - Principles and Practice**", *Prentice Hall* , (2$^{nd}$Edition) , (2011).
2 Vijay Garg, "**Wireless Communications and networking**", *Elsevier,* (1$^{st}$ Edition), (2007).
3 **Jonathan Rodriguez,** "Fundamentals of 5G Mobile Networks"***, Wiley*, (1$^{st}$ Edition),(2015).**
4 Mohamed Gado, Doaa Abd El-Moghith, "**Li-Fi Technology for Indoor Access**", *LAMBERT Academic Publishing,* (1$^{st}$ Edition), (2015).

**Reference Books:**

1 Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "**3G Evolution HSPA and LTE for Mobile Broadband"**, *Academic Press*, (2$^{nd}$Edition) , (2008).
2 Anurag Kumar, D.Manjunath, Joy kuri, "**Wireless Networking**", *Elsevier,* (1$^{st}$ Edition), (2011).
3 Simon Haykin, Michael Moher, David Koilpillai, "**Modern Wireless Communications**", *Pearson Education* , (1$^{st}$ Edition), (2013)
4 Aditya K. Jagannatham, "**Principles of Modern Wireless Communications Systems***", McGraw Hill Education (India) Private Limited*, (1$^{st}$ Edition), (2016).

**Online Resources:**

1 NPTEL Course on **"Introduction to Wireless and Cellular Communications",** https://nptel.ac.in/courses/108/106/106106167/#
2 NPTEL Course on **"Advanced 3G and 4G Wireless Mobile Communications**", https://nptel.ac.in/courses/117/104/117104099/

**Autonomous Program Structure of**

**Third and Final Year B. Tech.**
**Academic Year: 2022-2023 Onwards**

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Total Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Sem | End Sem | Oral | Practical | | |
| 20OEHS 501 | Open HS Elective –I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 601 | Open Elective-II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 801 | Open Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE 802 | Open Elective-IV* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |

* **Inter-disciplinary Course**

20OEHS 501 Open Elective I (Humanities)

| Sr. No. | Course Code | Course Title |
|---|---|---|
| 1 | 20OEHS501A | Entrepreneurship Development |
| 2 | 20OEHS501B | Intellectual Property Rights |
| 3 | 20OEHS501C | Introduction to Digital Marketing |
| 4 | 20OEHS501D | Law for Engineers |
| 5 | 20OEHS501E | Organizational Behaviour |
| 6 | 20OEHS501F | Project Management |

20OE601 Open Elective-II

| **20OE601 Open Elective-II** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE601A | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601B | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601C | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601D | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601E | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601F | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601G | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601H | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601I | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601J | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601K | Multimedia Systems | Y | Y | Y | N | Y |

20OE801 Open Elective-III

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

20OE802 Open Elective-IV

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | N | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | N | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Structures | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

**20OEHS501A ENTREPRENEURSHIP DEVELOPMENT**

**Teaching Scheme** | **Examination scheme:**
**Lectures:** 3 Hours / Week

**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Prerequisite:** NA

**Course Objectives:**

1. Understand the fit between individual entrepreneurial ambitions
2. Select a problem worth solving
3. Identify customers
4. Develop a solution for your customers' problems and problem solution
5. Build and demonstrate an MVP (Minimum Viable product)
6. Structure a business model around the problem, customer, and solution and present Business Model Canvas

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Describe what it takes to be an entrepreneur |
| CO2 | Analyze business opportunities and the basics to create, launch and manage new businesses |
| CO3 | Develop Business Model for their Idea/Problem |
| CO4 | Create MVP (Minimum Viable Product) |

**Module 1: Introduction (03)**

Discover yourself, Principles of Effectuation, Identify your entrepreneurial style

**Module 2: Problem Identification and Idea generation (04)**

Identify Problems worth Solving, Introduction to Design Thinking, Generate ideas that are potential solutions to the problem identified

**Module 3: Customer Segmentation (07)**

Customer identification, Market, Creative solution, Unique Value proposition

**Module 4: Business Model Canvas (04)**

Types of business models, Business Plan documentation, Risk identification

**Module 5: Validation (09)**
Identification of MVP, Solution development, Building products/services, Build-measure-learn loop for development, Market fit of solution

**Module 6: Money (05)**
Revenue streams, Pricing and cost, Venture financing, Investor expectations

**Module 7: Team building (03)**
Shared leadership, role of good team, Collaboration tools and techniques

**Module 8: Marketing and sales (03)**
Positioning, Channels and strategies, Sales planning

**Module 9: Support (04)**
Project management, Planning and tracking, Business Regulation

**Text Books:**
1. Course contents available at: https://staging.learnwise.org/ - Through a Cloud Technology Platform – WF Learn Wise Platform
2. PDF documents can be downloaded from the website for the distribution to students.

**Sample References:**

1. Effectuation: https://necrophone.com/2014/01/20/effectuation-the-best-theory-ofentrepreneurship-you-actually-follow-whethe
2. Value Proposition: https://www.youtube.com/watch?v=jZN6CUieuOQ&list=PLw540Wq5kay866m6A6xI7KOwE_Ah7is4m
3. The Lean BMC: https://www.youtube.com/watch?v=FjB_e7UO1hc
4. Define your MVP: https://startups.fb.com/en-in/categories/development/
5. Designing Experiments: https://www.youtube.com/watch?v=WiMZWCg1Hu8&t=111s
6. Beating the Competition: https://www.youtube.com/watch?v=46uP6vOj5G
7. Google : Think branding: https://www.youtube.com/watch?v=1l2CUjkg0ug

## 20OEHS501B Intellectual Property Rights

**Teaching Scheme** | **Examination scheme:**

**Lectures:** 3 Hours / Week

**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Prerequisite: No pre-requisite**

**Course Objectives:**
**To facilitate learners to,**

1 Overview of Intellectual Properties (IP) regime in India and International arrangements
2 Introduce the types of IP as Patents, Copyrights, Trade Secrets etc.
3 Understand the process and steps involved in filing Intellectual Properties
4 Understand intricacies involved in drafting patent applications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Demonstrate the concepts of Intellectual Property Rights, patents and other forms of IP |
| CO2 | Apply appropriate type of IP for the Intellectual property |
| CO3 | Analyze the patentability of inventive step by searching patents |
| CO4 | Construct patent drafts for given Patent specification |
| CO5 | Understand the advances in patent law, in national and international scenario |

**Unit 1: Introduction (06)**
Intellectual Property (IP) Vs. Physical property, History of IP in India, Importance of IP, Patentable inventions / art, types of IPR-Patents, Copyright, Industrial Design, Trade Marks etc., Basic principles of IPR, Economic Importance of Intellectual Property Rights, IPR-ownership, morality, public order, traditional knowledge

**Unit II: Patents (08)**
Introduction to Patents, Patentable Inventions as per the Indian Patent Act, Patent searching, types of Patent applications, Procedure for filing application (National and International), Patents offices, Register of Patents, Rights and obligations of patentee, Term of patent, Patent of Addition

**Unit III: Drafting of patent applications (08)**
Fundamentals of drafting, structure of the patent specification-Field of invention, prior art, patent classifiations, technical advance, Invention Disclosure Form, problem solution statement, claims, preamble, body, summary

**Unit IV: Transfer and Infringement of Patent Rights (06)**

Working of patents, compulsory licensing, Revocation of patents, Transfer of Patent Rights-Assignment, License; Concept of infringement, Infringement of Patents Rights, Infringement of Patents rights

**Unit V: Introduction to other types of IPs (08)**

Copyright, Trade Marks, Geographical Indications, Industrial Designs, Trade Secrets, Layout designs of Integrated Circuits : Introduction, Work protected by, ownership and infringement, Application process

**Unit VI : Advances in IPR (06)**

International Patenting, Patent Co-operation Treaty (PCT), Commercialization of Patents, Advances in IPR

**Text Books:**

1 Niraja Pandey, Khushdeep Dharni, "Intellectual Property Rights", PHI
2 N. S. Rathore, "Intellectual Propoerty Rights: Drafting,Interpretation of Patents Specification and Claims" , New India Publishing Agency

**Reference Books:**

1 Venkataraman M., "An introduction to Intellectual property Rights", Venkataraman M.
2 Mishra, "An introduction to Intellectual property Rights", Central Law Publications
3 R Anita, V. Bhanoji Rao, "Intellectual property Rights, - A Primer", Eastern book Company
4 R Puri, "Practical approach to intellectual propert Rights"
5 P Ganguly, "IPR unlisting the knowlege economy"

**Online Resources:**

1 NPTEL course material on "Patent Drafting for Biginners" - https://onlinecourses.nptel.ac.in/noc18_hs17/preview
2 IP India : www.ipindia.nic.in/
3 WIPO, World Intellectual property Organization - www.wipo.int/
4 Intellectual Property (IP) Policy | USPTO - https://www.uspto.gov/intellectualproperty-ip-policy

## 20OEHS501C Introduction to Digital Marketing

**Teaching Scheme** | **Examination scheme:**
**Lectures:** 3 | In Semester: 50 marks
End Semester: 50 marks
**Credits: 3**

**Prerequisite:**

**Course Objectives:**

1 Interpret Digital marketing campaign strategy
2 Explain social media and its role in marketing strategy through various channels which it operates
3 Explore search engine optimization
4 Explain concepts related to mobile marketing

**Course Outcomes:**
After successfully completing the course students will be able to
1 Explore methods to illustrate website and webhosting concepts
2 Develop a marketing plan for product or service by integrating social media platforms to generate leads
3 Examine mobile marketing strategies to connect with customers
4 Demonstrate importance of organic ranking through SEO

**Unit I: Overview of Digital Marketing (08)**
Introduction to Digital Marketing,Understand customer needs, Benefits of Digital marketing, Digital marketing platforms and Strategies, Comparing Digital with Traditional Marketing,Latest Digital marketing trends, What is Domain Name, Types of Domain, Web Hosting Concepts, Domain/Hosting Business,introduction to wordpress

**Unit II: Digital Advertising with Google AdWords (08)**
Introduction to Paid Marketing, Google Account setup, Account Structure, Campaigns settings, AdGroup setup, Keyword Match Types, Keyword Research Tools, Understanding Ad Auction, What is Quality Score, My Client Centre, Google AdWords Editor Tool,
Interface Tour and BillingSettings

**Unit III: Social Media Marketing (08)**
Introduction to Social Media, Integrating Social Media with Other Disciplines, Facebook Marketing, Facebook account setup, Personal account properties, Facebook marketing strategy, Facebook business page setup, Types of Business pages, Cover photo designing, Page management options, twitter and Instagram marketing

**Unit IV: Mobile Marketing (06)**

Introduction to Mobile Marketing and m-commerce, create mobile app,case study:market potential of mobile commerce.

**Unit V: Search Engine Optimization (06)**

**I**ntroduction to Search Engines, On-Page Optimization, Off-Site Optimization, Social media monitoring Tool

**Unit VI : Case study and Future Trends in Digital marketing (06)**

Digital marketing Scenario in india and world, Digital Strategies Influence r marketing, AI in Digital Marketing

**Text Books:**

1 Seema Gupta, **"Digital Marketing**", *McGraw-Hill Publication*, (1st Edition), (2018).
2 Benjamin Mangold, **"Google Adwords and Google Analytics"**, *loves data* , (1st Edition), (2018).
3 Richard stokes, **"Pay per click",** *Entrepreneur Press*,(2nd Edition), (2014).
4 Suraj Bandyopadhyay **"Models for Social Networks with Statistical Applications"**, *Sage Publications*, (1st Edition), (2011).

**Reference Books:**

1 Ian Dodson, "**The Art of Digital Marketing",** *Wiley*, (1st Edition), (2016).
2 Sira. R Bowden , "**Beginners Guide Digital Marketing Part 2:** *Mobile Marketing", BookRix,* (1st Edition), (2016).

**Online Resources:**

NPTEL:Marketing Management: *https://nptel.ac.in/courses/110/104/110104070/*

**websites:**

1 https://www.searchenginejournal.com/seo-guide/panda-penguin-hummingbird/
2 https://www.lynda.com/Analytics-tutorials/Online-Marketing-Fundamentals/188429-2.html

## 20HS501D - LAW FOR ENGINEERS

**Teaching Scheme**
**Lectures:** 3 Hours / Week

**Examination scheme:**
**ISE:** 50 Marks
**ESE:** 50 Marks
**Credits: 3**

**Course Objectives:**

1 To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it
2 To make students aware of the theoretical and functional aspects of the Indian Parliamentary System
3 To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers
4 To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework
5 To make students learn about role of engineering in business organizations and e- governance

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify and explore the basic features and modalities about Indian constitution |
| CO2 | Differentiate and relate the functioning of Indian parliamentary system at the center and state level |
| CO3 | Differentiate different aspects of Indian Legal System and its related bodies |
| CO4 | Correlate and apply different laws and regulations related to engineering practices |
| CO5 | Correlate role of engineers with different organizations and governance models |

**Unit 1: Legal Structure and Constitutional Law (06)**

Legal Structure **:** Court System in India (District court, District Consumer court, Tribunals, High courts, Supreme Court), Arbitration, Constitutional Law: The Preamble, Fundamental Rights, Fundamental Duties, Emergency provisions: Kinds, Legal requirements and Legal effects.

**Unit II: RTI and Contract Law (06)**

Right to Information Act, 2005: Evolution and concept, Practice and procedures, Contract Law : General Principles of Contract under Indian Contract Act, Kinds of government contracts and dispute settlement, Standard form contracts : Nature, Advantages, Unilateral character, Principles of protection against possibility of exploitation, Clash between two standard forms contract.

**Unit III: Sale of Goods Law and Consumer Protection Act (06)**

Sale of Goods Law **:** Goods- movable property, Warranty, Guarantee, Consumer Protection Act **:** Consumer Rights and Legislative framework on Consumer protection.

**Unit IV: Environment Law and Labour Laws (08)**

Environment Law**:** Laws relating to industrial pollution, environmental protection, Labour Laws**:** Industrial Disputes Act, Collective bargaining; Industrial Employment, Health and safety at work, Accidents, PoSH Act 2013 **:** Laws relating to Equality and Empowerment of Women, The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013

**Unit V: Patent and Cyber Law (08)**

Law relating to Patents : Patents Act, 1970, Law relating to Intellectual property, Law relating to Copyright, Law relating to Trademarks, Cyber law Act 2000 : The Information Technology Act, 2000 (also known as ITA-2000, or the IT Act) - dealing with cybercrime and electronic commerce.

**Unit VI : Corporate Law and Land Law (08)**

**Corporate** Law**:** Meaning of corporation; Law relating to companies, public and private (Companies Act, 1956) general provisions, Corporate liability, civil and criminal, Code of Business Conduct (COBC) provides the ethical guidelines and expectations for conducting business, Land Law: Transfer of Property Act, Land disputes.

**Text Books:**

1 D.D. Basu, "**Shorter Constitution of India"**, Prentice Hall of India, December 2017
2 S.K. Awasthi & R.P. Kataria, "**Law relating to Protection of Human Rights"**, Orient Publishing, 2000
3 Wadhera , "**Intellectual Property Rights"**, Universal Law Publishing Co, 5th edition
4 O.P. Malhotra, "**Law of Industrial Disputes"**, N.M. Tripathi Publishers, 1968

**Reference Books:**

1 M.P. Jain, "**Indian Constitutional Law"**, Wadhwa & Co., 2018
2 S.K. Kapur, "**Human Rights under International Law and Indian Law"**, Central Law Agency, 7th edition
3 Avtarsingh, "**Law of Contract"**, Eastern Book Co, 2020
4 T. Ramappa, "**Intellectual Property Rights Law in India"**, Asia Law House, 2016

**Online Resources:**

1 **Companies Act, 2013 Key highlights and analysis by PWC.**
https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlightsandanalysis.pdf

## 20OEHS501E ORGANIZATIONAL BEHAVIOR

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1 Develop familiarity with the concepts related to organizational behavior.
2 Gain knowledge about personality traits and individual behavior.
3 Study group dynamics.
4 Get exposure to the recent trends in Organizational behavior.

**Course Outcomes:**

After completion of the course, students will be able to

1 Explain concepts of organizational behavior, its importance and culture.
2 Outline meaning of personality and how individual behavior impact organization.
3 Relate with ideas of group dynamics and influence of groups in work place.
4 Recall latest trends in Organizational behavior.

**Unit 1: Introduction (07)**

Management and Organizational Behavior (OB), Organizational behavior in historical perspective, Developing an OB model, Challenges and Opportunities for OB, Foundation of individual behavior.

**Unit II: Individual (08)**

Personality, personality frameworks, big five model, perception, individual decision making, attitudes, components of attitudes, attitudes and behavior, Job attitudes, values

**Unit III: Diversity and Ethics (06)**

Environmental context : diversity and ethics, Communication, Case studies

**Unit IV: Trends (07)**

International organizational behavior, emotional intelligence, strategic organizational behavior, Intra-preneurship, flat organization,Gig economy

**Unit V: Group Dynamics (08)**

Foundation of group behavior, stages of group development, group decision making, team building, organizational conflicts and negotiation, power and politics,employee engagement

**Unit VI : Dynamic Environment and Culture (06)**

Information technology and globalization, Human resource policies and practices, OKR (Objective and Key results )framework, Learning

**Text Books:**

1 Stephen P. Robbins, Timothi A.Judge, **'Organisational Behavior'**, 18th Global Edition, Pearson Education(2017),ISBN: 978-0-13-410398-3
2 Dr. S. S. Khanka, **'Organisational Behaviour (Text and Cases)',** S.Chand & Company Pvt.Ltd. (2018), ISBN 978-81-219-2014-8
3 Fred Luthans, **'Organizational Behavior '**, 12th Edition, McGraw Hill Publication (2017), ISBN-978-1-25-909743-0

**Reference Books:**

1 Moorhead, Griffin, 'Introduction to Organizational Behavior', India Edition (2010), Cengage Learning, ISBN: 978-81-315-1242-5
2 P. Subba Rao, 'Organisational Behaviour (Text , Cases and Games)' Himalaya Publishing House (2017), ISBN 978-93-5024-673-3
3 K. Aswathappa, 'Organisational Behavior : Text, Cases & Games', 12th Revised Edition,Himalaya Publishing House(2017), ISBN 978-93-5051-588-4

**Online Resources:**

1 NPTEL on "Organizational Behavior": https://nptel.ac.in/downloads/110105034/#

## 20OEHS501F PROJECT MANAGEMENT

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| Tutorial : 1 Hour/ Week | ESE**:** 50 Marks |
| | Credits: 3 |

**Course Objectives:**

1 To introduce concepts of Project management
2 To discuss life cycle of real life projects and activities involved in projects
3 To understand risks involved in a project

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Identify scope of a project and lifecycle of a project |
| CO2 | Develop a plan for a project |
| CO3 | Determine schedule of a project |
| CO4 | Assess risks involved in a project |
| CO5 | Estimate budget of a project |
| CO6 | Adapt project management tools and techniques |

**Unit 1: Introduction (07)**

Definition of project, Objectives of Project Management, Classification of projects, Life cycle phases of the project. Project management and Project manager, Role and responsibilities of the project manager, Stakeholder Identification, team building

**Unit II: Project Planning (07)**

Project Planning: Introduction and basic requirements, establishing project objectives, Statement of work (SOW), project specifications, Work Breakdown structure (WBS).

**Unit III: Project Scheduling (07)**

Project scheduling: Introduction and basic requirements, milestone scheduling, Network Scheduling techniques: PERT(Program Evaluation Review Technique), CPM(Critical Path Method), GANNT chart, Schedule control

**Unit IV: Risk Assessment and Management: (07)**

Risk Management Planning, Risk identification, Qualitative Risk analysis, Quantitative Risk analysis, Risk response planning, Risk monitoring and controlling

**Unit V: Project Cost Estimation (07)**

Resource Planning, Cost Estimating, Cost Budgeting, Budget control, Earned Value Analysis, Project Audits, Project closure

**Unit VI : Tools and Techniques for Project Management (07)**

Project Management tools, International Project Management, Collaborative development, Planning Quality Management, Quality metrics, Techniques for Quality Control (statistical control, six sigma, ISO)

**Text Books:**

1 1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), PMI.
2 PROJECT MANAGEMENT A Managerial Approach, Jack R. Meredith, John Wiley & Sons

**Reference Books:**

1 Morris, P. W. G., Pinto, J. K., The Wiley Guide to Managing Projects, 2004, John Wiley & Sons
2 Phillips, J.PMP Project Management Professional Study Guide, McGraw-Hill, 2003.

**Online Resources:**

1 http://www.pmi.org
2 https://www.ipma.world

## 20OEHS601A Automation and Control Engineering [ACE – OE-II]

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures**:** 3 Hours / Week | ISE**:** 50 Marks |
| | ESE**:** 50 Marks |
| | Credits: 3 |

**Pre-requisite:** Engineering Mechanics, Fluid Mechanics, Basic Mathematics

**Course Objectives:**

**Course prepares students to**

1 To familiarize with the basic concepts of Industrial Automation
2 To acquaint with the concept of low cost automation with Hydraulic and Pneumatic systems.
3 To acquaint with the basic concepts of the Industrial Fluid Power and Factory Automation.
4 To familiarize with the working of different types of controllers and control actions.

**Course Outcomes:**

**Students will be able to**

1 Identify the elements of automation systems, levels of automation and types of automation.
2 Describe assembly line automation, Transfer system, and its components.
3 Analyze different hydraulics and pneumatics circuits for Industrial applications.
4 Study of control system and its types.
5 Develop the basic ladder logic using PLC for different industrial applications.

**Unit/Module: 1 Introduction to Automation 4 hours CO: 1**

Definition, Automation in Production system, Need of automation, Societal issues of automation, Automation strategies, levels of automation, types of automation, Architecture of an Industrial automation system.

**Unit/Module: 2 Hydraulics and Pneumatics devices 6 hours CO: 2**

Different types of Hydraulics and Pneumatics devices,

DCV: All possible configuration and valve designation for Single acting and double acting actuators

FCV, PCV, Actuator and auxiliary elements in hydraulic and pneumatic system, Industrial applications and Case studies.

**Unit/Module: 3 Hydraulic Systems 8 hours CO: 3**

ISO symbols for Hydraulics, Basics of Hydraulic system, Hydraulic Power Pack, Actuators, Circuits using Sequencing and cascading method, Design of Electro-Hydraulic circuits, Case studies and Industrial Applications. Digital and Servo hydraulic control circuits.

**Unit/Module: 4 Pneumatic Systems 6 hours CO: 4**

ISO symbols for Pneumatics, Basic circuits using linear and rotary pneumatic actuators, Circuits using Cascade method and shift register method, Design of Electro-pneumatic circuits using solenoids to operate single acting and double acting actuators.

**Unit/Module: 5 Assembly line Automation and control 6 hours CO: 5**

Automated Material handling systems, automated inspection, transfer lines, part placing and part escapement, AGV's and conveyors

Control System: Open loop, Close Loop, Mathematical Modelling of basic systems :Hydraulic, Pneumatic, Thermal and Fluid systems, Case Studies

**Unit/Module: 6 Controllers 6 hours CO: 6**

Programmable Logic Controller: Basics of PLC, PLC operating cycle, Architecture of PLC, PLC Ladder Programming, Logic Gates, Timers, Counters, Concept of Latching and Interlocking, Selection of PLC for different industrial applications.

Control Actions: On-Off controller, Proportional controller (P),Integral Controller(I) ,Derivative Controller(D),Compound Controller actions: PI,PD,PID

**Total Lecture hours: 36 hours**

**Text Books:**

1 Anthony Esposito, "Fluid Power with Applications",7th Edition, 2008,PHI Publication.
2 M.P.Groover, "Automation, Production System and Computer Aided Manufacturing",3rd Edition,PHI Publication,New Delhi.
3 M.P.Groover, "Industrial Robotics: Technology, Programming and Applications
4 Ogata, "Modern Control Engineering"
5 Nagrath and Gopal "Mathematical Modelling, Simulation and Analysis", MGH Pub
6 Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
7 Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons.

**Reference Books:**

1 C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi. ISBN: 8120309871
2 Vickers "Industrial Hydraulics" Manual, 3rd Edition, Vickers Inc.

## 20OE601B AUTOMOTIVE ELECTRONICS

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:** 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To explain the operation of basic automotive System components
2. To discuss sensors and actuators in automotive applications
3. To describe the system view of automotive control systems and In-vehicle Communication Protocols
4. To introduce diagnostic methodologies and safety aspects in automotive system

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain the functioning of automotive systems |
| CO2 | Identify key components of automotive control systems and represent in terms of block diagram |
| CO3 | Develop a model for simple systems using model based development. |
| CO4 | Compare communication protocols, safety systems and diagnostic systems Estimate |

**Unit 1: Fundamentals of Automotive Systems (10)**

Overview of an Automotive System, Basics of Spark Ignition, Compression Ignition Engines, Need of Electronics in Automobiles, Ignition systems, Transmission systems, Suspension system, Braking system, Steering system, Fuel Delivery system, Alternator and battery charging circuit, Basics of Hybrid Electric Vehicles.

**Unit II: Automotive Sensors, Actuators, Control Systems (08)**

Systems approach to Control and Instrumentation: Concept of a system, Analog and Digital system, Basic Measurement system, Types of Control Systems, Sensor Characteristics, In-vehicle Sensors: Air flow sensing, Crankshaft Angular Position sensing, Throttle angle sensing, Temperature sensing, EGO sensor, Vibration sensing (in Air Bags), Actuators: Fuel injector, EGR actuator, Ignition system, Variable Valve Timing (VVT), BLDC motor, Electronic Engine Control, Engine Management System strategies for improving engine performance and efficiency.

**Unit III: Microcontrollers / Microprocessors in Automotive Domain, Model Based Development (09)**

Critical review of Microcontroller / Microprocessor (Architecture of 8-bit /16-bit Microcontrollers with emphasis on Ports, Timers/Counters, Interrupts, Watchdog Timer and PWM ), Criteria to choose the appropriate microcontroller for automotive applications, Automotive grade processors, Fuel Maps and Ignition Maps, Introduction to Model Based Development.

**Unit IV: Automotive Communication Protocols (07)**

Overview of Automotive Communication Protocols, CAN, LIN, FLEXRAY, MOST, Communication Interface with ECUs, Interfacing with infotainment gadgets, Application of telematics in automotive domain: GPS and GPRS, Relevance of Protocols such as TCP/IP, Bluetooth, IEEE 802.11x standard, in automotive applications.

**Unit V: Safety Systems in Automobiles, Diagnostics, Standards (08)**

Active Safety Systems: Anti-lock Braking System (ABS), Traction Control System, Electronic Stability Program, Passive Safety systems: Airbag System, Advanced Driver Assistance System (ADAS), Anti-theft systems, Fundamentals of Diagnostics, Self Diagnostic System, On-Board Diagnostics and Off-Board Diagnostics, Importance of Reliability in Automotive Electronics, Reliability Testing with example, Environmental and EMC Testing for Automotive Electronic Components, ISO, IEC and SAE Standards.

**Text Books:**

1 Williams B. Ribbens, **"Understanding Automotive Electronics**", *Newnes*, (7th Edition), (2003).
2 Robert Bosch, **"Automotive Electronics Handbook"**, *John Wiley and Sons*, (1st Edition), (2004).

**Reference Books:**

1 Ronald K Jurgen, **"Automotive Electronics Handbook",** *McGraw-Hill*, (2nd Edition), (1999).
2 James D Halderman, **"Automotive Electricity and Electronics",** *PHI Publication* , (1st Edition), (2005).
3 Tom Denton, **"Automobile Electrical & Electronic Systems",** *Routledge*, (4th Edition), (2002).
4 Tom Denton, **"Advanced Automotive Diagnosis",** *Elsevier*,(2"d Edition), (2006).
5 V.A.W. Hillier, **"Fundamentals Automotive Electronics",** *Oxford University Press*, (6th Edition), (2014).
6 Mehrdad Ehsani, Ali Emadi, Yimin Gao, **"Modern Electronic, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press*, (2nd Edition), (2009).
7 Terence Rybak, Mark Steffka, **"Automotive Electromagnetic Compatibility (EMC)"**, *Springer*, (2004).

**Online Resources:**

1 **NPTEL Course "Fundamentals of Automotive Systems"** https://onlinecourses.nptel.ac.in › noc20_de06 › preview

## 20OE601C Avionics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Control Systems, Basics of Communication System

**Course Objectives:**
1 To integrate the digital electronics with cockpit equipment
2 To understand the various principles in flight desk and cockpit panels.
3 To understand the communication techniques used in aircraft.
4 To explain the modern era of flight control system

**Course Outcomes:** The student will be able to
1 Identify the mechanical and electronic hardware required for aircraft.
2 Compare the communication and navigation techniques used in aircrafts.
3 Disseminate the autopilot and cockpit display related concepts.
4 Compare and identify different actuators in avionics.

**Unit 1: Introduction to Avionics (08)**
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

**Unit 2: Digital Avionics Bus Architecture (07)**
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies.

**Unit 3: Flight Deck and Cockpit (07)**
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

**Unit 4: Avionics Systems (06)**
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals- Certification-Military and civil aircrafts.

**Unit 5: On Board Navigation Systems (07)**
Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.

**Unit 6: Basics of Final Control Element (06)**

Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

**Text Books:**

1 R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.

2 N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

**Reference Books:**

1 Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2 Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3 Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4 Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

## 20OE601D Bioinformatics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2 To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3 To understand the concepts and types of Phylogeny.

**Course Outcomes:** Students will be able

1 Apply basic concepts of bioinformatics to biological data analysis.
2 Classify different types of biological databases.
3 Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4 Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

**Unit 1: Introduction to Bioinformatics (06)**

Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

**Unit 2: Bioinformatics Databases (08)**

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

**Unit 3: Algorithms for bioinformatics (08)**

Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

**Unit 4: Sequence Analysis (08)**

Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms

**Unit 5: Sequence Alignment (06)**

Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

**Unit 6: Phylogeny (06)**

Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

**Text Books/Reference Books:**

1 Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2 Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3 N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4 Bioinformatics: Databases and Systems, by Stanley I. Letovsky
5 Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6 Mathematical Biology & Medicine), by SorinDraghici
7 Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8 Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

## 20OE601E COMPUTER VISION

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite:**20EC501 Digital Signal Processing

**Course Objectives:**
1 To introduce major ideas, methods and techniques of Computer Vision algorithms
2 To introduce fundamentals of Image formation
3 To explain concepts of Camera Calibration and Stereo Imaging
4 To explain different Background Subtraction techniques and Motion tracking algorithms

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the fundamentals of Image formation, Camera calibration parameters and Stereo Imaging |
| CO2 | Apply camera calibration concepts to calculate intrinsic and extrinsic parameters of camera |
| CO3 | Explain different Background Subtraction techniques and Calculate the Performance measures of it. |
| CO4 | Select the appropriate feature extraction techniques according to the requirement of the applications |
| CO5 | Analyze the appropriate Background Subtraction techniques and Object tracking algorithms according to the requirement of the applications |

**Unit I: Camera Calibration (07)**
Geometrical primitives and transformations, 3D to 2D projections, Image Formation, Capture and Representation, Camera Calibration and parameters, Digital camera.

**Unit II: Stereo Imaging (08)**
Stereo Vision: Epipolar geometry, Rectification, Correspondence, triangulation, RANSAC algorithm, Dynamic programming.

**Unit III: Visual Features and Representations (09)**
Edge, Blobs, Corner Detection, SIFT, SURF, HoG.

**Unit IV: Background Subtraction Techniques for Moving Object Detection (09)**
Frame differencing, Mean and Median filtering, Gaussian Mixture Model (GMM), Kernel density estimation, Applications.

**Unit V: Motion Tracking (09)**

Motion tracking using Optical flow, blob tracking, Colour feature based mean shift, Kalman tracking, Applications.

**Text Books:**

1 D. Forsyth, J. Ponce, **"Computer Vision, A Modern Approach"**, *Prentice Hall*, (2nd Edition), (2003).
2 R. Szeliski, **"Computer vision algorithms and applications",** *Springer-Verlag*, (2nd Edition), (2010).

**Reference Books:**

1 L. G. Shapiro, George C. Stockman**, "Computer Vision"**, *Prentice Hall*, (1st Edition), (2001
2 E. Trucco, A. Verri, **"Introductory Techniques for 3-D Computer Vision"**, *Prentice Hall*, (1st Edition), (1998)
3 D. H. Ballard, C. M. Brown, **"Computer Vision"**, Prentice Hall, (1st Edition), (1982).
4 M. Sonka, V. Hlavac, R. Boyle, **"Image Processing, Analysis, and Machine Vision",** *Thomson Press*, (3rd Edition), (2011).

**Online Resources:**

NPTEL Course **"Computer Vision"**

1 https://nptel.ac.in/courses/106/105/106105216/
2 http://www.ai.mit.edu/projects/vsam/Publications/stauffer_cvpr98_track.pdf
3 https://people.cs.rutgers.edu/~elgammal/pub/ieeeproc-paper-final.pdf
4 http://www.cs.cmu.edu/~16385/s15/lectures/Lecture24.pdf

## 20OE 601F Design Thinking

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| Tutorial: - | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisite:**

**Course Objectives:**

Familiarize students with

1 Design thinking process
2 User centric approach for designing a solution
3 Problem analysis with various methods
4 Applications of Design Thinking

**Course Outcomes:**

Students should be able to

1 Analyze problems with various methods
2 Recommend a solution based on empathy, ideation, prototyping, and playful testing
3 Apply design thinking methods to generate innovative and user centric solutions
4 Test designed prototypes to reduce risks and accelerate organizational learning

**Unit I: Design and Design Problems 8 Hours**

What is Design? The components of design problems; measurement, criteria and judgement in design

A model of design problems – Defining problems: Selecting goals and diverse teams, creating a unified vision and scope, mapping stakeholders and personas; Analysing design problems, generators of design problems, roles of generators, design constraints

**Unit II: Design Solutions 8 Hours**

Solutions to Design Problems: Designer's response: procrastination, non-committal design and throw away design, design problems and solutions
Design Process: define, search, ideate, prototype, select, implement, learn, Refresher and restate the challenge, getting inspiration, understanding innovation ambition, Solution ideation, Narrowing solution choice, Solution evaluation, Road map

**Unit III: Design Thinking 9 Hours**

Types and Styles of Thinking – theories of design, types of thinking; creative thinking - what is creativity? creativity in design, Principles of design thinking

**Unit IV: Design Philosophies and Strategies 9 Hours**

Theory and practice, three early phases of working on the same problem
Prototype Creation: Choosing a prototype approach, user interface prototypes, applications vs custom build, reference architectures, prototype and solution evaluation

**Unit V: Design Tactics and Traps 8 Hours**

Methods and Tactics, understanding the problem, the model of problems, One or many solutions? Common traps and ways of avoiding them

**Text Books:**

1 Bryan Lawson, "How designers think: The design process demystified", 2nd Edition, Butterworth Architecture
2 Nigel Cross, "Design Thinking", Berg Publishers - 2011

**Reference Books:**

1 Ben Crothers, "Design Thinking Fundamentals", O'Reily

2 Tim Brown, "Change by Design: How Design Thinking Transforms Organizations", HarperCollins – 2009

3 Susan Weins Chenk, "Hundred things every designer needs to know about people", New Riders Publication

4 Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley Publication

5 Roger L. Martin, "Design of Business: Why Design Thinking is the Next Competitive Advantage" Harvard Business Press

6 Karl Ulrich, "Design: Creation of Artifacts in Society" - 2011

7 Bala Ramadurai, "Karmic Design Thinking"

8 T. Amabile, "How to kill creativity", SAGE Publication - 2006

9 William Lidwell, Kritina Holden, Jill Butler, "Universal principles of Design ", Rockport Publishers

10 Bella Martin, Bruce Hanignton, Bruce M Hanington "Universal methods of design", Rockport Publishers - 2012

11 Roman Kizanie, "Empathy: Why it matters, how to get it", TarcherPerigee Publishers

12 Karla McLaren, "The Art of Empathy: A complete Guide to life's most essential skill", Sounds True Publishers

# 20OE601G e-Business

**Teaching Scheme** **Examination scheme:**
**Lectures:** 3 Hours / Week
In Semester**:** 50 Marks
End Semester**:** 50 Marks
Credits: 3

**Prerequisite:** No Prerequisites

**Course Objectives:**
To facilitate the learners to-
1. Understand the technological, economic and social phenomena behind rapid changes in the e-businesses.
2. Have a good working knowledge of e-business concepts, applications and technologies.
3. Understand the e-business models and infrastructure.
4. Learn how e-business concepts are applied to different fields, such as: education, banking, tourism and so on.
5. Inspire with online business ideas and motivate them to apply in the real life.
6. Study the new trends in e-business, e-commerce

**Course Outcomes:**
By the end of this course, students will be able to

| | |
|---|---|
| CO1 | Explain the concepts of e-business and e-business models |
| CO2 | Apply suitable principles and practices of designing and developing e-business website |
| CO3 | Apply necessary back end system components required for successful e-business implementations |
| CO4 | Outline the meaning of e-business security and how it impacts the business |
| CO5 | Relate e-business, BI and KM to fulfil modern e-business trends |

**Unit I: Introduction (07)**
E-commerce and e-business, advantages of e-business in growth of a business, Transition from traditional business to e-business, features of e-business technology, e-business models, IT Infrastructure requirements of e-business Case Study : Various e-business models

**Unit II: Building e-business Websites (07)**
Issues involved in designing a website, designing in-house websites, steps involved in website development, e-business and website development solutions, Advantages of using an e-business solution, selection of a suitable e-business solution, security issues involved in websites, tracking and analysing website traffic data. Digital Marketing Case Study

**Unit III: e-Business Infrastruture / Back end Systems (07)**
Back end system support requirements - security, scalability, availability, adaptability, manageability, maintainability, assurance, interoperability, load balancing; internet technology, World Wide Web, Internet software; Content management, Case Study

**Unit IV: e-security & online payment systems (07)**

e-Business security policy, risks and risk assessment, practice guidelines to e-security, legal framework and enforcement, ethical, social and political issues in e-business

Performance characteristics of online payment systems, online payment methods, security and risk handling in online payments, fraud detection in online payments, IT Act 2000, digital signatures, digital certificates, and PKI; Case Study

**Unit V: Knowledge management & BI for strategic e-business (08)**

From information processing to knowledge world, aligning knowledge with business, knowledge management platforms, state of knowledge and measuring parameters; knowledge industry, knowledge strategy, and knowledge workers

Business and Intelligence - applications and importance of business intelligence, implementation of intelligence, building BI systems, selecting BI tools, integrating BI and KM, decision-making and BI, Case Study

**Unit V: Launching an e-Business and e-business trends (06)**

Launching a successful e-business – requirement analysis, managing Web site development, search engine optimization, Evaluate Web sites on design criteria.

Future and next generation of enterprise e-business, challenges and new trends, ethical and regulatory issues

**Text Books:**

1. Papazoglou, Michael and Pieter Ribbers, "E-Business : Organizational and Technical Foundations", John Wiley, 2nd Edition (Sept 2011).
2. Parag Kulkarni, Sunita Jahirabadkar, Pradeep Chande, "E-Business", Oxford University Press (May 2012)

**Reference Book:**

1. Daniel Amor, "The E-business (R)evolution", Prentice Hall PTR (2000)
2. Kenneth Laudon, Carol Guercio, "E-commerce : Business, Technology, Society", Prentice Hall, 4th Edition (January 2008).
3. Kalakota Ravi, Marcia Robinson, "E-Business 2.0 – Roadmap for Success", Pearson Education, 2nd Edition (2004).

## 20OE601H - Electric Vehicles

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| Tutorial: - | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**

1 Understand and identify and integrate EV subsystems
2 Learn and find energy storage requirements for vehicle application
3 Comprehend design of battery thermal management system
4 Undestand calculations of motor power ratings for an EV application
5 Study suitable type of sensors for EV applications
6 Study appropriate control strategy for EV

**Course Outcomes:**
Students should be able to
1 To identify and integrate EV subsystems
2 To calculate energy storage requirements for vehicle application
3 To select and design battery thermal management system
4 To calculate motor power ratings for an EV application
5 To select a suitable type of sensors for EV applications
6 To select appropriate control strategy for EV

**Unit 1: Introduction to hybrid and electric vehicles:** (6)
Engineering case, legislative push, incentives, market pull. EV : micro to mild to PHEV to HEV to REEV to EV - Hybrid-Electric Vehicle Power trains, Vehicle Energy Storage System Design, System and sub-systems, Modelling and design of EVs as a system, Motors & motive power spilting concepts, and interface within power train system

**Unit 2: Power train architecture:** (6)
Parallel, Series and Combined, Types of EVs, Vehicle layout and packaging options, Duty Cycles in Indian cities; performance, Components of Power Train**,** Auxiliary Inverter, HV-LV DC-DC converter, Traction Inverter, Gear Trains, Integration of power train components, regenerative brakes

**Unit 3: Introduction to Energy Storage** (6)
Energy storage requirements for vehicle applications, Storage technologies and metrics for comparison, Distribution of Energy, Storage Form of Energy, Intermediary Conversion, Control and Diagnostic, Ragone Chart, Theory of Ragone Plots. Ragone Plot of a Battery

**Unit 4: BMS, Packing and Charging:** (6)

Battery Management Systems (BMS), Lithium-Ion Batteries Aging Effects. Battery characterization and testing systems, Thermal management & Battery life cycle, Modular battery packs, packaging, thermal control, Changing Systems and Infrastructure

**Unit 5: Electric Drives** (6)

DC motors, induction motors and synchronous motors, permanent magnet motors, BLDC, switched reluctance motors, Switched Reluctance Motors (SRM),Permanent Magnet Synchronous Motor (PMSM)

**Unit 6: Sensors in Electric Vehicles:** (6)

MEMS Sensors for Engine Management, Battery Monitoring Sensors, State of the Charge Sensing, Sensors for Passenger Safety, Sensors for Skidding and Rollover Detection, Tire Pressure Sensors, Electronic Stability Control of Vehicles, Sensors for Antitheft, Vehicle Navigation Sensors. EV sensors of Texas Instruments, STM, NXP, etc.

**Books:**

1 Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Celll vehicles-Fundamentals - Theory and Design", CRC Press
2 Energy Storage by Robert A. Huggins, Springer Publication
3 Chang Liang Xia,Permanent Magnet Brushless Dc Motor Drives and Controls, Wiley 2012.
4 Katsuhiko Ogata, "Modern Control Engineering" 5th edition, Prentice Hall of India Private Ltd., New Delhi, 2010.
5 Cooper W.D & Hlefrick A.D., Electronic Instrumentation Measurement Technique, III Edition, Prentice Hall of India – 1999

## 20OE 601I Gamification

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 To develop problem solving abilities using gamification.
2 To identify the various methods of gamification.
3 To apply gamification mechanics to solve a problem.
4 To make use of gamification tools to solve a problem.

**Course Outcomes:**
After completion of the course, students will be able to
1 To apply steps of problem solving using gamification.
2 To analyze player motivation and counter gamification.
3 To develop game using game mechanics.
4 To apply tools of gamification to real life applications.

Gamification is about applying game concepts, driving engagement into non game environments/contexts like a website designing, online community for interactive discussion, a fun way of learning management system for engagement of stakeholders etc.

Gamification is NOT about designing fancy games, video games, virtual reality games etc. Therefore this course does NOT cover games and game design aspects. Course will also discuss the negative impact and influence of games (when played in excess) on young minds like addiction to video games, over spending time for games.

**Unit I: Gaming Foundations (6)**
Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

**Unit II: Player Motivation (7)**
Powerful Human Motivators, Why People Play, Player types, Social Games, Intrinsic verses Extrinsic Motivation, Progression to Mastery, Case studies for Thinking: Tower of Hanoi,Concepts Applied to Video games and Gamification.

**Unit III: Counter Moves in Gamification (8)**
Reclaiming Opposition: Counter gamification, Gamed Agencies: Affectively Modulating Our Screen-and App-Based Digital Futures, Remodeling design, Designing for Engagement, Case study of Maze Problem.

**Unit IV: Game Design (8)**

Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, Putting it together, Case study of 8 queens problem.

**Unit V: Game Mechanics and Applications (7)**

Gamification case Studies, Coding basic game Mechanics,Gamification Applications : Education,Healthcare,Marketing,Gamification for Machine Learning.

**Unit VI: Gamification Platforms (6)**

Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server
(ref: https://github.com/ngageoint/gamification-server).

**Text Books:**

1 Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press,2014, ISBN: 978-3-95796-000.
2 Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly,August 2015, ISBN: 978-1-449-397678.

**Reference Books:**

1 B. Burke, Gamify: How Gamification Motivates People to Do Extraordinary Things, Gartner 2014,ISBN:1937134857.
2 **Stieglitz**, S.**Lattemann**, C.**Robra-Bissantz**, S.**Zarnekow**, R.**Brockmann**,Gamification :Using Game Elements in Serious Contexts,2016,ISBN: 978-3-319-45557.

## 20OE 601J Geographical Information Systems

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Learn basics of GIS
2 Understand representation of GIS models
3 Relate GIS and DBMS for various applications, analyze and visualize the spatial data
4 apply GIS to supply chain management

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basics of GIS to database design
2 Make use of various data models to given data
3 Apply data editing techniques to spatial data
4 Apply spatial data analysis to GIS data
5 Create maps using ArcGIS
6 Apply GIS in supply chain management

**Unit I: Introduction to GIS (05)**
Define GIS, GISystems, GIScience, Spatial and Geoinformation, Components of GIS, Recent trends and applications of GIS; Data structure and formats, Spatial data models – Raster and vector, Database design- editing and topology creation in GIS, Linkage between spatial and non-spatial data, Data inputting in GIS. Rectification, Transformation Methods; Root Mean Square (RMS) Error

**Unit II: Data Types and data models (05)**
Data Types; Spatial Data; Non-Spatial Data, Data Input; Existing GIS Data, Metadata; Conversion of Existing Data, Creating New Data, Data Models; Vector Data Model; Raster Data Model; Integration and Comparison of Vector and Raster Data Models.

**Unit III: Data Exploration and spatial data editing (08)**
Attribute Data in GIS, Attribute Data Entry, Manipulation of Fields and Attribute Data, Data Exploration; Attribute Data Query, Raster Data Query, Map- Based Data Manipulation, Types of of Digitizing Errors, Causes for Digitizing Errors; Topological Editing and Non-topological Editing; Other Editing Operations; Editing Using Topological Rules.

**Unit IV: Spatial data Analysis (08)**

Spatial Data: Definition, Analysis, Processes & Steps, Software and Tools, Geodatabase Model, Role of Databases in GIS, Creating, Editing and Managing, Classification scheme of Vector-Based and Raster- Based GIS Operation Raster- Based Techniques: Methods of reclassification, overlay analysis, Digital Terrain Analysis and Modeling- TIN and DEM, Surface representation and analysis, Slope and Aspect, Geographic Visualization Data Classification

**Unit V: ArcGIS (08)**

Introduction, Geographical terms, ArcMap main window, Coordinate system, Georeferencing, Generation of vector referencing, Table administration, Geoprocessing tools, spatial analysis, Design and publication, API for ArcGIS

**Unit VI: Trends and applications (08)**

Need for GIS network analysis in SCM, data for GIS logistic service, understanding logistic management, types of GIS services, supply chain audit, ISRO-Bhuvan, Web GIS

**Text Books:**

1 "Fundamentals of GIS", Franz Pucha et al, 2018
2 "Principles of Geographic Information Systems",Kang-tsung chang, 2017

**Reference Books:**

1 "Essentials of Geographic Information Systems",Jonathan E. Campbell Michael Shin, 2018
2 "Introduction to GIS",Víctor Olaya

## 20OE601K MULTIMEDIA SYSTEMS

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**20EC402 Analog and Digital Communication
**Course Objectives:**

1. To introduce basic concepts and design of Colour TV and Digital TV
2. To explain advanced TV technologies like HDTV, CATV, CCTV, DTH, CAS and case study for live telecast
3. To introduce multimedia compression techniques, standards and multimedia over the internet
4. To familiarize the students with digital recording and playback systems, acoustic design, microphones and loudspeakers

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the concepts of colour TV design, systems and Digital TV |
| CO2 | Discuss and compare advanced TV systems like CATV, CCTV, DTH, HDTV, CAS, Wi-fi TV, 3DTV and different display technologies |
| CO3 | Apply and analyze multimedia compression standards for text, audio, image and video and explain multimedia over the internet |
| CO4 | Compare optical recording techniques, microphones and loudspeakers |
| CO5 | Design acoustics and PA system for auditorium, public meeting, debating hall, football stadium and college classrooms |

**Unit I: Colour and Digital TV (11)**
Resolution, interlaced scanning, BW, CVS, Color TV systems, frequency interleaving, colour difference signals, colour TV receiver, NTSC, PAL, SECAM encoders and decoders, Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters and receivers.

**Unit II: Advanced TV Systems (10)**
HDTV standards and systems, HDTV transmitter and receiver, CCTV, CATV, Direct to Home TV (DTH), Set top box, Conditional Access System (CAS), 3D TV systems, Case study (Cricket match, Marathon, Football match), Wi-Fi TV, Video door phone systems, Display devices: LED, LCD, Plasma.

**Unit III: Multimedia Compression and Multimedia over Internet (11)**

Introduction, Overview, Concept of Multimedia, Multimedia Applications, Text: Types, Compression, Hypertext, Image Compression techniques: JPEG, Multimedia Audio: MIDI, MP3, Video: MPEG, Animation: Introduction, types, 3D animation, Virtual reality, Multimedia over Internet**:** Introduction to Multimedia Services, Transmission of Multimedia over the Internet, IP Multicasting, Explaining VOIP

**Unit IV: Acoustics and Digital Audio Video (10)**

Optical recording, noise, CD, DVD, dual layer DVD, rewritable DVD, Blu Ray DVD, Studio acoustics and reverberation, acoustic chambers, PA system for : auditorium, public meeting, debating hall, football stadium, college hall, Advanced PA systems, Different types of speakers and microphones.

**Text Books:**

1 R. R. Gulati, **"Modern Television Practice",** *New Age International*, (5th Edition), (2015).
2 Ralf Steinmetz, Klara Nahrstedt, **"Multimedia: Computing, Communication and Applications"**, *Pearson Publication*, (8th Edition), (2011).
3 R.G. Gupta, **"Audio and Video Systems"**, *Tata Mcgraw Hills*, (2nd Edition), (2020).
4 Robert D. Finch, **"Introduction To Acoustics",** *PHI*, (2nd Edition), (2007).
5 Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, "**Advance Computer Network"**, *Wiley*, (2nd Edition), (2014).

**Reference Books:**

1 A. M. Dhake, "**Television and Video Engineering**", *Tata Mcgraw Hills*, (2nd Edition), (2003).
2 Ranjan Parekh, **"Principles of Multimedia**", *Tata Mcgraw Hills*, (2nd Edition), (2013).
3 Alec Nisbett , "**The Sound Studio**", *Focal Press*, (5th Edition) , (1993).

**Online Resources:**

**NPTEL Course " Multimedia Systems"**

1 https://nptel.ac.in/courses/117/105/117105083/

**20OE 801A Big Data And Analytics**

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Understand the concepts, challenges and techniques of Big data and Big data analytics
2 Understand the concepts of Hadoop, Map Reduce framework , Spark for Big data analytics
3 Apply skills and tools to manage and analyze the big data
4 Understand latest big data trends and applications.

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basic concepts of big data for the various applications.
2 Apply data analytics life cycle to real-world big data applications
3 Choose Hadoop ecosystem components based on requirement of application
4 Compare Spark and Hadoop architecture
5 Compare various methods used in data Analytics and big data trends.

**Unit I: Introduction (6)**
Database Management Systems, Structured Data, SQL. Unstructured data, NOSQL, Advantages of NOSQL, Comparative study of SQL and NOSQL. Big data overview, characteristics of Big Data, Case study- SAP HANA.

**Unit II: Data Analytic Life Cycle (6)**
Data Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach. Data Analytic Life Cycle: Discovery, Data preparation, Model Planning, Model Building, Communicate Results, Opearationalize. Case Study: GINA

**Unit III: Big Data Architectures, Hadoop (8)**
Introduction to Big Data and Hadoop, Building blocks of hadoop: Ecosystem, HDFS, HBASE, YARN, Map Reduce working.

**Unit IV: Introduction to Spark (7)**
Spark Framework, Architecture of Spark, Resilient Distributed Datasets, Data Sharing using Spark RDD, Operations in Spark;

Introduction to Kafka: need, use cases, components.

**Unit V: Machine learning (8)**

Supervised, unsupervised learning; Classification, Clustering; Time series analysis, basic data analysis using python: libraries,functions.

Text Analysis: Text Pre-processing, Topic modelling algorithms, Text Similarity measure.

**Unit VI: Big Data Trends and applications (7)**

Exploratory data analysis, Big data Visualization using python;

IoT and big data, Edge computing, Hybrid cloud.

Applications of Big data, Case study: E-commerce, healthcare.

**Text Books:**

1 "Data Science and Big Data Analytics", Wiley, 1stEdition (January 2015)
2 "Big Data, Black Book" ,Dreamtech Press (27 May 2015),ISBN-13-978-9351197577

**Reference Books:**

1 Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game",MC Press(November 2012)
2 J.Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "Big Data for Dummies", 1st Edition (April 2013)
3 Tom White, "Hadoop: The Definitive Guide", O′Reilly, 3rdedition (June 2012)
4 Abraham Silberschatz, Henry Korth, S. Sudarshan, "Database System concepts",McGraw Hill Education, 6th Edition (December 2013).
5 Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing (November 2013)
6 Shiva Achari ,"Hadoop Essentials - Tackling the Challenges of Big Data with Hadoop" ,Packt Publishing(April 2015), ISBN:978-1-78439-668-8

**Online/Web/Other References:**

1 https://nptel.ac.in/courses/106/104/106104189/
2 https://hadoop.apache.org/docs/stable/
3 https://kafka.apache.org/documentation/
4 https://spark.apache.org/

## 20OE801B Cyber Physical System

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite:** 20EC404 Embedded System, 20EC603 Control Systems

**Course Objectives:**

1 To introduce modeling of the Cyber Physical System (CPS).
2 To analyze the CPS.
3 To explain the software modules.

**Course Outcomes:**

After completion of the course, students will be able to

1 Categorize the essential modeling formalism of CPS
2 Analyze the functional behavior of CPS based on standard modeling formalisms
3 Apply specific software for the CPS using existing synthesis tools
4 Design CPS requirements based on operating system and hardware architecture constraints

**Unit I: Cyber Physical Systems (CPS) applications and Characteristics (07)**

CPS in the real world, Basic principles of design and validation of CPS, CPS: From features to software components, Mapping software components to Electronic Control Unit (ECU), CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal methods for Safety Assurance of CPS.

**Unit II: CPS physical systems modeling (07)**

Stability Analysis: CLF (Common Lyapunov function), MLF (Multiple Lyapunov function), stability under slow switching, Performance under Packet drop and Noise.

**Unit III: CPS computer systems modeling (07)**

CPS SW Verification: Frama-C, C Bounded Model Checker (CBMC), Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Hybrid Automata Modelling: Flow pipe construction using Flowstar (Flow*), Polyhedral Hybrid Automaton Verifier (Phaver) tools (Reliability testing).

**Unit IV: Operating systems and hardware architecture support for CPS (07)**

CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques, CPS HW platforms: Processors, Sensors, Actuators, CPS Network.

**Unit V: Analysis and verification of CPS (07)**

Advanced Automata based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, Reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

**Unit VI: CPS case studies (07)**

Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

**Text Books:**

1 Lee, Edward Ashford, and SanjitArunkumarSeshia, "Introduction to embedded systems: A cyber physical systems approach", MIT Press, (2nd Edition), (2017).
2 Rajeev Alur, "Principles of Cyber-Physical Systems". MIT Press, (1st Edition), (2015).
3 Wolf, Marilyn, "High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing". Elsevier, (1st Edition), (2014).

**Reference Books:**

1 P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag, ($1^{st}$ Edition), (2009).
2 Raj Rajkumar, Dionisio De Niz , and Mark Klein, "Cyber-Physical Systems", *SEI Series in Software Engineering*, ($1^{st}$ Edition), (2018).
3 André Platzer, "Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics", *Springer*, ($1^{st}$ Edition), (2010).
4 Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", *CRC Press*, ($2^{nd}$ edition), (2011).

**Online/Web/Other References:**

1 Coursera course, Cyber Physical system modelling
https://www.coursera.org/learn/cyber-physical-systems

## 20OE801C Digital Control

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Basics of Control Systems

**Course Objectives:** To
1 Understand the basic components of a digital control system.
2 Design various Digital Controllers and Study response of those controllers.
3 Learn and understand the stability of the system in the Z plane.
4 Introduce Optimal Control Design and Its need.

**Course Outcomes:** Students will be able to

1 Analyse system design in various planes S-W-Z and its mapping.
2 Analyse system stability in the S and Z plane.
3 Design and analyse systems using classical methods and State Space.
4 Design Optimal Control for a Discrete System.

**Unit 1: Introduction to Discrete Time Control System (08)**
Basic building blocks of Discrete Time Control System, Sampling Theorem, Choice of Sampling Rate, Z Transform and Inverse Z Transform for applications of solving Differential Equations, Impulse Sampling, Reconstruction – Zero Order Hold

**Unit 2: Pulse Transfer Function and Digital Controllers (08)**
Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop System, Pulse Transfer Function of Digital PID Controller, Design of Deadbeat Controller

**Unit 3: Stability Analysis of Discrete Control System (08)**
Stability regions in S plane W plane and Z plane, Mapping between three planes, Stability Tests for Discrete Systems

**Unit 4: Design of Discrete Control System by State Space Approach (07)**
Different Canonical Forms, Relation between Pulse Transfer Function and State Equation, Solution of Discrete Time State Space Equations, Eigen Values, Eigen Vectors

**Unit 5: Pole Placement and Observer Design (07)**

Concept of Controllability and Observability, Pole Placement Design by State Feedback, Design of Feedback Gain Matrix by Ackerman's Formula, State Observer Types.

**Unit 6: Introduction to Optimal Control (05)**

Basics of Optimal Control, Quadratic Optimal Control, Performance Index.

**Text Books:**

1 K. Ogata, "Discrete Time Control Systems", Prentice Hall, Second Edition.
2 M. Gopal, "Discrete Control and State Variable Methods", Tata McGraw Hill.
3 Kannan Moudgalya, "Digital Control", John Wiley and Sons.

**Reference Books:**

1 G. F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, Third Edition.
2 M. Gopal, "Digital Control Engineering", Wiley Eastern LTD.
3 Forsytheand W, Goodall R, "Digital Control".
4 Contantine H. Houpis, Gary B. Lamount, "Digital Control Systems", McGraw Hill International, Second Edition.

## 20OE801D Industrial Engineering and Management

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
The Industrial Engineering course prepares students to…
1 Understand type of organisation and calculate partial and total productivity
2 Learn the fundamental knowledge, skills, tools and techniques of methods study and work measurement.
3 Understand type of production environments, resource planning and control methods.
4 Learn basic resource scheduling techniques, human resource management and industrial safety norms.

**Course Outcomes:**
Students will be able to
1 Identify type of organisation and analyze partial and total productivity
2 Manage and implement different techniques of methods study and work measurement of process under consideration for improvement.
3 Analyze production environment under consideration w.r.to its resource planning and control.
4 Apply basic resource scheduling and human resource management techniques.

**1 Introduction to Industrial Management and Productivity Analysis 6**
1 Industrial management: Functions and principles of management; Organisation: Concept, characteristics, structures and types of organisation- (formal line, military, functional, line and staff organisation);
2 Productivity analysis: Definition, measurement of productivity: productivity models and index (numerical); factors affecting the productivity; productivity improvement techniques;
3 Definition and scope of Industrial Engineering.

**2 Method Study 7**
1 Work Study: Definition, objective and scope of work-study.
2 Method Study : Definition, objective and scope of method study, activity recording and exam aids, Charts to record moments in shop - operation process charts, flow process charts, travel chart, two handed chart and multiple activity charts. Charts to record movement at work place - principles of motion economy, classification of moments, SIMO chart, and micro motion study. Definition and installation of the improved method;
3 Human factors in Work-Study;
4 Value Engineering and Value Analysis.

| | | | |
|---|---|---|---|
| **3** | | **Work Measurements** | **6** |
| | 1 | Introduction: Definition, objectives and uses; Work measurement techniques: | |
| | 2 | Time study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination(numerical); | |
| | 3 | Work sampling: Need and procedure, sample size determinations (numerical); | |
| | 4 | Synthetic motion studies: PMTS and MTM. Introduction to MOST (numerical). | |
| **4** | | **Production Management** | **7** |
| | 1 | Production Planning and Control: Types of production systems, functions of PPC, Aggregate production planning; Master Production Schedule; ERP | |
| | 2 | Forecasting techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality; (Numerical). | |
| | 3 | Supply Chain Management: Concept, Strategies, Supply Chain Network, Push and Pull Systems, Logistics, Distribution; Order Control strategies: MTO, MTA, MTS. | |
| **5** | | **Facility Management** | 6 |
| | 1 | Facility Layout: Factors affecting facility location; Types of Plant Layout; Computer Aided Layout Design Techniques; Assembly Line Balancing (Numerical); | |
| | 2 | Material Handling and Inventory Control: Principles, Types of Material Handling Devices; Stores Management, Inventory costs, Types of inventory models - Deterministic and Probabilistic, Concept of EOQ, purchase model without shortages (Numerical); ABC and VED Analysis (Numerical). | |
| **6** | | **Project Scheduling, Human Resource and Industrial Safety** | 6 |
| | 1 | Scheduling Techniques: CPM and PERT(Numerical); | |
| | 2 | Human Resource Development: Functions: Manpower Planning, Recruitment, Selection, Training; Concept of KRA (Key Result Areas); Performance Appraisal (Self, Superior, Peer, $360^0$); | |

**Text Books:**

1 Industrial Engineering and Production Management, M Mahajan, Dhanpat Rai and Co.
2 Industrial engineering and management by O. P. Khanna, Dhanpatrai publication
3 Industrial Engineering , Martend Telsang, S. Chand Publication.
4 Industrial Organisation & Engineering Economics by Banga and Sharma, Khanna publication.
5 Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
6 J. K. Sharma, Operations Research : Theory And Application, Laxmi pub. India.

**Reference Books:**

1 Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008
2 Maynard's Industrial Engineering Hand Book By H.B. Maynard, KJell, McGraw Hill Education, 2001
3 Zandin K.B. - Most Work Measurement Systems, ISBN 0824709535, CRC Press, 2002.

Assignment based evaluations are designed. **This evaluation is treated as T1-Marks**. Marks will be calculated (at the end of semester) on the basis of successful completion / submission of assignments explained to you time to time on the basis of syllabus content. [Note: these assignments are part of activity based learning. Hence, students are to work in a group to complete following assignments].

| Assignment Details | Mapped COs |
|---|---|
| 1. Case study based Assignment on Method Study. [Data may be collected from: 1) Day to day activity : Workshop, Library, Admin area, Canteen, Parking 2) Students visiting industrial area for project 3) Quality concept Assignments in a Group.] | **CO1** |
| 2. Hands on Assignment on application of Work Measurement technique(s). [1) Using stopwatch work measurement can be completed. (E.g. in workshop)] | **CO1, CO1** |
| 3. Simulation / Assignment on Routing & Scheduling Model. [Open Source Softwares 1) Flexsim (Videos are available online) 2) Arena - Student Version 3) Pro model – Student Version 4) Excel templates available online. Note: Backward / Forward Scheduling concepts are to be included.] | **CO1, CO4** |
| 4. Assignment on simulation of Manufacturing System / Service System Operations for demand forecasting of the given product using any two methods. [1) Data from shops malls, manufacturing company, etc.] | **CO1, CO4** |
| 5. Assignment on simulation determination of EOQ and plot the graphs. [1) Use of any freeware available.] | **CO1, CO4** |
| 6. Assignment on analysis of Manufacturing / Service Operation for Capacity Planning. [1) Define capacity term for the real life environment you are working for (e.g. foundry= tons of casting, hospital = no. of bed, etc.) 2) Study and collect the data of Variation in demand and capacity planning. 3) Analysis the pattern of data set and report… how they manage the change in capacity.] | **CO1, CO4** |
| 7. Case study based assignment on supply chain model. [1) Select any real life supply chain (any engineering product processing, vendors for vegetable grocery, etc.) 2) Identify all major supply chain elements and prepare supply chain diagram and report.] | **CO1, CO4** |
| 8. Assignment on analysis of (selected) plant layout modeling / Simulation for bottleneck / line balancing. [Plant layout with its detail (with Scale) and identify the type.] | **CO1, CO4** |
| 9. Assignment on analysis of material handling system - for the selected plant layout. [This assignment must be completed with the help of plant layout visited in earlier assignment.] | **CO1, CO4** |
| 10. Case study based assignment on identification of Key Result Areas for performance appraisal for selected company (3600 feedback). [Real life case studies.] | **CO1, CO4** |
| 11. Assignment on industrial safety audit of selected work environment. [Download standard questionnaire and visit any work environment and submit it as assignment.] | **CO1, CO4** |
| **Note**: If student groups working with industry for their project, they are advised to collect data related to above mentioned assignments for submission. | |

## 20OE 801E Introduction to Cyber Crime and Forensics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
**To facilitate the learners to-**

1 Learn fundamental concepts of cyber security
2 Understand Security challenges presented by mobile devices and information system access in cybercrime world
3 Learn tools used in Computer forensics and Cyber Applications
4 Understand risks associated with social media networking

**Course Outcomes:**
**By taking this course the learner will be able to-**

1 Classify Cyber Crimes
2 Identify threats and risks within context of Cyber Security
3 Outline Relevant laws and Acts in Cyber Security
4 Appraise various roles and tools used in Cyber Security/ Digital forensics

**Unit I: Introduction to Cybercrime: (7)**
Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Ethical dimensions of cybercrime,Ethics and Morality,Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes

**Unit II: Cyber Offenses**: **(7)**
How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Typical Cyber Crimes like Social Engineering, Cyber stalking, Cyber Defamation, Intellectual property Infringement Botnets: The Fuel for Cybercrime, Dark net

**Unit III: Cybercrime:Mobile and Wireless Devices** : **(8)**
Introduction, Trends in Mobility, Financial Frauds in Mobile and Wireless Computing, Security Challenges Posed by Mobile Devices, structure of Sim card, Sim card forensics, Sim card cloning, Organizational Measures for Handling Mobile,Mobile Apps and cybercrime, Whats app forward frauds, End point detection systems, End point detection systems in devices in organisation

**Unit IV: Methods Used in Cybercrime: (8)**
Introduction, Proxy Servers and Anonymizers,Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow

**Unit V: Digital Forensics- (6)**
Introduction to Digital Forensics, Forensics Software and Hardware, Evaluating computer forensic tools , Software tools and Hardware Tools, New Trends, Mobile forensics for android, Sample Case studies.

**Unit VI: Cyber Security Tools- (6)**
wireshark, Nmap, Nessus, Ncat, Burp Suite, Snort, Nikto Carer Opprtunities and trends in Cyber Security.

**Text Books:**

1 Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA. ISBN 978-81-265-2179-1
2 Information Security & Cyber Laws By Sarika Gupta, Gaurav Gupta,Khanna Publication ISBN: 978-93-810-6824-3 2019
3 Computer Forensics and Investigations Bill Nelson, Amelia Phillips and Christopher Stuart Cengage learning. ISBN 978-81-315-1946-2

**Reference Books:**

1 Intoduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group
2 Eoghan Casey,"Digital evidence and computer crime Forensic Science,Computers and the Internet , ELSVIER,2011 ISBN 978-0-12-374268-1

## 20OE801F Instrumentation in Food and Agriculture

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Basics of sensors and transducers, knowledge of Unit operations and basics of process control, PLC and pneumatic and hydraulic instrumentation

**Course Objectives:**
1 To know the scope of Instrumentation in agriculture field
2 To know greenhouse, food packaging automation schemes
3 Understand sensors used in agriculture field and weather monitoring stations
4 To get acquainted with food quality standards

**Course Outcomes:** The student will be able to
1 Identify the different unit operations, process control equipments involved in different types of process industries
2 Select appropriate measurement techniques for measurement of various process parameters related to soil, green house, Dam and agro-metrology
3 Analyse and develop various control loops for processes involved in various food processing plants
4 Assess various automation tools to develop automation strategy to Dam, Green house, food processing and packaging in accordance to various food standards

**Unit 1: Process Control in Agriculture and Food Industries (08)**
Sensors in Agriculture (Hygrometers, Anemometers, fine wire thermocouple, etc), Sensors in Food (ph, temperature sensor for pasteurization, brix sensor, etc), Flow diagram of some continuous processes like sugar plant, dairy, juice extraction, etc & batch process (Fermentation)

**Unit 2: Instrumentation in Irrigation and Green House (09)**
SCADA for DAM parameters & control, irrigation canal management systems, Auto drip & sprinkler irrigation systems
Green House Automation: Construction of green houses, Sensors for greenhouse, Control of ventilation, cooling & heating, wind speed, temperature & humidity

**Unit 3: Instrumentation in Farm equipments, Food Safety and Sanitation (09)**
Instrumentation for farm equipment: Implementation of hydraulic, pneumatic and electronic control circuits in harvesters cotton pickers, tractors, etc; Classification of pumps, pump characteristics, selection and installation.
Food safety standards (Food safety and standards bill 2005, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products)
Sanitation regulatory requirements: Sanitation standards operating procedure (SSOP's), Sanitation performance standards (SPS), 11 principles of sanitary facility design, Sanitation best practices.

**Unit 4: Automation in Food Packaging (08)**

Ware house management, Cold Storage Units, PLC and SCADA in food packaging

**Unit 5: Smart Instrumentation in Agriculture and Food Industries (08)**

Wireless sensors, Application of IOT in agriculture and food industries, application of Image processing in agriculture and food industries, application of robots in agriculture and food industries, Case studies.

**Text Books:**

1 D. Patranabis, "Principles of Industrial instrumentation", TMH (2010), ISBN-13: 978-0070699717
2 Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3 Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015,Person, ISBN: 9789332549456, 9332549451
4 Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584

**Reference Books:**

1 Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812
2 Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
3 Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-084933862

## 20OE801G Medical IoT

| **Teaching Scheme** | **Examination scheme:** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisites:**

**Course Objectives:**

1 To understand smart Objects and IoT Architecture
2 To learn sensor Interfacing
3 To learn IoT Protocols
4 To build simple IoT based Health care system

**Course Outcomes:**

1. Ascent the basic concepts of IOT in healthcare
2. Relate the existing hardware platforms and sensor interfaces for various healthcare-based Applications
3. Comprehend the ways of communication between the client and the server in IOT
4. Build various applications in healthcare using IOT based approach with appropriate case studies.

**Unit 1: Medical Measurements (06)**

Cardiovascular system, respiratory system, nervous system etc. Measurement of Heart, Brain and Muscle activity using wearable sensors. Monitor health parameters like Blood Pressure, ECG, EMG, EEG, HR, RR, SPO2 etc.

**Unit 2: Sensors & Smart Patient Devices (08)**

Role of Wearables, Challenges and Opportunities, Future of Wearables, Social Aspects, Wearable Haptics, Intelligent Clothing, Industry Sectors' Overview – Sports, Healthcare, Military, Environment Monitoring, Mining Industry, Public Sector and Safety.

**Unit 3: Wearable mechatronics device (08)**

Accelerometers, Gyroscopic Sensors; In – Shoe Force and Pressure Measurement its applications. Physical Activity Monitoring: Human Kinetics, Cardiac Activity.
Cuffless Blood Pressure Monitor, Study of Flexible and Wearable Piezo resistive Sensors for Cuffless Blood Pressure Measurement, Wearable Pulse Oximeter, Wearable Sweat Analysis, Wearable Heart Rate Measurement.

**Unit 4: Device Connectivity and Security / Biomedical Sensors with Internet connectivity (08)**

Gateway, Embedded Systems for devices like RPi, Arduino, etc, Protocols as applied to medical devices.
Sensor interface: Temperature sensor, pressure sensor, optical sensor etc. Wireless body area network. IoT Privacy and Security.

**Unit 5: Data Analytics for Medical Applications (06)**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit 6: IoT in Biomedical Applications - Case Studies (06)**

Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Applicatio development in mobile and cloud Environments.

Case Study1: Wireless Patient Monitor system; Design an IoT System for Vital Sign Monitors Weight measuring device, Blood pressure measuring device, ECG, Blood glucose measuring Heart rates measuring devices and Pulse Oximeters etc.

Case Study2: Wearable Fitness & Activity Monitor; Walking time measuring device ii. Ste counting device iii. Speed measuring device iv. Calorie spent measuring device v. Time spent i rest or sleeping measuring device.

**Text Books:**

1 Joseph D. Bronzino, "Handbook of Biomedical Engineering", 2nd edition –Volume II, CRC press, 2010.
2 Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications", Elsevier Inc., 2014.
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
4 Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

**Reference Books:**

1 Subhas Chandra Mukhopadhyay and Tarikul Islam, "Wearable Sensors - Applications, design and implementation" IOP Publishing Ltd 2017.
2 Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors", Springer Nature Singapore Pte Ltd. 2018.
3 Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
4 "The Internet of Things: Key Applications and Protocols", by, Wiley
5 Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

## 20OE801H QUANTUM COMPUTING

**Teaching Scheme** | **Examination scheme:**
Lectures: 3 Hours / Week | In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS04 Physics, 20BS01 Linear Algebra & Univariate Calculus,20BS03 Multivariate Calculus

**Course Objectives:**

1 To give an introduction to quantum computation
2 To explain the basics of quantum mechanics
3 To analyze quantum circuits using qubit gates
4 To elaborate difference between classical and quantum information theory
5 To explain quantum algorithms
6 To explain noise and error correction

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe the basics of quantum computation
CO2 Apply the concepts of quantum mechanics
CO3 Design of quantum circuits using qubit gates
CO4 Comparison between classical and quantum information theory
CO5 Utilize quantum algorithms
CO6 Apply noise and quantum error correction

**Unit I: Introduction to Quantum Computation (03)**

Quantum bits, Bloch sphere representation of a qubit, multiple qubits.

**Unit II: Background Mathematics and Physics (08)**

Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics, Measurements in bases other than computational basis.

**Unit III: Quantum Circuits (08)**

Single qubit gates, Multiple qubit gates, Design of quantum circuits.

**Unit IV: Quantum Information and Cryptography**

Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Quantum Cryptography, No cloning theorem.

**Unit V: Quantum Algorithms**

Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit VI: Noise and error correction**

Graph states and codes, Quantum error correction, fault-tolerant computation.

**Text Books:**

1 Michael Nielsen and Isaac Chuang, **"Quantum Computation and Quantum Information"**, *CambridgeUniversity Press, UK*, (10th Edition), (2012).
2 Phillip Kaye, Raymond Laflamme and Michele Mosca,**"An Introduction to Quantum Computing"**, *Oxford University Press, UK*, (1st Edition), (2007).

**Reference Books:**

1 N. David Mermin, **"Quantum Computer Science An Introduction"**,*Cambridge University Press*, UK, (1st Edition), (2007).
2 NosonYanofsky and MircoMannucci, **"Quantum Computing for Computer Scientists"**, *Cambridge University Press*, (1st edition), (2008).

**Online Resources:**

1 NPTEL Course **"Quantum Computing"**
https://onlinecourses.nptel.ac.in/noc19_cy31/

## 20OE801I RENEWABLE ENERGY SOURCES

**Teaching Scheme** | **Examination scheme:**
Lectures: 3 Hours / Week
ISE: 50 Marks
ESE: 50 Marks
**Credits: 3**

**Course Objectives:**
**To make students**

1. Understanding basic characteristics of renewable sources of energy and technologies for their utilization.
2. Learning engineering approach for renewable energy projects.
3. For analyze energy potential of renewable sources of energy.

**Course Outcomes:**
**Students will be able to**

1. Understand of different renewable sources of energy and technologies for their utilization.
2. Select engineering approach to problem solving when implementing the projects on renewable sources of energy.
3. Undertake simple analysis of energy potential of renewable sources of energy.
4. Describe main elements of technical systems designed for utilisation of renewable sources of energy.

**Unit/Module: 1 Solar Energy 8 hours CO: 1**

Solar potential, Solar radiation geometry, Solar radiation data, radiation measurement, Types of Solar Collectors, Collection efficiency, Applications of Solar Energy, Solar Desalination system, Solar dryer, Solar Energy storage. Solar PV Principle, Photo-cell materials, Applications.

**Unit/Module: 2 Wind Energy 7 hours CO: 2,3**

Wind parameters and wind data, Power from wind, Site selection, selection of components, Blade material, Wind energy conversion systems and their classification, Construction and working of typical wind mill, wind farms, present status.

**Unit/Module: 3 Biomass Technology 7 hours CO: 2,3**

Introduction to biomass technology, Combustion and fermentation, Biomass gasification, types of gasifire, Pyrolysis, various applications of Biomass energy, Bio-fuel types, and applications.

**Unit/Module: 4 Ocean – Tidal – Geothermal Energy 6 hours CO: 3**

Introduction to OTEC, open and closed cycle OTEC systems, Energy through waves and tides. Geothermal Energy, Energy generation through geothermal system, types of geothermal resources, Introduction of tidal systems, Environmental impact.

**Unit/Module: 5 Hydrogen - Fuel Cell – Hybrid Energy System 7 hours CO: 4**
Introduction to hydrogen and fuel cell technology, applications of hydrogen and fuel cell technology. Need for hybrid energy systems, Case studies of hybrid energy system such as Solar-PV, Wind-PV, Micro hydel- PV, Biomass-Diesel systems.

**Total Theory hours: 35 hours**

**Text Books:**

1. Solar Energy by Dr. S.P.Sukhatme Tata McGraw Hill.
2. Non Conventional Energy Sources by G.D.Rai.- Khanna Publishers.
3. Energy Technology by S. Rao, Dr. B.B.Parulekar Khanna Publishers.

**Reference Books:**

1. Fan Lin You,Hong ye (2012), Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press
2. John. A. Duffie, William A.Beckman (2013) Solar Engineering of Thermal processes, Wiley
3. Godfrey Boyle (2017), Renewable Energy, power for sustainable future, Oxford University Press.
4. A.R.Jha (2010), Wind turbine technology, CRC Press.

## 20OE 801J Soft Computing

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

1. To understand basics in soft computing
2. To understand concepts of fuzzy logic and fuzzy sets
3. To understand supervised neural network architecture, training and testing algorithms and tools for the same
4. To understand unsupervised neural network architecture, training and testing algorithms
5. To understand concept for optimization, evolutionary programming and genetic algorithm and tools for the same
6. To understand concept swarm intelligent systems and tools for the same

**Course Outcomes:**
After completion of the course, students will be able to

1 Identify various soft computing and artificial neural network constituents to solve the problems in engineering domain
2 Experiment with fuzzy logic principles
3 Apply Supervised learning algorithms in artificial neural networks to simple real life problems
4 Apply Unsupervised learning algorithms in artificial neural networks to simple real life problems
5 Apply principles of genetic algorithm in solving engineering optimization problems
6 Apply principles of swarm intelligence in solving engineering optimization problems

**Unit I: Introduction to Intelligent systems, soft tools and Artificial Neural network (07)**

Soft computing constituents and conventional Artificial Intelligence, Artificial Neural network: definition, advantages of artificial neural network, Fuzzy Set Theory, Genetic algorithm, hybrid systems: neuro fuzzy, neuro genetic, fuzzy genetic, soft computing, Introduction to Artificial Neural Network: Fundamental concepts, basic models of artificial neural network, important terminologies of ANNs, McCulloch- Pitts Neuron, linear separability.

**Unit II: Fuzzy logic and fuzzy sets (07)**

Introduction to fuzzy logic, fuzzy sets, fuzzy set operations, properties of fuzzy sets, classical relation, fuzzy relation, membership function, fuzzification, Methods of membership value assignments, lambda-cuts for fuzzy set, lambda-cuts for fuzzy relations, defuzzification.
Introduction to tools for fuzzy logic using MATLAB/ Python

**Unit III: Supervised Learning Networks (07)**

Introduction, Perceptron Networks: Perceptron learning rule, Architecture, perceptron training algorithm for single output classes, perceptron training algorithm for multiple output classes, perceptron network testing algorithm, Back Propagation Network: flowchart for training process, training algorithm, linear factors of back- propagation networks, number of training data, number of hidden layer nodes, testing algorithm of back- propagation networks. Introduction to tools for Supervised Learning Networks using MATLAB/ Python

**Unit IV: Associative Memory Networks and Unsupervised Learning Networks (07)**

Associative Memory Networks: Introduction, Training algorithm for pattern association: Hebb rule, Auto-associative Memory networks, Bidirectional associative memory: architecture, discrete bidirectional associative memory, Unsupervised Learning Networks: Introduction, Fixed wright competitive nets: max net, Kohonen Self organizing feature maps

**Unit V: Genetic Algorithm (07)**

Introduction, Traditional Optimization and Search Techniques, biological background, genetic algorithms and search space, genetic algorithm vs. traditional algorithms, basic terminologies in in genetic algorithm, simple GA, operations in genetic algorithm: encoding- binary, octal, selection- Roulette wheel selection, random selection, crossover- single point cross over, two point crossover, mutation- flipping, interchanging, stopping condition for genetic algorithm flow, constraints in genetic algorithm. Introduction to tools for Genetic Algorithm using MATLAB/ Python

**Unit VI: Swarm Intelligent Systems (07)**

Introduction, background of Ant Intelligent systems, Importance of the Ant Colony Paradigm, Ant colony systems, Development of Ant colony systems, Applications of Ant Colony Intelligence, the working of ant colony systems, practical swarm intelligent systems: The basic of PSO method, Characteristic features. Introduction to tools for Swarm Intelligent Systems using MATLAB/ Python

**Text Books:**

1 S.N. Sivanandam- **"Principles of Soft Computing",** Third Edition, Wiley India- ISBN 9788126577132, 20018
2 B K Tripathy, J Anuradha, "Soft Computing- Advances and Applications", Cengage India, ISBN: 78-8131526194, 1st, 2018
3 P.Padhy, **"Artificial Intelligence and Intelligent Systems"** Oxford University Press, ISBN 10: 0195671546, 2005

**Reference Books:**

1 De Jong, **"Evolutionary Computation: A Unified Approach",** Cambridge (Massachusetts): MIT Press. ISBN: 0-262-04194-4. 2006

2 J. S. R. Jang, CT Sun and E.Mizutani, **"Neuro-Fuzzy and Soft Computing" ,** PHI PVT LTD, ISBN 0-13-261066-3. 2015

3 S. Rajsekaran and G.A. Vijayalakshmi Pai, **"Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications"** , Prentice Hall of India, ISBN: 0451211243, 2003

4 1. Sinha N.K., **" Soft Computing And Intelligent Systems: Theory And Applications"**, ISBN-13: 978-0126464900, Elsevier. 2007.

# 20OE 801K Software Testing and Quality Assurance

| **Teaching Scheme:** | **Examination Scheme:** |
| --- | --- |
| Lectures : 3 hours/week | In-Semester : 50 Marks |
| Tutorial : -- | End-Semester : 50 Marks |
| | Credit : 3 |

**Prerequisites:**

**Course Objectives:**
Familiarize students with
1. Testing strategies in projects.
2. Levels of testing strategies
3. Various quality assurance models
4. Automated Testing Tools

**Course Outcomes:**
Students should be able to
1. Explain different terminologies in software testing.
2. Apply appropriate testing technique based on the project scenario
3. Choose quality assurance models for the project
4. Make use of modern testing tools suitable for the project

**Unit – I Fundamentals 7 Hours**
Testing as a Process, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, Testing fundamentals, the defect repository and test design, Defect examples, Developer /Tester support for developing a defect repository. Process model to represent Different phases, Lifecycle models

**Unit – II Levels of testing 7 Hours**
Need for levels of testing, Unit testing, Integration testing, System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing, Stress testing, Regression testing, Alpha, Beta and Acceptance testing.

**Unit – III Testing techniques 7 Hours**
Using White Box Approach to Test design - Static Testing, Structural Testing, Unit Functional Testing, Challenges in White box testing, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing.

**Unit – IV Fundamentals of software quality assurance 7 Hours**
SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

**Unit – V Quality assurance models 7 Hours**
Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM, Clean-room software engineering, Defect Injection and prevention, Inspections & Walkthroughs, Case Tools and their effect on Software Quality.

**Unit – VI Software test automation 7 Hours**

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug. Combining Manual and Automated Testing

**Text Books**

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson
2. Ilene Burnstein, "Practical Software Testing", Springer International edition

**Reference Books**

1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications
2. William Perry, "Effective Methods of Software Testing", Wiley Publishing, Third Edition
3. Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition
4. Watts S Humphrey, "Managing the Software Process", Pearson Education Inc.

## 20OE 802A Applied Statistics with R programming

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Mathematics

**Course Objectives:**

Familiarize students with
1 Fundamentals in Statistics
2 Evaluation and Interpretation of applied statistics
3 Hypothesis Test
4 R programming used in statistical analysis

**Course Outcomes:**

Students should be able to
1 Apply probability for statistical analysis.
2 Draw inferences from statistical analysis of data
3 Apply statistical methods and hypothesis tests on data
4 Explain Multivariate Analysis

**Unit I: Probability** **7 Hours**

Introduction, conditional probability, Bayes Theorem and independence, random variable and Probability distribution, normal distribution.

**Unit II: Basic statistical measures** **9 Hours**

Introduction to statistics, type of data, processing the data, classification, graphical representation. Introduction Measures of central Tendency: Arithmetic Mean, Weighted Arithmetic Mean, Median, mode, Measurement of variation: Quartile, Average and Standard Deviations, Coefficient Variation, Measurement of skewness
Case Study with R programming

**Unit III: Analysis of Variance** **8 Hours**

Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, ANOVA, Completely randomized design, Latin square Design, Duncan's Multiple Range Test
Case Study with R programming

**Unit IV: Types of hypothesis** **9 Hours**

Introduction , types of hypothesis, Tests of hypothesis concerning means, hypothesis concerning proportions, Hypothesis concerning variations (Chi-square and F-tests), Chi square test for checking independence of categorized data, goodness of Fit Test
Case Study with R programming

**Unit V: Multivariate Analysis 9 Hours**

Correlation: Introduction , types of correlations, Correlation Analysis, correlation coefficients, Regression: Introduction, Linear Regression, Regression analysis, regression coefficients. MANOVA, Discrimination Analysis, Factor Analysis, Principle Component Analysis and Independent Component Analysis
Case Study with R programming

**Text Books:**

1. S.P. Gupta, "Statistical Methods", Sultan Chand and sons Publication, 41st Edition.
2. B.L. Agarwal, "Basic Statistics", New Age Publication, 9th Edition
3. A. Papoulis, S.U. Pillai, "Probability Random Variables and Stochastic Processes", Tata McGraw Hill, (4th Edition)

**Reference Books:**

1. S. M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier Publication, 5th Edition
2. Piegorsch W.W, "Statistical Data Analytics", Wiley Publication.
3. E. Rukmangadchari, E.K.Reddy, "Probability and Statistics", Pearson India Pvt.Ltd.,1st Edition
4. Rohatgi A.K. Md e. Saleh, "Introduction to Probability and Statistics", Wiley Publication Pvt. Ltd. 3rd Edition.

**Web References**

1. NPTEL NOC: Descriptive Statistics with R software, Prof. Shalabh, IIT Kanpur,
2. NPTEL NOC: Applied Statistics and Econometrics, Prof. Mukherjee, IIT Kanpur

## 20OE802-B Automobile Engineering (AE)

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
ISE: 50 Marks
ESE: 50 Marks
**Credits: 3**

**Course Objectives:**
**To make students**

1 To study layout of the vehicles.
2 To understand function of various components of automotive systems
3 To understand use of alternative fuels for vehicle.

**Course Outcomes:**
**Students will be able to**

1 Identify different layouts of automobile vehicle and engine auxiliary systems.
2 Explain latest transmission, steering, braking and suspension systems in vehicle.
3 Explain EV, HEV, latest trends in AI technologies
4 Understand energy sources, current emission norms and emission control systems.

**Unit/Module: 1 Vehicle Structure and Engine auxiliary systems 6 hours CO: 1**
Vehicle construction and different layouts, chassis, frame and body, components of engine. Electronically controlled gasoline injection system for SI engines. Electronically controlled diesel injection system, electronic ignition system. Introduction to Vehicle Maintenance and Servicing.

**Unit/Module: 2 Transmission Systems 6 hours CO: 2**
Introduction to transmission system, Automatic transmission system (fluid coupling, clutch less drive, fluid flywheel – torque converter), Semi-automatic transmission, continuously variable transmission (CVT), dual clutch hybrid transmission

**Unit/Module: 3 Steering, Brakes and Suspension Systems 6 hours CO: 2**
Introduction to Steering geometry and its function, Power Steering. Introduction to suspension system, Active and passive Suspension. Introduction to Braking Systems, Regenerative breaking, Anti-lock Braking System (ABS), EBS and Traction Control.

**Unit/Module: 4 Electric and hybrid vehicles 6 hours CO: 3**

Concept of electric and hybrid vehicle, EV and HEV fundamentals, architecture of EV and HEV power train, drives and energy sources in EV and HEV, Artificial intelligence technologies such as Autonomous Vehicles, computer vision assist drivers to improve safety, improve services such as vehicle inspection or insurance. Role of IoT to secure communication between vehicles as well as vehicles and infrastructure components

**Unit/Module: 5 Modern Energy Sources and optimizing supply chain 6 hours CO: 4**

Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LNG), Bio-fuels, lithium-ion battery, hydrogen fuel cell in Automobiles, Introduction to Optimization of Supply Chain in Automotive Industry

**Unit/Module: 6 Emission control in automobiles 6 hours CO: 4**

Emission and Fuel Roadmap Euro 6 / BS V norms (proposed 2020-21), Effect of car emissions on human health and the environment. Exhaust gas re-circulation (EGR) and Engine emission control (three-way catalytic converter system SCR and particulate filter).

**Text Books:**

1 Kirpal Singh, Automobile Engineering Vol 1 and 2, Standard Publishers, 7th Edition, 1997
2 M. Chris and M. A. Masrur, Hybrid Electric Vehicles, Wiley Publications, 2nd Edition, 2017
3 Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press

**Reference Books:**

1 K. K. Jain and R. B. Asthana, Automobile Engineering, Tata McGraw Hill Publishers, New Delhi, 1999.
2 Barry Hollembeak, "Automotive Electricity and Electronics" Cengage Learning, Cliftorn Park, USA 2007.
3 Dr. K. R. Govindan, Automobile Engineering, Anuradha Publications, Chennai, 2013.
4 Joseph Heiner, Automotive Mechanics, Litton Education Publishing Ins., New York, 1999.
5 Angelin, Automotive Mechanics, Tata McGraw Hill Pub. Comp. Ltd., 10th Edition, 2004.
6 Josep Aulinas, Hanky Sjafrie, AI for Cars, Chapman and Hall/CRC Press, 1st Edition.

## 20OE802C AUTONOMOUS ROBOTS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1 To explain fundamentals of robotic system
2 To introduce kinematics, dynamics and control for robotics systems
3 To introduce trajectory planning for motion
4 To describe application of robots in automation

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain and classify different components used in developing autonomous robot |
| CO2 | Select sensors, actuators and grippers for autonomous robot |
| CO3 | Apply formulations to obtain kinematics, dynamics and trajectory planning of autonomous robot |
| CO4 | Develop path planning and navigation algorithm for autonomous robot |
| CO5 | Design robot for automation |

**Unit I: Introduction to Robotics (10 )**
Definition of robotics, Types of robots, Components of Robot system, Classification of robots , Robot architecture, Robot locomotion, Specification of robot, Robot sensors for position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and robot vision, Actuators and end effectors.

**Unit II: Introduction to Mechanics of Robotic Arm (10)**
Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and inverse kinematic analysis, Dynamics and inverse Dynamics of robots, Newton–Eller formulation, Trajectory and Path planning, Application of robotic arm.

**Unit III: Mobile robot Kinematics and Dynamics (08)**
Forward and inverse kinematics, holonomic and nonholonomic constraints, Kinematic models of simple car and legged robots, Dynamic simulation of mobile robots.

**Unit IV: Localization (06)**

Odometric position estimation, Belief representation, Probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, Positioning beacon systems.

**Unit V: Introduction to Planning and Navigation (08)**

Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm, A-star, D-star, Voronoi diagrams, Probabilistic Road Maps (PRM), Rapidly exploring Random Trees (RRT), Markov Decision Processes (MDP), Stochastic Dynamic Programming (SDP).

**Text Books:**

1 R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).
2 Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).
3 Robin R. Murphy, **"Introduction to Artificial Intelligence for Robotics"**, *The MIT Press*,(2nd Edition), (2000).
4 S. K. Saha, **"Introduction to Robotics"**, *Tata McGraw Hill*, (2nd Edition), (2014).

**Reference Books:**

1 K. S.Fu, R. C. Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence" ,** *Tata McGraw Hill* **,** (2nd Edition), (2008).
2 Robert J. Schilling, **"Fundamentals of Robotics- Analysis and Control",***Prentices Hall India*, (1st Edition), (2008).

**Online Resources:**

1 NPTEL Course **"Wheeled Mobile Robot"**
https://nptel.ac.in/courses/112/106/112106298/

## 20OE802D Building Automation and Energy Audit

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**

1 To understand Need and Applications Building automation systems.
2 To understand the working of various Building automation components.
3 To Select and Implement Building automation with various applications.

**Course Outcomes:** The student will be able to

1 Investigate the system requirements for developing building automation systems
2 Compare and choose the suitable building automation systems for the applications
3 Design building automation system for required application
4 Evaluate the performance of the designed building automation system

**Unit 1: Fire Alarm Systems I (08)**
Introduction: to BAS, Need and Applications of BAS, Block diagram of BAS.FAS: Need and Applications of FAS, Types of FAS, Block diagram of FAS, Fire, Fire Development Stages, Fire Signatures, Initiation Devices, Notification Appliances, IDC Placements, NAC Placements, Fire Suppression: Fire Extinguishers & Its Classification, Fire Suppression Systems.

**Unit 2: Fire Alarm Systems II (08)**
IDC, NAC, SLC, FAS Wiring Standards, FAS Communication Protocols, Voltage Drop Analysis, Battery Capacity Analysis, Cause & Effect Matrix.

**Unit 3: Access Control Systems (06)**
Introduction to Security Systems, Types of Security systems, Access Control Systems: Introduction, Applications, Concept, Generic Model, Components, Card Technologies, Communication Protocols for ACS, Biometrics for ACS, CCTV System Types: CCTV Components, Digital Video Management System

**Unit 4: HVAC- Air Systems (06)**
Human Comfort Parameters and Air Properties Need of HVAC System, HVAC Block Diagram. AHU: Concept, Working, AHU Functions, AHU Components: Dampers, Filters, Cooling coil, Heating coil, etc., AHU Configurations, AHU Locations, AHU Terminal Units: CAV, VAV, Measurement and Control Loops for Air Systems.

**Unit 5: HVAC- Water Systems (07)**

Cold Water System: Refrigeration Cycles, Chillers, Cooling Towers, Types of chilled water system, Concept of Free Cooling : Direct Waterside, Series Waterside, Parallel Waterside. Hot Water Systems: Heating Circuits, Boilers, Types of Boilers, Heat Exchangers: Steam Input and Hot Water Input, Solar Hot Water System, Measurement and Control Loops for Water Systems.

**Unit 6: Building Energy Management System (07)**

Overview of Building Energy Management Systems, BEMS Control systems overview, Benefits of BEMS, Energy System Monitoring, Application of Energy Efficient Strategies, Effective Energy management, Computerized Energy Management Systems.

**Text Books:**

1 Robert Gagnon, Design of Special Hazards and Fire Alarm Systems
2 Damjanovski, Vlado, CCTV, Butterworth-Heinemann, 3rd ed
3 Benantar M., Access Control System
4 Montgomery R, Fundamentals of HVAC Control Systems, Elsevier Publications
5 Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6 James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7 "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1 "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2 "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
3 "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4 "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

## 20OE 802E Data Analysis and Visualization

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1. Basic Mathematics
2. Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1. To understand the data analytics and visualization as well as the statistics behind it.
2. To understand and analyze the machine learning methods used in data analysis
3. To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1. Develop the knowledge of data analysis and the statistical tools used for analysis
2. Identify the relevant data analysis method for a real time application
3. Select the appropriate data visualization method for the application in hand
4. Understand recent trends in data analysis and visualization

**Unit 1: INTRODUCTION TO DATA ANALYTICS (06)**
Introduction to Data, Data types and their relationships, Data Analytics workflow, Types of analysis Applications.

**Unit 2: BASIC DATA ANALYTICS (08)**
Statistical analysis, Attribute correlation, Regression analysis, Dimensionality reduction, Feature extraction and selection, Time series prediction, Hypothesis Analysis
Case study, Python based examples

**Unit 3: MACHINE LEARNING FOR DATA ANALYTICS (10)**
Data analysis methods used for Clustering, Classification, Regression, Outlier Detection, Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 4: DATA VISUALIZATION (10)**
Purpose and types of Visualization, Graphical Representation, Multidimensional Visualization, Handling data Cleaning, data reduction for visualization, Sorting and Scaling, Multivariate Glyphs
Case study, Python based examples

**Unit 5: RENDS IN DATA ANALYSIS AND VISUALIZATION (08)**

Deep Learning for Data Analysis, handling of small and Big Data,
Storytelling and Data Visualization Dashboards
Case study, Python based examples, Demo with tool like Tableau.

**Text Books:**

1. Dr. Anil Maheshwari, '**Data Analytics'**, McGraw Hill Education (India) Pvt. Ltd. (2017)
2. Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1. Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2. Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3. Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4. Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1. Academic use of Tableau - https://www.tableau.com/academic/teaching
2. NPTEL Courses
   a. Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/
   b. Data Analytics with Python https://nptel.ac.in/courses/106/107/106107220/
   c. Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
   d. Introduction to Learning Analytics https://nptel.ac.in/courses/127/101/127101012/
   e. Data Analytics with Python https://onlinecourses.nptel.ac.in/noc20_cs46/preview

# 20OE 802F Data Science Using Python

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data science.
2 Identify the relevant Python method used in data science.
3 Select the appropriate data operation method for the application in hand.
4 Understand recent trends in data science and analysis.

**Unit 1: INTRODUCTION TO DATA (06)**
Introduction to Data, Data types and their relationships, Handling different types of data using Python, Handling numeric and categorical data using Python

**Unit 2: BASIC DATA Processing using NumPy, Pandas (08)**
Statistical operations, data cleaning, missing data, indexing, slicing, iterating, attribute selection, dimensionality reduction, Handling tabular data, time series
Case study, Python based examples

**Unit 3: MACHINE LEARNING using Sci-Kit, Tensorflow - I (08)**
Clustering, Classification, Regression, Outlier Detection
Case study, Python based examples

**Unit 4: MACHINE LEARNING using Sci-Kit, Tensorflow- II (08)**
Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 5: REGRESSION ANALYSIS AND PREDICTIVE ANALYSIS (06)**

Introduction to types of analysis - Predictive, descriptive and decision based, Regression analysis, types - linear, logistic, ridge, lasso

**Unit 6: DATA VISUALIZATION AND GRAPHICS USING Matplotlib / Seaborn (06)**

Basic visualization plots - Area, histogram, bar, Specialized plots - pie, box, scatter, bibble, Waffle, Word clouds, Seaborn, Regression plots
Introduction to Folium, maps with markers, choropleth maps, dashboards

**Text Books:**

1 Aurélien Géron, '**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**', O'Reilly Media (2017)
2 Samir Madhavan, '**Mastering Python for data science**', Packt (2015)
3 David Beazley, '**Python CookBook**', O'reilly (2013)
4 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching
2 NPTEL Courses
   a Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
   b Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/

## 20OE802G Industrial Drives and Control

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 To evaluate and select a suitable drive for a particular application.
2 To analyse the basic drive system dynamics
3 To develop the basic design of an electric drive system.

**Course Outcomes:**

1 Selection of appropriate drive for the given application
2 Selection of suitable control system scheme along with the interlocking for given application
3 Analysis of the control drive dynamics for the desired drive system
4 Design of the total electric drive system based on desired application

**Unit 1: Introduction to Industrial Drives (07)**
Concept of electric drive, Power modulators, Motors used in drives, types of loads choice of drives, classification of drives Multi quadrant operation of Drives.

**Unit 2: Introduction to Control Systems (07)**
Open and closed loop systems with examples, automatic control, speed control of motors

**Unit 3: Electrical Control of Machines (08)**
Manual control – Magnetic control – Semi-automatic and Automatic control of Modern machinery – Development of Control circuits–Two wire and Three wire control – Remote control –

**Unit 4: Interlocking of drives (08)**
Control circuit components –Symbols for control components–Fuses, Switches and Fuse Switch units.

**Unit 5: Dynamics and Control of Electric Drives (06)**
D.C. motor drives, Induction motor drives, Synchronous and Brushless D.C. motor drives.

**Unit 6: Industrial process and drives (06)**

Process flow diagram of paper mill, cement mill, sugar mill, steel mill, Hoists and cranes, centrifugal pumps and compressors, solar powered pump drives, selection of drives for the above processes

**Text Books:**

1 Electrical Motor Drives, R. Krishnan [PHI-2003]

2 Electric Drives, Vedam Subrahmaniam [TMH-1994]

3 Industrial Drives and Control, Sandeep M. Chaudhari, Nilesh R. Ahire [Nirali Prakashan]

**Reference Books:**

1 Control of Electric Drives,W. Leonard, [Springer- 2001]

2 Electrical Drives, Second Edition, S.A. Nasar, Boldea [CRC Press - 2006]

## 20OE802H Smart Sensors and Systems

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

**Course Objectives:**

1 Theoretical understanding of various physical phenomena behind the operation of different types of sensors and microsystems
2 Overview of micro/nano fabrication process
3 Develop a complete sensor or sensor system, MEMS device or microsystem

**Course Outcomes:**

1 Selection of suitable sensor along with the associated electronics and fabrication process for given application
2 Selection of appropriate smart sensors for the desired application in the field of Automobile, Biomedical, Military, Space and Défense.
3 Design of application-based sensors in the field of Military, Défense, Spacecraft and environment
4 Analysis of the system designed for applications in the field of Biomedical and Automobile

**Unit 1: Introduction to Smart Sensors and Systems (07)**
Principles of Sensing, Classification and Terminology of Sensors. Introduction to micromachining - Fabrication and miniaturization techniques
Digital Signal Controllers (Microcontrollers and Digital Signal Processors) for Smart sensors
Key features, Certain case studies - for eg: temperature, fingerprint recognition

**Unit 2: Microfabrication process (08)**
Fabrication and miniaturization techniques, Steps involved in fabrication

**Unit 3: Smart sensors in Biomedical field (08)**
Bio-analytical [sample preparation and detection of compound] sensors & systems, Transduction modes & classifications,
Hall Effect sensors and associated signal conditioning circuits, Sensors for displacement (linear and angular), velocity, acceleration, force, torque, vibration and shock measurements. Sensor measurements for conductivity and viscosity. Electrochemical transducer in Biology and medicine Biochemical Transducer, Enzyme-based electrochemical biosensors, electronic tongue, few related Case studies

**Unit 4: Smart sensors in Automobile industry (07)**

Introduction to Modern Automotive Systems and need for electronics in Automobiles, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Sensors for chassis management, Powertrain sensors, Air Bag and Seat Belt Pre tensioner Systems, Case studies explaining the Modern Trends and Technical Solutions, Related communication systems

**Unit 5: Smart sensors related to Environment and in Spacecraft (06)**

Human Toxicology Ecotoxicology, W ater and air pollution sources
E-nose for Sensitive and Selective Chemical Sensing, Chemical sensors, Ocean environment
Smart sensors in spacecraft - in monitoring applications, Smart Instrumentation Point Bus (SIP), Solid state micro-gyroscopes, related Case studies

**Unit 6: Smart sensors in Military and Defence (06)**

Types of sensors (Accelerometers, Inertial Sensors, Pressure Sensors, Force Sensors, Motion Sensors, Gyroscopes, Temperature Sensor and Others), Device-based Sensor, Clothing-based Sensor, Application based sensors - Wrist Wear, Foot Wear, Eye Wear, Body Wear and Neck Wear, intelligent sensor technology for surveillance and electronic intelligence, Case studies, related communication systems

**Text Books:**

1. Understanding Smart Sensors, Randy Frank [Artech House, Boston London]
2. Smart Sensors for Environmental and Medical Applications, Hamida Halilil, Hadi Heidari [Wiley]
3. Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, S Nihtianov, Antonio Luque [Science Direct]

**Reference Books:**

1. Smart Sensors and Systems, Lin, Y.-L., Kyung, C.-M., Yasuura, H., Liu, Y. [Springer]
2. Smart Sensor Systems, Gerard Miejer [Wiley]

# 20OE802I Wireless Networks

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Prerequisites:** Nil

**Course Objectives:**

1 To explain the importance of wireless communication and multiple access techniques
2 To elaborate the behavior of communication system for indoor and outdoor wireless networks
3 To introduce 3G, 4G cellular network components and 5G future wireless network
4 To explain MIMO technology
5 To introduce visible light communications

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain fundamentals of wireless communication and multiple access techniques |
| CO2 | Analyze the behavior of communication system for indoor and outdoor wireless networks |
| CO3 | Apply 3G, 4G cellular network standards and describe 5G future wireless network |
| CO4 | Interpret MIMO technology its advantages and limitations |
| CO5 | Explain LiFi networking and technology for indoor network access |

**Unit I: Introduction to wireless communication (08)**
Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Media, Spread spectrum, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA.

**Unit II: Wireless indoor and outdoor networks (08)**
WLAN, WiFi, Bluetooth, Zigbee, Ultra Wideband communication, Infrared, UHF narrowband, WiMax, Limitation of indoor networks.

**Unit III: Cellular Network (08)**
Spectrum reuse and re-framing, Cell cluster concept, Co-channel and adjacent channel interference, Cell site, call blocking and delay, Channel allocation strategies, 3G and 4G standard.

**Unit IV: Future Wireless networks (10)**
Introduction to 5G, Modulation techniques for 5G, Architecture, MIMO, Massive MIMO, Limitations and applications.

**Unit V: Visible Light Communications (08)**
LiFi Technology, LiFi Networking, LiFi technology for indoor network access, Applications.

**Text Books:**

1 T. Rappaport, "**Wireless Communications - Principles and Practice**", *Prentice Hall* , (2$^{nd}$Edition) , (2011).
2 Vijay Garg, "**Wireless Communications and networking**", *Elsevier,* (1$^{st}$ Edition), (2007).
3 **Jonathan Rodriguez,** "Fundamentals of 5G Mobile Networks"**, *Wiley*, (1$^{st}$ Edition),(2015).**
4 Mohamed Gado, Doaa Abd El-Moghith, "**Li-Fi Technology for Indoor Access**", *LAMBERT Academic Publishing,* (1$^{st}$ Edition), (2015).

**Reference Books:**

1 Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "**3G Evolution HSPA and LTE for Mobile Broadband"**, *Academic Press*, (2$^{nd}$Edition) , (2008).
2 Anurag Kumar, D.Manjunath, Joy kuri, "**Wireless Networking**", *Elsevier,* (1$^{st}$ Edition), (2011).
3 Simon Haykin, Michael Moher, David Koilpillai, "**Modern Wireless Communications**", *Pearson Education* , (1$^{st}$ Edition), (2013)
4 Aditya K. Jagannatham, "**Principles of Modern Wireless Communications Systems**", *McGraw Hill Education (India) Private Limited*, (1$^{st}$ Edition), (2016).

**Online Resources:**

1 NPTEL Course on **"Introduction to Wireless and Cellular Communications",** https://nptel.ac.in/courses/108/106/106106167/#
2 NPTEL Course on **"Advanced 3G and 4G Wireless Mobile Communications**", https://nptel.ac.in/courses/117/104/117104099/

MKSSS's Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University)

# Autonomous Program Structure
## Third Year B. Tech. Fifth Semester
## (Instrumentation and Control)
## Academic Year: 2022-2023 Onwards

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Semester | End Semester | Oral | Practical | | |
| 20IN501 | Process Loop Components | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN502 | Digital Signal Processing | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20IN503 | Internet of Things (IoT) | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20PEIN501 | Programme Elective-I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEIN502 | Programme Elective-II* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OEHS501 | Open HS Elective –I | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN501L | Process Loop Components Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| 20IN502L | Digital Signal Processing Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| 20PEIN501L | Programme Elective Lab-I | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20AC501 | Audit Course | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | No Credit |
| | **Total** | **18** | **2** | **8** | **375** | **300** | **25** | **50** | **750** | **23** |
| | **Grand Total** | **28** | | | **750** | | | | **750** | **23** |

*** NPTEL/Swayam Course**

Department of Instrumentation & Control Engineering

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

**Programme Elective-I**
20PEIN501A Modern Control Theory
20PEIN501B Biomedical and Analytical Instrumentation
20PEIN501C Advanced Micro controller Techniques

Open Elective I (Humanities)

| Sr. No. | Course Code | Course Title |
|---|---|---|
| 1 | 20OEHS501A | Entrepreneurship Development |
| 2 | 20OEHS501B | Intellectual Property Rights |
| 3 | 20OEHS501C | Introduction to Digital Marketing |
| 4 | 20OEHS501D | Law for Engineers |
| 5 | 20OEHS501E | Organizational Behaviour |
| 6 | 20OEHS501F | Project Management |

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

CUMMINS COLLEGE OF ENGINEERING FOR WOMEN
KARVE NAGAR PUNE-411 052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

## 20IN501 Process Loop Components

**Teaching Scheme:**
Lectures: 3 Hrs /week

**Examination Scheme:**
In semester: 50 Marks
End semester: 50 Marks
Credit: 3

**Prerequisites**: Sensors and transducers, pneumatic flapper nozzle system**,** op amp circuits

**Course Objectives:**
1. To understand the different types of systems and basics of process control.
2. To explain the need, construction, working, types of process control components
3. Develop process control circuits/loops for various applications using standard symbols and notations
4. To demonstrate PLC programming skill for industrial applications

**Course Outcomes**:
1. Delineate the working of different process control components.
2. Compare to select different process control components for various applications.
3. Analyse the performance of the process control components with respect to calibration, configuration, tuning.
4. Develop process control circuits/loops and PLC programs for various industrial applications using standard symbols and notations.

**Unit 1: Types of systems and process control components (08)**
Introduction to different types of systems, process control components related to different types of systems like switches, contactors, miniature circuit breaker, relays, actuators, FRL, Relief/safety valve, DCV, NRV etc, and applications.

**Unit 2: Process Control Fundamentals (07)**
Elements of process control loop, Types of process variables, Representation of process loop components using standard symbols (basics with reference to control loop), P & ID for temperature, flow, level, pressure process loops, Process Characteristics like process load, plant lags, dead time, capacity and regulation. Auxiliary components like alarm annunciator.

**Unit 3: Transmitters and Converters (06)**
Need of transmitter (concept of field area & control room area) ,Need for standardization of signals, Current, voltage, and pneumatic signal standards, Concept of live & dead zero, Types of transmitters (Two and four wire transmitters), Types, mounting (Installation), manifold, calibration setup, of electronic Differential Pressure Transmitter (DPT). DPT for Level measurement, zero elevation, zero suppression, Square root extractor, Block schematic and

calibration of Smart transmitter, Comparison of SMART with conventional transmitter, Difference between converter and transmitter, Converters like Current to pressure converter and Pressure to current converter

**Unit 4: Controllers (08)**

Discontinuous (Two position, time-proportional), Continuous controllers (Proportional, Integral, Derivative, Proportional-Integral, Proportional- Derivative, Proportional-Integral-Derivative (PID), Reset windup, Anti reset windup, Rate before reset, Bump less transfer, Effect of process characteristics on PID combination, Tuning of controllers, Block schematic and face plate of digital controllers, Position and Velocity algorithms

**Unit 5: Programmable Logic Controller (07)**

Continuous versus Discrete Process Control, Limitations of relay based system, PLC architecture, Types of Input & Output modules, Fixed & Modular PLC, Interfacing pneumatic systems to PLC, PLC specifications, PLC manufacturers, PLC Basic instructions, Timers & Counters, PLC programming languages, Ladder programming for process applications

**Unit 6: Control valve (06)**

Parts of pneumatic control valve, Control valve terminologies, Inherent and Installed control valve characteristics, types of control valves, Control valve selection criteria, Control valve accessories, types of actuators, Introduction to Control valve sizing and cavitation and flashing

**Text Books:**

1. Petruzella, "Industrial Electronics", McGraw-Hill
2. Andrew Parr, "Hydraulics and pneumatics: A Technician's and Engineer's guide",
4. Butterworth Heinemann Ltd
5. C. D. Johnson, "Process control and Instrument technology", Tata McGraw Hill Publications
6. B. G. Liptak, "Process Control", Instrument Engineering Handbook CRC Press.
7. N.A. Anderson, Boca Ratan, "Instrumentation for Process measurement and control" CRC Press, Third ed., 1980.
9. Frank Petruzella, "Programmable Logic Controllers" McGraw-Hill, 2011
10. Gary Dunning, "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third ed., 2006.

**Reference Books:**

1. Armando B. Corripio,"Tuning of industrial control systems", ISA.

2. James W. Hutchinson, "Control valve Handbook", ISA
3. E. B. Jones, "Instrument Technology", Butterworth's, Forth ed., 1985
4. William Andrews, "Applied Instrumentation in Process Industries", Gulf, Second ed., 19

## 20IN502 Digital Signal Processing

| Teaching Scheme: | Examination Scheme: |
|---|---|
| Lectures: 3 Hrs/Week | In Semester: 50 Marks |
| Tutorial: 1 Hr/Week | End Semester: 50 Marks |
| | Credit: 4 |

**Prerequisites:** Linear Algebra, Complex numbers, basics of ZT and FT

**Course Objectives:**
1. To understand the concept of digital different types of signals and systems.
2. To learn the use of various transforms for different applications.
3. To understand designing steps of various types of digital filters for given applications.

**Course Outcomes:** After the successful completion of the course the students will be able to:
1. Analyse the signals in time and frequency domain.
2. Apply the transformation tools on signals and systems and analyse their significance and applications.
3. Design the structures of different types of digital filters.
4. Design various digital filters and analyse their frequency response

**Unit 1: Introduction to Signals and Systems (08)**
Introduction to Signals, Classification of Signals, Continuous Time and Discrete Time Signals, Step and Impulse Functions, Transformation of Independent Variable. Introduction to Systems, Classification of Systems, Properties of Systems, Normal Form of System Equation, Initial Conditions, Impulse Response of a Physical System, system Impulse Response

**Unit 2: Analysis of Discrete-LTI Systems (07)**
Introduction to Convolution, Convolution Sum, Linear and Circular Convolution, Sampling theorem, reconstruction, aliasing, sampling in the frequency domain, sampling of discrete time signals, autocorrelation, cross correlation, decimation and interpolation

**Unit 3: Z-Transform, Discrete Fourier Transform and its Properties (08)**
Z-transform and its properties, solving difference equations and analysis of discrete-time systems in z-domain, Transfer function, pole-zero plot.
Discrete Fourier Transform (DFT) and its properties, Fast Fourier Transform (FFT), Divide and Conquer Approach, Decimation in Time and Decimation in Frequency FFT Algorithms.

**Unit 4: Design of Digital Filters: FIR (07)**
FIR Filters: Concept of analog filter design, Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters

**Unit 5 : Design of Digital Filters: IIR (06)**

**IIR Filters:** IIR filter design by approximation of derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters

**Unit 6: DSP Practical Application: 1-D Signal Processing (06)**

Applications of Convolutions, Auto-correlation, Cross-correlations, DFT, Digital filters.
Biomedical Signal Processing:
Baseline Wander removal techniques, Power line Interference removal techniques, EMG noise removal techniques, Motion Artifacts removal techniques, Feature extraction like RR interval, Heart rate, Time vs Frequency domain filtering
Audio Signal Processing: Basics of LPC, MFCC, Introduction to SVD, PCA, ICA, NMF, Spectrogram, Time vs Frequency domain filtering Applications of Audio Signal Processing: Audio Equalizer, Noise Filtering, Audio Compression
Vibration Analysis: Vibration signature analysis for defective gear teeth

**Text Books:**

1. Nagoor Kani, Digital Signal Processing, Tata McGraw-Hill Education
2. Salivahanan, A Vallaraj, C. Gnanapriya, “Digital Signal Processing”, Tata McGraw-Hill Publishing Company Limited.
3. P. Ramesh Babu, “Digital Signal Processing”, Sci-Tech Publications
4. S. K. Mitra, “Digital Signal Processing-A Computer Based Approach”, MGH

**Reference Books:**

1. J. G. Proakis and D. J. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, PHI, 2000.
2. V. Oppenheim and R. W. Schafer, “Discrete Time Signal Processing”, Pearson Education.
3. Rabiner, Gold, “Theory and Applications of Digital Signal Processing”, TMH.
4. E. C. Ifeachor and B. W. Jervis, “Digital Signal Processing-A practical Approach”, Addison-Wesley publication

**Tutorials:**
**Minimum 8 assignments based on the course contents**

# 20IN503 Internet of Things

**Teaching Scheme:**
Lectures: 3 Hrs/week
Tutorial: 1 Hr/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

**Prerequisites:** Basics of sensors and actuators, networks, logic building ability

**Course Objectives:**
1. To understand building blocks and components of IOT
2. To understand technologies used in IOT
3. To understand the role of platforms and big data in IOT

**Course Outcomes:** the students will be able to
1. Compare connectivity technologies for IoT
2. Compare protocols used for IoT applications
3. Select appropriate IoT technology for given application
4. Design small system solution for given problem statement

**Unit 1: Introduction to IoT (08)**
IoT Basics, Components, architecture, Interdependencies, categories, gateways, associated technologies, Challenges, Considerations, Scalability
Role of sensors, actuators and networks in IoT
Study of Raspberry Pi/ Arduino/ equivalent for integration of sensors/ actuators/ devices in IoT based systems. Small system examples of interfacing sensors and devices to embedded systems for IoT applications

**Unit 2: Connectivity Technologies -I (08)**
Connectivity technologies: Introduction, Features, working principle, addressing, Routing and applications of Zigbee, IEEE 802.15.4, ZWave, LoRa WAN, Bluetooth and BLE. System examples and case studies using these technologies.

**Unit 3: Connectivity Technologies -II (07)**
Connectivity technologies: Introduction, Features, working principle, addressing, Routing and applications of GSM, Low Power WiFi, Power Line Communication, RFID, NFC, Sigfox. System examples and case studies using these technologies.

**Unit 4: Networking Protocols and Security (07)**
Introduction, features, components, methods, variants, communication, Response models, message types, addressing, Routing and applications of 6LoWPAN, MQTT, CoAP, XMPP, AMQP. System examples and case studies using these technologies.
Privacy and Security issue in IoT. Overview of Governance in IoT.

**Unit 5: Communication Protocols in Industrial IoT (06)**
Introduction, features, components, methods, variants, communication, Response models, message types, addressing, Routing and applications of Wireless HART, ISA100.11A, IEEE1451, OPC UA. Case Studies from Home, Infrastructures, Buildings, Industries, Health Care, Inventory Management and Equivalent.

**Unit 6: Wireless Sensor Networks and Big Data (06)**
Introduction, Features, Components, Multi-hop Paths, Challenges of WSN, Detection and Connectivity, Event Aware Topology Management, Information Theoretic Self-Management of WSN, Applications
Platforms in IoT, Functions, Types, Privacy and Trust in IoT-Data-Platforms for applications
Introduction to Big Data, Cloud Computing, Edge computing and Fog computing
Case Studies from Home, Infrastructures, Buildings, Industries, Health Care, Inventory Management and Equivalent.

**Books:**

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
2. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.
3. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving".
4. Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
5. "The Internet of Things: Key Applications and Protocols", by, Wiley
6. Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

**Tutorials:**
**Minimum 8 assignments based on the course contents**

## 20PEIN501A Modern Control Theory

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Control Systems

**Course Objectives:** To
1. Learn basics of Compensator, its types, and Electrical Network.
2. Learn how to Choose and Design a Compensator.
3. Learn PID Control Actions, Requirements, Constraints and Tuning Procedures.
4. Learn and Analyse Controller Design Methods using Modern Control Theory.

**Course Outcomes:** Students will be able to
1. Investigate and Interpret System Requirements in Time and Frequency Domain.
2. Classify, Choose, Compare suitable Compensator.
3. Determine, Compare and Choose Controller Tuning Parameters.
4. Apply Modern Control Techniques in Continuous and or Discrete Domain.

**Unit 1: Introduction to Modern Control (08)**
Introduction to Modern Control Techniques, Classical Control Vs Modern Control, Need to Modern Control Techniques, Advantages and Limitations of Modern Control Techniques, Basic Representation of Modern Control.

**Unit 2: Basics of Control Actions and Controller Tuning (06)**
Control Actions: ON/OFF, Proportional, Proportional plus Integral, Proportional plus Integral plus Derivative, Controller Tuning Methods.

**Unit 3: Controller Design (07)**
Design of PI/PD/PID using Root Locus and Bode Plot Approach, Direct Synthesis of Controller, Controller Design for System with and without Dead Time through Controller Synthesis Formula.

**Unit 4: State Space Analysis (07)**
State Transition Matrix, Concept of Controllability and Observability, Controllability and Observability Matrix, Necessary and Sufficient condition for State Controllability and State Observability.

**Unit 5: Design Concepts in State Space (08)**

State Variable Feedback, Control System Design using Pole Placement, State Observer, Quadratic Optimal Control System, Design of Optimal State Regulator using Riccati Equation, Concept of Performance Indices.

**Unit 6: Fundamentals of Digital Control (06)**
Introduction to Digital Control, Analog Control Vs Digital Control, Need of Digital Control, Advantages of and Limitations of Digital Control, Sample and Hold, Nyquist Theorem, Interpolation and Extrapolation.

**Text Books:**

1. B. C. Kuo, "Digital Control Systems", John Wiley and Sons, 2003.
2. K. Ogata, "Modern Control Engineering", 4th Edition, Pearson Education.
3. D. Roy Choudhury, "Control System Engineering", PHI.

**Reference Books:**

1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., 3rd Edition, 1998.
2. Norman Nise, "Control System Engineering", 3rd Edition, John Wiely and Sons.
3. R.C. Dorf & R.H. Bishop, "Modern Control System", 11th Edition, Pearson Education.
4. Graham C Goodwin, Stefan F. Graebe, Mario E. Salgado, "Control System Design", PHI.
5. Christopher T. Kilian, "Modern Control Technology Components & Systems", 3rd Edition, Cengage Learning.
6. R. T. Stefani, B. Shahian, C. J. Savant and G. H. Hostetter, "Design of Feedback Control Systems", Oxford University Press.
7. Samarjit Ghosh, "Control Systems Theory and Applications", Pearson Education.

## 20PEIN501B Biomedical and Analytical Instrumentation

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Human Anatomy and Physiology and Basics of optical Instrumentation.

**Course Objectives:**
1. To learn functioning of various body organs
2. To study the characteristics of signals generated during the functioning of the organ.
3. To learn bio signal acquisition and measurement techniques
4. To understand laws of photometry
5. To interpret instrumentation required for all types of spectroscopy

**Course Outcomes:**
1. Identify the characteristics of bio-signal generated during the functioning of an organ.
2. Analyse the various bio-signals recovered using different biomedical instruments
3. To interpret instrumentation required for all types of spectroscopy
4. To apply various principles for analysing different samples using suitable analytical technique

**Unit 1: Cell Anatomy (08)**
Structure and function of Cell. Generation and Conduction of Bio potential, Homeostasis, Sensors: Study of Bio transducers, Biochemical Sensors (Glucose, pH, Po2,Pco2), Electrode as sensor, Types of electrodes, Electrode circuit model.

**Unit 2: Cardiovascular System and measurement (08)**
Function of heart as Pump, electro conduction system, Basics of ECG, Einthoven triangle, 12 lead Configuration & Electrocardiograph, Types of ECG monitors, Analysis of ECG signal. Correlation of Blood Pressure, Heart Sounds, Blood Flow with ECG, Phonocardiography, Plethysmography Pulse transit time, Pulse wave Velocity, Blood pressure measurement-Manual and Automatic, Blood Flow meters- Electromagnetic, Ultrasound and Dye dilution.

**Unit 3: Physiological Systems (08)**
Respiratory system: lungs anatomy, Regulation of Respiration. Pulmonary function test: lungs volume and capacities, Artificial respiration, Spirometers, ventilators.
Structure and function of Neurons, brain anatomy, 10-20 electrode system, EEG basics.
Structure and function of Neurons, brain anatomy, 10-20 electrode system, EEG basics, Electroencephalograph.
Structure and function of kidneys and Nephron, regulation of water and electrolyte balance, dialysis.

**Unit 4: Overview and Introduction of Spectroscopy (06)**
Introduction to Analytical methods and its classification, Laws of Photometry, components of optical systems (source, wavelength selector, detectors, signal processor, readout device), UV- Visible Spectroscopy, IR Spectroscopy.

**Unit 5: Absorption & Emission Spectroscopy (06)**
Fluorescence & Phosphorescence Spectroscopy, Atomic absorption spectroscopy: Principle, Hollow cathode source, Types, working, Background correction methods.
Atomic emission spectroscopy: Principle, Sources (AC & DC Arc Excitation, Plasma Excitation), Types, working and Flame photometer.

**Unit 6: Separative Methods & Gas Chromatography (06)**
Components of mass spectrometry, Mass analyser types, Quantitative analysis of mixtures Chromatography: Fundamental of chromatographic separation, Gas chromatography, High Performance Liquid Chromatography.

**Text Books:**

1. Human Physiology- The Mechanism of Body Function By Vander, Sherman, TMH Ed.1981
2. Introduction to Biomedical Equipment Technology By Carr& Brown
3. Biomedical Instrumentation and Measurements By Cromwell, 2nd edition, Pearson Education.
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
5. Text book of clinical Ophthalmology- Ronald Pitts Crick, Pang Khaw, 2nd Edition, World Scientific publication. ISBN 981-238-128-7.
6. Medical Instrumentation, John G Webster
7. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw–Hill Publications, 3rd ed.
8. Ewing Galen W., Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company, 5th ed.
9. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers. & Distributors, New Delhi, 7th ed.

## 20PEIN501C Advanced Microcontroller Techniques

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:**
1. Concepts of Microprocessors and Microcontrollers
2. Logic building concepts and programming microcontrollers in C

**Course Objectives**:
1. To introduce the architecture and features of high-capacity microcontrollers
2. To provide an understanding of integrated peripherals and its configuration
3. To design system for specified application

**Course Outcomes:** The students will be able to
1. Select appropriate features of microcontroller for given application.
2. Identify detailed hardware structure and software model of the microcontroller for the given application.
3. Develop configuration of integrated peripherals.
4. Design system for given application using microcontrollers

**Unit 1: Introduction to ARM Cortex (07)**
Architecture, Block Diagram, Programmer's Model, Registers and Memory Management, CPU operating modes, Pipeline, Thumb instructions set, Reset circuit and Sequence. Development Tools, Tool chains, Libraries and Software for programming

**Unit 2: The ARM Cortex Processor (08)**
Buses, System Timing, Interrupt handling and NVIC, Power management, Clock, comparison with ARM7 and ARM10

**Unit 3: Introduction to STM32 microcontrollers (08)**
Overview and Features of STM32 Microcontrollers, Advantages, Drawbacks and Subfamilies, Low Power operation and reset sources

**Unit 4: Integrated Peripherals of STM32 microcontrollers-I (07)**
General Purpose I/O, External Interrupts, ADC and Timers, DMA

**Unit 5: Integrated Peripherals of STM32 microcontrollers-II (06)**

SPI, I2C, USART, CAN and USB

**Unit 6: Small System Design with STM32 microcontrollers (06)**

System design for specified applications using integrated peripherals and external components necessary for the same.

**Books:**

1. Discovering the STM32 Microcontroller, Geoffrey Brown
2. The Insider's Guide To The STM32 ARM Based Microcontroller, Trevor Martin, Published by Hitex (UK) Ltd.
3. Mastering STM32, Carmine Noviello, Lean Publishing, 2016
4. The Definitive Guide to ARM Cortex®-M0 and Cortex-M0+ Processors, Joseph Yiu, Second Edition, Elsevier

**20PEIN502A Industry 4.0 and IIOT**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basic knowledge of Computer and Internet

**Course Objectives:**

1. To understand building blocks, components of IoT and concepts of Industry 4.0
2. To understand technologies used in IoT and Industry 4.0
3. To understand the role of platforms and big data in IoT

**Course Outcomes:** The students will be able to

1. Identify the different stages of industrial revolution & features of Industry 4.0.
2. Compare connectivity technologies & protocols used for IoT.
3. Comprehend IoT, cyber-physical systems, cloud computing and big data, smart factories and their role in Industry 4.0.
4. Select appropriate IoT technology for an application.

**Description:**

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.

**Suggested Swayam link:**

https://onlinecourses.nptel.ac.in/noc22_cs95/preview

**Reference Books:**

1. S. Misra, A. Mukherjee, and A. Roy, 2020. *Introduction to IoT*. Cambridge University Press.
*Availability:*
https://www.amazon.in/Introduction-IoT-Sudip-Misra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1

2. S. Misra, C. Roy, and A. Mukherjee, 2020. *Introduction to Industrial Internet of Things and Industry 4.0.* CRC Press.
*Availability:*
https://www.amazon.in/dp/1032146753/ref=sr_1_3?dchild=1&keywords=sudip+misra&qid=1627359971&sr=8-3

3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.

4. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

## 20PEIN502B Biomedical

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of signals and systems and linear algebra.

**Course Objectives:**

1. Deduce which imaging technique is appropriate for a given application.
2. Describe their fundamental promises and limitations
3. Differentiate the imaging modalities covered in the course.

**Course Outcomes:** The students will be able to

1. Delineate various biomedical imaging modalities
2. Differentiate the imaging modalities covered in the course.
3. Select the appropriate imaging technique for given application
4. Identify various medical image processing algorithms

**Description:**

This course attempts to provide an introduction to the different commonly-used medical imaging systems. Overview of biomedical imaging systems and analysis. Examination of various imaging modalities. Although there are several courses and textbooks available from medical physics background, there are only a few materials that treat the subject from a system's perspective, which is the view point taken here.

Topics: Introduction, 2D- Signals Systems review, Image Quality metrics, Projection Radiography,:X-ray CT, Nuclear Medicine- PET/SPECT, Ultrasound Imaging, MRI

**Suggested Swayam link:**

https://onlinecourses.nptel.ac.in/noc22_bt56/preview

**Reference Books:**

1. Medical Imaging Signals and Systems by J. L. Prince and J. M. Links, Pearson Prentice Hall, 2006, ISBN 0130653535.
2. Webb's Physics of Medical Imaging, 2nd Edition, CRC press
3. Foundations of Medical Imaging , Z. H. Cho, J. P. Jones, and M. Singh , Wiley , 1993
4. Stewart C. Bushong, Radiologic Science for Technologists: Physics, Biology, and Protection, 10th ed., Mosby, 2012. (ISBN-13: 978-0323081351)

**20IN501L Process Loop Components Lab**

**Teaching Scheme:**
Practical: 2Hrs/weeks

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:**

1. Calibrate various process control components like transmitter, converter etc by selecting proper test and measuring instruments
2. Find the characteristics of various process control components like transmitter, converter, control valve etc.
3. Configure, tune and test various process control components like pressure switch, transmitter, controller, control valve etc by proper analysis of given application
4. Develop and implement control circuits and PLC programs for the given application

**List of Practical Assignments: (**Minimum 8)

1. Plot the characteristics of the pressure switch and observe the switch output.
2. Testing of various pneumatic and hydraulic components.
3. Identify the sequence of the given Alarm Annunciator and testing of Alarm annunciator using pressure switch
4. Calibration of Temperature Transmitter
5. Calibration of Current to pneumatic Converter
6. Plot the characteristics of square root extractor
7. Calibration of Differential pressure transmitter
8. Calibration of SMART differential pressure transmitter and Flow measurement using SMART differential pressure transmitter
9. Plot the step response of electronic controllers
10. PLC programming
11. Interfacing of PLC to pneumatic circuit
12. Plotting control valve characteristics
13. Open ended assignment on PLC programming

**Or similar type of practical assignments based on the course contents**

**20IN502L Digital Signal Processing Lab**

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:** After the successful completion of the course the students will be able to:
1. Implement various DSP operations like convolution, auto correlation using Matlab.
2. Implement different transforms applied to signals using Matlab.
3. Design and implement IIR and FIR filters for bandpass, band stop, lowpass and high pass filters in Matlab.
4. Develop digital signal processing blocks for given application.

**List of Practical Assignments:**
Students are expected to perform at least eight experiments using MATLAB or equivalent software:
1. Write a program to generate the basic signals and implement the basic DSP operations on the given signals.
2. Write a Program to implement Linear Convolution of the two given sequences.
3. Write a Program to obtain the auto-correlation and Cross-correlations of the given sequences.
4. Write a Program to obtain the transfer function and plot is pole-zero plot
5. Write a Program to find the DFT of the given sequences. Plot its magnitude and phase plot. Also find its IDFT to obtain the original sequence.
6. Write a Program to design and implement FIR filters using difference windowing methods.
7. Write a Program to design and implement IIR filters (Using Butterworth or Chebyshev approximations).
8. Generation of signal. Generate a noise signal. Mix both the signals. Design a Filter. Recovery of original signal using filter.
9. DSP Application: design solution to any application using emerging technologies which is beyond syllabus.

**Or similar type of practical assignments based on the course contents**

**20PEIN501LA Modern Control Theory Lab**

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** Students will be able to
1. Investigate Time and Frequency Domain Specifications.
2. Choose, Compare suitable Compensator.
3. Determine, Compare and Choose Controller Tuning Parameters.
4. Apply Modern Control Techniques in Continuous and or Continuous/Discrete Domain.

**List of Practical Assignments:**
1. Effect of Addition of Pole and Zero on Transient and Steady State Performance of System.
2. Design of Lag, Lead-Lag and Lead Compensator.
3. Analysis of Effect of Proportional, Integral and Derivative Control Action.
4. Design of P, PI, PID Controller using Frequency Response Approach.
5. Design of Controller using Direct synthesis Approach for System with and without Dead Time.
6. Computation of State Controllability and State Observability for a System.
7. Computation of State Feedback Controller using Pole Placement Technique.
8. Computation of Full Order State Observer.
9. Design of Optimal State Regulator for Minimising Performance Index.
10. Formation of a Control System in Discrete Domain.

**Or similar type of practical assignments based on the course contents**

**20PEIN501LB Biomedical and Analytical Instrumentation Lab**

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:**

1. Analyse the bio signals acquired by biomedical instruments.
2. Operate biomedical instruments to record bio-signals.
3. Select appropriate analytical instruments for sample analysis based on application.
4. Test samples using various analytical instruments.

**List of Practical Assignments:**

1. To Study principles and design concept of biosensors and their applications in biomedical field.
2. To Measure systolic and diastolic Blood Pressure Using Sphygmomanometer and automatic BP apparatus for different subjects.
3. To study 12 lead configuration and details of ECG waveform using ECG recorder and calculation of heart rate.
4. To study standard amplitude and frequency of EEG signal and to learn frequencies of alpha, beta, delta, theta waves of EEG signal.
5. To learn and record various lung capacities of Respiratory system using Power lab.
6. To Study and Check Specifications of an ECG Recorder. To record various leads of ECG using ECG machine and analysis of recorded ECG signal.
7. To record/monitor first and second heart sound using Electronic Stethoscope and Power lab and analysis of recorded heart sound.
8. To design and implement the photo-plethysmography Sensor for Pulse Rate Measurement.
9. Analysis by using photoelectric colorimeter.
10. Analysis by using Densitometer.
11. Analysis by using Double beam spectrometer.
12. Analysis by using Flame photometer.
13. Analysis by using Spectrofluorometer.

**Or similar type of practical assignments based on the course contents**

**20PEIN501LC Advanced Microcontroller Techniques Lab**

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** The students will be able to
1. Program microcontroller for given application
2. Select integrated peripheral for given application
3. Configure the peripherals in different modes
4. Debug the developed program / given problem statement

**List of Practical Assignments:**
Part A: (any 5)
1. Introduction and familiarization with programming environment of ARM
2. Display interfacing and Programming using ARM
3. Wave generation using ARM
4. Introduction and familiarization with programming environment of STM32
5. Port configuration and programming for input/ output devices
6. Analog input measurement using ADC
7. Communication interface configuration and programming

Part B:
System development using STM32 microcontroller for given problem statement

**Or similar type of practical assignments based on the course contents**

MKSSS's Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University)

# Autonomous Program Structure
## Third Year B. Tech. Sixth Semester
## (Instrumentation and Control)
## Academic Year: 2022-2023 Onwards

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Semester | End Semester | Oral | Practical | | |
| 20IN601 | Process Instrumentation and Control | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20IN602 | Industrial Automation | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN603 | System Engineering and Management | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20HS601 | Management Information System (MIS) | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEIN601 | Programme Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE601 | Open Elective-II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN602L | Industrial Automation Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| 20IN603L | System Engineering and Management Lab | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20PEIN601L | Programme Elective Lab-III | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20IN604 | Mini Project | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **18** | **2** | **8** | **400** | **300** | **50** | **50** | **800** | **24** |
| | **Grand Total** | **28** | | | **800** | | | | **800** | **24** |

| Programme Elective-III | Programme Elective-III Lab |
|---|---|
| 20PEIN601A Building Automation | 20PEIN601LA Building Automation |
| 20PEIN601B Embedded Product Design | 20PEIN601LB Embedded Product Design |

Department of Instrumentation & Control Engineering

**APPROVED BY**
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

CUMMINS COLLEGE OF ENGINEERING FOR WOMEN
KARVE NAGAR PUNE-411 052

**APPROVED BY**
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

| | |
|---|---|
| 20PEIN601C MEMS | 20PEIN601LC MEMS |

| 20OE601 Open Elective-II | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE601A | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601B | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601C | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601D | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601E | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601F | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601G | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601H | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601I | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601J | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601K | Multimedia Systems | Y | Y | Y | N | Y |

| 20OE601L Open Elective-II Lab | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE601LA | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601LB | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601LC | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601LD | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601LE | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601LF | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601LG | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601LH | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601LI | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601LJ | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601LK | Multimedia Systems | Y | Y | Y | N | Y |



APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

**20IN601 Process Instrumentation and Control**

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| Lectures: 3 Hrs/week | In Semester: 50 Marks |
| Tutorial: 1 Hr/week | End Semester: 50 Marks |
| | Credit: 4 |

**Prerequisites:** Principle and applications of various Sensors and Transducers, Basics of control systems, Principle of actuators and final control element and their applications.

**Course Objectives:**
1. To understand the principles of multi-loop controllers and nonlinear systems.
2. To equip students with knowledge of multi variable control, interaction, the pairing, decoupling and design of controllers for interacting multi variable systems.
3. Explain the control loops related to heat exchanger, Boiler, distillation column, reactor, pumps and compressors

**Course outcomes:** The students will be able to
1. Identify the characteristics of given process
2. Compare the features of different control strategies
3. Select appropriate control strategy for given application
4. Develop the instrumentation and control loops for various processes

**Unit 1: Multi-Loop Control & Nonlinear Systems (09)**
SLPC and MLPC features, Feedback, feed forward control, cascade control, ratio control, selective control, split-range control
Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues.

**Unit 2: Multivariable Control (09)**
Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and multiloop Control system. Multiloop control Performance through: Loop Paring, tuning, Enhancement through Decoupling, Single Loop Enhancements.

**Unit 3: Heat exchanger and Boiler controls (08)**

Types, gain and time constants, degrees of freedom. Basic controls in Heat exchangers, Steam Heaters, Condensers, fired heaters and vaporizers. Advanced Control Override, Feed forward Control.
Types, Components, Boiler controls like Drum level control (1,2,3,5 element), Air to fuel ratio control, Combustion controls, Steam temperature and pressure control, Safety interlocks, Burner management system, startup and shutdown procedures, boiler safety standards

**Unit 4: Distillation Column control** **(08)**
Mass and Energy balance, column feed control, column pressure control, control of overhead and bottom composition, distillate reflux flow control. Frequency response, lag in liquid and vapour flow, concentration lag, predicting the behaviour of control system

**Unit 5: Reactor and pumps and compressor control** **(08)**
Types of reactions and reactors, factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management.
Pumps: Types, Basic Controls, Multi pump system controls. Compressors: Types, Basic Controls.

**Text Books:**
1. Process Control Systems -F.G. Shinskey, TMH.
2. Instrument Engineers' Handbook: Process Control: B.G. Liptak, Chilton.
3. Optimization of Industrial Unit Processes - Bela G. Liptak

**Reference Books:**
1. Boiler Control Systems: David Lindsey, Mc GRAW-HILL

**Tutorials:**
**Minimum 8 assignments based on the theory syllabus**

# 20IN602 Industrial Automation

**Teaching Scheme:**
Lectures: 3Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Process Loop Components

**Course Objectives:**
1. Understand the basic concepts of automation and its requirements.
2. To develop an automation project and its documentation.
3. To learn and apply standards and recommended practices to automation.
4. To understand the activities followed in automation projects.

**Course Outcomes:** The student will be able to,
1. Classify and compare the different automation tools used in industry.
2. Select suitable communication protocol for the required automation system.
3. Develop the logic and communication for any PLC/DCS system.
4. Discuss various safety methods used in automation industries.

**Unit 1: Introduction to Industrial Automation (08)**
Introduction to industrial automation (Automation Pyramid according to industry 4), Introduction to automation tools (PLC, HMI, SCADA, DCS, Robotics and Drives), Introduction to automation tools performance criteria, Development of URS (User Requirement Specification) for automation and FDS (Functional Design Specification) for automation tools.

**Unit 2: Components and Hardware (07)**
Controllers: PLC, DCS, Embedded controllers; Operator Interfaces: Text based interfaces, graphical interfaces, Touch screens; Sensors: Discrete devices (sourcing and sinking concept, limit switches, proximity switches), Analog (pressure, flow, temperature sensing), Special purpose components: Encoders(high speed counter), vision sensors, bar code, RFID; Contactors, Starters, Circuit breakers, fuses, terminal blocks; Actuators and motion control : Pneumatic and hydraulic actuators, motors. Wiring of discrete, analog input and output devices.

**Unit 3: Industrial Protocols (08)**

Definition of protocols, Introduction to OSI model, Communication standards (RS232, RS485), Modbus (ASCII/RTU), Foundation fieldbus (H1/HSE), Profibus, Profinet, Industrial Ethernet, CAN, DeviceNet, ControlNet and HART protocols, Introduction to third party interface. Comparison between the protocols.

**Unit 4: PLC Based Automation (07)**

IEC 61131-3 standard, Logic development(Timer, Counter, Compare, Math, Conversion and Move instructions) Analog control loop (PID) configuration in PLC, PLC to PLC communication, PLC to HMI communication, PLC to other devices communication programs(servo motor and stepper motor logic in PLC)

**Unit 5: Distributed Control System (06)**

DCS introduction, Architecture of different makes: comparison and specification, Configuration of discrete and analog IO’s and programming, Development and configuration of user interface, alarm management, diagnosis, security and user access management.

**Unit 6: Process Safety and Safety Management System (06)**

Introduction to process safety, hazardous area classification, process hazard analysis, safety integrity levels (SIL), Introduction to IEC61511 standard, SIS application for safety system.

**Text Books:**

1. S.K.Singh, “Computer Aided Process Control”, PHI.
2. Garry Dunning, “Introduction to Programmable Logic Controllers”, Thomson Learning.
3. Krishna Kant, “Computer Based Process Control”, PHI.
4. Frank Lamb, “Industrial Automation Hands On”, Mc Graw Hill.

**Reference Books:**

1. Samuel Herb, “Understanding Distributed Process Systems for Control”, ISA.
2. Webb & Reis, “Programmable Logic Controllers: Principles and Applications”, PHI.

## 20IN603 System Engineering and Management

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures: 3hrs/week | In Semester: 50 Marks |
| Tutorial: 1 Hr/week | End Semester: 50 Mark |
| | Credit: 4 |

**Prerequisites**: -

**Course Objectives:**
1. To Know the basic concepts of Project Engineering and Management.
2. To Understand various engineering documents.
3. To interpret and apply national and international standards, and recommended practices.
4. To Know the activities followed in instrumentation projects.

**Course Outcomes:** By the end of the course, students should be able to
1. Develop documentation for, work distribution, team, planning and scheduling for any project.
2. Apply national and international standards, and recommended practices
3. Develop instrumentation detailed engineering documents as per required standards
4. Develop testing and commissioning documentation

**Unit 1: Basic Concept of Project Management (08)**
Definition, Types and Life cycle phases of project, Basics of Project management, Project Planning, Scheduling, Tools and techniques of project management.

**Unit 2: Instrumentation Documentation and its Related Standards (07)**
Detailed discussion of ISA standards, FEED documents (PFD, Material balance, P&ID etc.) and DED documents (Process data sheets, instrument index, instrument specification sheet, calculation sheets like valve sizing, thermowell design, orifice design etc.).

**Unit 3: Panels and Wiring Documentation (08)**
Electrical Panels: Specification, GA drawings, Instrumentation Panels (Instrument panels, Marshalling panels) Terminal Strip reports, Power requirement calculation etc. Instrument Cable: Types, specification, Cable trays, Control room engineering.

**Unit 4: EPC Contracting and Procurement Activities (07)**
Introduction to EPC contracting, Vendor registration, requirements for qualification documents. Tendering and bidding process, requirement and qualification documents, Bid

evaluation (Role and knowledge required as an instrumentation engineer), Purchase orders etc..

**Unit 5: Installation (06)**

Understand, design and develop instrument Installation sketches for various instruments (Hook up drawings like Thermowell, Flow transmitter, Differential pressure transmitter, orifice, pitot tube, rotameter, DPT type level transmitter installation specification etc.

**Unit 6: Commissioning and testing (06)**

Inspection and Testing: Factory Acceptance Test (FAT) Team, Planning, documentation, Customer or Site Acceptance Test (CAT or SAT), Team, Planning, documentation. Test and inspection reports. Pre-commissioning planning activities, documents required for Cold Commissioning and hot commissioning, Performance trials and final hand over, Calibration records

**Text Books:**

1. Applied instrumentation in process industries by Andrew & Williams (Gulf Publishing)
2. Management systems by John Bacon (ISA)
3. Process control Instrument Engineers Handbook by Liptak.

**Reference Books:**

1. Instrument Installation Project Management (ISA).
2. Successful Instrumentation & Control Systems Design, by Michael D. Whitt (ISA)

**Tutorials:**

**Minimum 8 assignments based on the course contents**

**20HS601 HS – Management Information System**

**Teaching Scheme:**
Lectures: 3 Hr/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To introduce the students to the Management Information Systems
2. Its application in organizations and related technology
3. The course would expose the students to the managerial issues relating to information systems.
4. Help them identify and evaluate various options in Management Information Systems.

**Course Outcomes:**
1. Identify the functionalities and use of Management information system in industry.
2. Analyse various factors of Management Information System in organization e.g. sales, profit, digital marketing.
3. Develop various information system like ERP,CRM, data warehouse, etc
4. Analyse various parameters of technology solutions in any organization

**Unit 1: Introduction to Management Information Systems (07)**
Need, Purpose and Objectives - Contemporary Approaches to MIS, architecture of MIS, MIS as an instrument for the organizational change. Organizational levels, functional area. Automation pyramid, MIS in level 5 of industry 4.0.

**Unit 2: Information System in Business (08)**
Data and Information: Introduction, data and information- measuring data, information as a resource, information in organisational functions, types of information technology, types of information systems- transaction processing systems-management information systems

**Unit 3: Management Information Systems, Technology, and Strategy (08)**
Role of Information Technology in Organization, Plant Operation management and digitization. Information System and Strategy; Strategic Analysis and management. The Information Centre, Plant Operation management and digitization.

**Unit 4: Systems Analysis and Design (07)**
Systems Development Life Cycle (SDLC), Alternative System Building Approaches Prototyping, Rapid Development Tools, Agile, CASE Tools, Object Oriented Systems. MIS in renewable energy.

**Unit 5: Decision Support Systems** **(06)**
Understanding DSS- MIS and DSS-Decision making-types of decisions, Analytics and Business Intelligence- BI techniques. Group Decision Support Systems, Executive Information Systems, Executive Support Systems, Expert Systems and Knowledge Based Expert Systems, Artificial Intelligence in DSS.

**Unit 6: SCM, CRM, EIS and International Systems** **(06)**
Introduction, Supply Chain Management Systems, Customer Relationships Management Systems, Challenges of Enterprise Systems Implementations- Managing the implementation, International Information Systems-Outsourcing and off-shoring.

**Text Books:**
1. Management Information Systems, Laudon and Laudon, 7th Edition, Pearson Education Asia
2. Management Information Systems, Jawadekar, Tata McGraw Hill
3. Management Information Systems - Sadagopan, Prentice Hall
4. Analysis and Design of Information Systems, Rajaraman, Prentice Hall

**Reference Books:**
1. Decision Support Systems and Intelligent Systems, Turban and Aronson, Pearson Education Asia
2. Management Information Systems, Schultheiss, Tata McGraw Hill
3. Management Information Systems, Davis and Olson, Tata McGraw Hill 4. Management Information Systems - Jayant Oke

## 20PEIN601A Building Automation

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**
1. Enable students to understand basic concept of building automation
2. Learn to create safe, secure, comfortable, healthy, and sustainable environment in buildings
3. Learn to bring energy efficiency in building systems

**Course Outcomes:** The student will be able to
1. Delineate various HVAC system, fire and security system components and systems.
2. Investigate the system requirements to select HVAC system, fire and security system components.
3. Develop the HVAC air systems and water system operations and control philosophies
4. Develop the Fire Safety, Security and Access Control Systems.

**Unit 1: Introduction to Building Automation Systems (08)**
Intelligent buildings, its's architecture and structure - Evolution of intelligent buildings. Facilities management vs. intelligent buildings, Lifecycle of building. BAS System Hierarchy – Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS). Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS. Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design. BAS communication protocols and addressing concepts – BACnet and LON

**Unit 2: Comfort parameters and measurement in BAS system (08)**
Comfort parameters for human being - temperature, humidity, flow, pressure, clean air: Working Principle, Characteristics of different types of temperature sensors - RTD, Thermistor, Thermocouple, Bimetallic strip; Humidity, Specific Humidity, Relative Humidity, Dew point, Saturation point; Dry bulb & Wet bulb temperature, Working principle of Psychrometer; Pressure and Flow measurements in HVAC for air-side and water-side applications; Measurement of CO2 level in air, Air filtration techniques, ozonisation and UV; Other Parameters affecting building operation - Building load for Chilled water and hot water system, Working principal of BTU meter, BTU meter mounting.

**Unit 3: HVAC Water Systems (07)**

Chilled Water Systems: Concept of refrigeration cycle. Working, mechanical configuration of different types of components used in refrigeration cycle - evaporator, condenser, compressor, expansion valve. Difference between air-cooled chiller and water-cooled chiller. Working and mechanical configuration of different types of cooling towers. Concept and working of heat pump. Design, working of different types of chilled water system - single chiller system, series chiller system, parallel chiller system. Working of different components of chilled water system - decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps.

Hot Water Systems: Working and design of different types of boilers- fire tube, water tube, packaged boiler. Working and design of different types of heat exchanger. Design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input. Concept of geothermal system - Variable frequency drives: Use of VFD's for Pumps and Fans. Purpose and application of VFD.

**Unit 4: HVAC Air Systems (07)**

Air Handling Units and Terminal units - Concept of Air handling unit. Design, working of different components in AHU - damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier. Design and working of different types of AHU with combination of - 100% outdoor air, mixed air, constant volume, variable volume, dual duct, single duct. Operation of different modes in AHU - cooling, heating, humidification, dehumidification, static pressure control, volume matching, economizer mode. Heat recovery techniques - plate heat exchanger, heat recovery wheel and glycol heat recovery loop. Concept of Variable Air Volume (VAV) system - Design, working, use of different types of VAV- CAV, cooling only, with reheat, supply-exhaust VAV for critical areas (hospital and labs)

**Unit 5: Introduction to Fire Alarm System & Fire Detection (06)**

What is Fire? Fire alarm System-The History, FAS architecture & operation, Classification of Fire Alarm System, Conventional and Addressable Fire Alarm System, Important Codes-NFPA72, IS 2189, BS 5839, Critical fire & safety parameters in Facility Environment FAS Loops-Classification of Loops and Examples, Power Supply Requirement and its designing parameters. Battery Calculations. Network terminology for Fire Systems, Classification of Cables, Class of Cables, Types, and distance Supported specific to fire alarm system, Working Principles of Fire Alarm devices and its working Application in building safety, Components of fire detection system, SLC wiring and its classification, Concepts of Water leak detection system & Concepts of VESDA (Very early smoke detection system)

**Unit 6: Introduction to Building Security – Access Control & CCTV (06)**

Basic Concept of Access Control System it's benefits & architecture, Access Control System Devices –Its features and Working principles. Antipassback, Forgiveness, Two-man Rule, Time and Attendance, Guard Tour, Elevator Control, Secure and Non-Secure Concept, Card Technology Overview –Smartcard, Proximity Card, MI fare Cards, System Architecture of Access Control System, Basic of CCTV system, System Architecture of CCTV System, Types of Camera –Fixed, PTZ, Analog, Digital, Video Analytics, Camera Connectivity, Video Management System: DVR, DVM, NVR

**Text Books:**

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann , 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems , Elsevier Publications
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6. James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7. "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1. "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers
   (product code: B0009 for online shopping)
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4. "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

## 20PEIN601B Embedded Product Design

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Embedded system design, Knowledge of Assembly and C programming, Electronic instrumentation and system design

**Course Objectives:**
1. To give knowledge of interfacing analog and digital input devices to microcontrollers.
2. To give knowledge of interfacing analog and digital output devices to microcontrollers.
3. To implement different power optimization techniques for low power systems.
4. To give an overview of product design with case study.

**Course Outcomes:** Students will be able
1. Apply different methodologies to interface different sensors and devices to microcontrollers.
2. To apply different methodologies to interface different actuators to microcontrollers.
3. To explore and select proper power optimization techniques.
4. To design and test performance of a system.

**Unit 1: Programming and interfacing analogue input devices (07)**
Load cell, Temperature sensor, 2-wire transmitters, potentiometric sensors, LVDT, Linear opto IL300

**Unit 2: Programming and interfacing analogue output devices (08)**
Linear opto IL300, PWM based DAC, serial DAC, Voltage to current converter, Lamp/indicator, miniature DC motor,

**Unit 3: Programming and interfacing digital input devices (08)**
Key board, Proximity switch, incremental Encoders, Ultrasonic sensors, serial ADC, RTC-1307, Optocoupler MCT2E

**Unit 4: Programming and interfacing digital output devices (08)**
Alpha-numeric LCD, 7-Segment LED display, serial memories, Optocoupler MCT2E, printer, Stepper motor, relays (SSR and Electro-mechanical)

**Unit 5: Power efficient system and communication design (06)**

Design considerations for battery powered systems, communication based on RS-232, RS-485, Bluetooth, USB drives

**Unit 6: Small system design with case study (05)**

Embedded system design for Temperature data logger, Burglar alarm, Fire alarm, WSN based system, RFID based access control

**Text Books:**

1. Microcontrollers: Theory & Applications by Dr. A. V. Deshmukh, Tata McGraw Hill, Publications
2. Programming and Customizing the AVR Microcontroller by Dhananjay V. Gadre, Tata McGraw Hill Publishing Company Limited, 2003.
3. AVR microcontroller & Embedded System by A. Mazidi , Prentice Hall

**Reference Books:**

1. Internet resources for AVR:
2. Atmel AVR Page:. http://www.atmel.com/images/doc2502.pdf
3. http://www.atmel.in/Images/doc0856.pdf
4. Datasheets of ATmega 8535, ATtiny2313
5. Datasheets of IL300, RTC1307, MCT2E, serial ADCs, DACs

## 20PEIN601C MEMS

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Conventional sensors and materials, application of sensors

**Course Objectives:**
1. To introduce emerging MEMS field and importance of micro scaling to students
2. To provide knowledge of advanced materials, sensors and actuators
3. To learn advance micro fabrication techniques
4. To know advancement in instrumentation field of bio, automotive, aerospace field

**Course Outcomes:** The student will be able to,
1. Compare smart material based on their characteristics.
2. Select the appropriate micro sensor, micro actuator and type of microfluidic flow for given application.
3. Identify and define various phases of micro scaling and micro fabrication process.
4. Develop applications using MEMS devices.

**Unit 1: Introduction to MEMS (06)**
Introduction to MEMS, Introduction to micro sensors, Evaluation of MEMS, Application of MEMS

**Unit 2: Smart Material (08)**
Shape memory Materials, Electrostrictive Materials, Magnetostrictive Materials, Rheological Materials, Electro chromic Materials, Self-healing Material, Conducting polymer

**Unit 3: Micro Fabrication (09)**
Study of Silicon as a Material for Micromachining, Thin-film Deposition –Evaporation, Sputtering, Chemical Vapor Deposition, Epitaxial Growth of Silicon Thermal Oxidation, Lithography, Doping the Silicon Wafer: Diffusion and Ion, Implantation of Dopants, Etching. Dry Etching, Silicon Micromachining Bulk Micromachining, Surface Micromachining

**Unit 4: Micro Sensor and Micro Actuator (07)**
Micro sensor - Silicon Capacitive Accelerometer, Conductometric Gas Sensor, Fibre-Optic Sensors, Electrostatic Comb-Drive
Micro Actuator - Magnetic Micro relay, Microsystems at Radio Frequencies, Piezoelectric Inkjet Print Head, Portable Blood Analyzer, Micro mirror Array for Video Projection

**Unit 5: Microfluidics** **(06)**
Droplet Microfluidics, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers. Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.

**Unit 6: MEMS –Electronics, Packaging and Applications** **(05)**
Wafer Bonding & Packaging of MEMS Interface Electronics for MEMS

**Text Books:**

1. Micro And Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Atre : Wiley, India (2010).
2. Microfluidics and Microfabrication by Suman Chakraborty
3. Foundation of MEMS by Chang Liu
4. An Introduction to MEMS by Nadim Maluf and Kirt Williams

**Reference Books:**

1. Smart Material Systems and MEMS: Design and Development Methodologies, Vijay, K., Varadan K., Vinoy J. Gopalakrisham S. Willey 2006
2. Smart materials and new technologies, Addington, M. ,Schodek, Daniel L. Architectural Press, 2005.
3. Smart Structure and Materials, Brain Culshaw Artech House – Borton. London 1996
4. Smart Structure analysis and design, Srinivasan A.V., Michael McFarland D., Cambridge University Press, 2001
5. Fundamentals of Micro fabrication, Marc Madou

**20OE601C Avionics**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Control Systems, Basics of Communication System

**Course Objectives:**
1. To integrate the digital electronics with cockpit equipment
2. To understand the various principles in flight desk and cockpit panels.
3. To understand the communication techniques used in aircraft.
4. To explain the modern era of flight control system

**Course Outcomes:** The student will be able to
1. Identify the mechanical and electronic hardware required for aircraft.
2. Compare the communication and navigation techniques used in aircrafts.
3. Disseminate the autopilot and cockpit display related concepts.
4. Compare and identify different actuators in avionics.

**Unit 1: Introduction to Avionics (08)**
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

**Unit 2: Digital Avionics Bus Architecture (07)**
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies

**Unit 3: Flight Deck and Cockpit (07)**
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

**Unit 4: Avionics Systems (06)**
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals-Certification-Military and civil aircrafts.

**Unit 5: On Board Navigation Systems (07)**

Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.

**Unit 6: Basics of Final Control Element (06)**

Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

**Text Books:**

1. R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.
2. N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

**Reference Books:**

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

## 20OE601D Bioinformatics

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2. To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3. To understand the concepts and types of Phylogeny.

**Course Outcomes:** Students will be able
1. Apply basic concepts of bioinformatics to biological data analysis.
2. Classify different types of biological databases.
3. Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4. Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

**Unit 1: Introduction to Bioinformatics (06)**
Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

**Unit 2: Bioinformatics Databases (08)**
Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

**Unit 3: Algorithms for bioinformatics (08)**
Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

**Unit 4: Sequence Analysis (08)**

Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms

**Unit 5: Sequence Alignment (06)**

Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

**Unit 6: Phylogeny (06)**

Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

**Text Books/Reference Books:**

1. Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2. Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3. N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
5. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6. Mathematical Biology & Medicine), by SorinDraghici
7. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

## 20IN602L Industrial Automation Lab

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:** Students will be able to,
1. Develop URS and FDS documents for any automation project.
2. Develop PLC/ DCS logic for any given industrial application.
3. Simulate and test the developed logic for the given application.
4. Interface different devices with PLC/ DCS

**List of Practical Assignments:(any 8)**
1. Compare the applicability of different automation tools for the given application.
2. Preparing URS and FDS for any automation project.
3. Logic implementation of any automation project in PLC using ladder language.
4. Logic implementation of any automation project in PLC using FBD language.
5. Simulate digital and analog function blocks in DCS.
6. Tune PID controller for any loop using PLC/DCS.
7. Interface PLC and HMI for any automation project through OPC or suitable protocol.
8. Study the interfacing of PLC to PLC and PLC to other devices(Servo motor, stepper motor, printer, etc)
9. Develop Graphical User Interface in DCS for any control loop.
10. Study the application of different safety systems (Case study).

**Or similar type of practical assignments based on the course contents**

**20IN603L System Engineering and Management Lab**

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** By the end of the course, students should be able to
1. Develop Project Management documents
2. Apply national and international standards and recommended practices.
3. Create instrumentation detailed engineering documents as per specified standards
4. Create testing and commissioning documentation.

**List of Practical Assignments:**
1. Develop documents for SOW/WBS/Organization structure for any I&C Project
2. Interpret the Process flow diagram and Material Balance sheet.
3. Introduction Auto CAD like (smart sketch etc.) software.
4. Develop P&ID for given process
5. Develop Instrument Index sheet, I/O list for given P&ID
6. Develop Specification sheets for given instruments and P&ID
7. Develop GA drawings for a given panel (JB/Electrical/ PLC/DCS) .
8. Develop Hook up drawings (Control valve, Thermowell, orifice plate, rotameter etc..)
9. Create Loop Wiring Diagram/Logic diagram
10. Create documents for tests like FAT/SAT or CAT
11. Develop commissioning documents.

**Or similar type of practical assignments based on the course contents**

**20PEIN601LA Building Automation Lab**

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes**: Student will be able to,
1. Describe the various components of a Building Automation System.
2. Investigate the system requirements of a Building Automation System.
3. Design the various Building Automation System components.
4. Develop the various Building Automation System components.

**List of Practical Assignments:** (minimum eight)
1. To study Architecture of BMS & IBMS
2. To study Psychrometric chart and various parameters
3. To study different types of Air Handling Units
4. To study various terminal unit systems (CAV, VAV)
5. To study Chilled Water System and loops
6. To study Hot Water System and loops
7. To study FAS loops and classifications
8. To study SLC wiring, loops, classifications
9. To study cause and effect matrix-Fire alarm system
10. To study CCTV System Architecture and types of cameras

**Or similar type of practical assignments based on the course contents**

**20PEIN601LB Embedded Product Design Lab**

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** The student will be able to
1. Verify and compare the performance of different displays
2. Design and interface various sensors to embedded controller
3. Select appropriate output devices for given application
4. Design and test embedded controller-based systems for industrial application.

**List of Practical Assignments: (minimum 5)**
1. Interfacing of Keyboard and LCD
2. Interfacing of 2-wire transmitter
3. Design of up-down counter and Interfacing of 7-segment LED display
4. Design and testing of an application based on power down mode of microcontroller

**(Any 1 from)**

5. Temperature indicator using LM35
6. Interfacing of proximity switch and relay using MCT2E optocoupler
7. Distance measurement using ultrasonic sensor HC-SR04

**(Any 1 from)**

8. Speed control of miniature DC motor
9. Intensity control of Lamp/Power LED
10. Programmable voltage to current converter

**Or similar type of practical assignments based on the course contents**

## 20PEIN601LC MEMS Lab

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Practical: 2Hrs/Week | In Semester: 25 Marks |
| | Oral: 25 Marks |
| | Credit: 1 |

**Course Outcomes:**
1. Simulate a sensor design through software like COMSOL
2. Selection of appropriate sensor and actuator for the specified application
3. Characterization of simulated sensor design
4. Design a MEMS system based on the specified application

**List of Practical Assignments:**
1. Finite element simulation of MEMS sensor – COMSOL/ANSYS
2. Design of MEMS sensor – system on a chip approach
3. Fabrication of MEMS sensor – resistive/capacitive type
4. Characterization of MEMS sensor – resistive/capacitive type
5. Microfluidics – Design, simulation, fabrication and characterisation
6. Micromixers – Design, simulation, fabrication and characterisation
7. Paper microfluidics – Simulation, fabrication and characterisation

**Or similar type of practical assignments based on the course contents**

# 20IN604 Mini Project

**Teaching Scheme:**
Practical: 2 Hrs/week

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:** Students will be able to
1. Identify and define with proper study, problem statement related to industry, healthcare, society, laboratory.
2. Design various stages to solve the identified problem.
3. Implement and test the developed design or system or prototype
4. Prepare and present technical documentation of the developed system.

MKSSS's Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University)

Cummins

**Autonomous Program Structure**
**Third Year B. Tech. Sixth Semester**
**(Instrumentation and Control)**
**Academic Year: 2022-2023 Onwards**

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Semester | End Semester | Oral | Practical | | |
| 20IN601 | Process Instrumentation and Control | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20IN602 | Industrial Automation | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN603 | System Engineering and Management | 3 | 1 | 0 | 50 | 50 | 0 | 0 | 100 | 4 |
| 20HS601 | Management Information System (MIS) | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEIN601 | Programme Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE601 | Open Elective-II | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN602L | Industrial Automation Lab | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| 20IN603L | System Engineering and Management Lab | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20PEIN601L | Programme Elective Lab-III | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20IN604 | Mini Project | 0 | 0 | 2 | 25 | 0 | 0 | 25 | 50 | 1 |
| | **Total** | **18** | **2** | **8** | **400** | **300** | **50** | **50** | **800** | **24** |
| | **Grand Total** | **28** | | | **800** | | | | **800** | **24** |

| Programme Elective-III | Programme Elective-III Lab |
|---|---|
| 20PEIN601A Building Automation | 20PEIN601LA Building Automation |
| 20PEIN601B Embedded Product Design | 20PEIN601LB Embedded Product Design |

Department of Instrumentation & Control Engineering

**APPROVED BY**
**Secretary Governing Body**
**MKSSS's Cummins College of Engineering For Women, Pune-411052**

CUMMINS COLLEGE OF ENGINEERING FOR WOMEN
KARVE NAGAR PUNE-411 052

**APPROVED BY**
**Chairman Governing Body**
**MKSSS's Cummins College of Engineering For Women, Pune-411052**

| 20PEIN601C MEMS | 20PEIN601LC MEMS |
|---|---|

| 20OE601 Open Elective-II | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE601A | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601B | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601C | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601D | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601E | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601F | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601G | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601H | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601I | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601J | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601K | Multimedia Systems | Y | Y | Y | N | Y |

| 20OE601L Open Elective-II Lab | | | Eligible Departments | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | Course Code | Course Title | EnTC | Comp | IT | Mech | Instru |
| 1 | 20OE601LA | Automation and Control Engineering | Y | Y | Y | Y | Y |
| 2 | 20OE601LB | Automotive Electronics | Y | Y | Y | Y | Y |
| 3 | 20OE601LC | Avionics | Y | Y | Y | Y | Y |
| 4 | 20OE601LD | Bioinformatics | Y | Y | Y | N | Y |
| 5 | 20OE601LE | Computer Vision | Y | Y | Y | Y | Y |
| 6 | 20OE601LF | Design Thinking | Y | Y | Y | Y | Y |
| 7 | 20OE601LG | e-Business | Y | Y | Y | Y | Y |
| 8 | 20OE601LH | Electric Vehicles | Y | Y | Y | Y | Y |
| 9 | 20OE601LI | Gamification | Y | Y | Y | Y | Y |
| 10 | 20OE601LJ | Geographical Information Systems | Y | Y | Y | Y | Y |
| 11 | 20OE601LK | Multimedia Systems | Y | Y | Y | N | Y |



APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

**20IN601 Process Instrumentation and Control**

**Teaching Scheme:**
Lectures: 3 Hrs/week
Tutorial: 1 Hr/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 4

**Prerequisites:** Principle and applications of various Sensors and Transducers, Basics of control systems, Principle of actuators and final control element and their applications.

**Course Objectives:**
1. To understand the principles of multi-loop controllers and nonlinear systems.
2. To equip students with knowledge of multi variable control, interaction, the pairing, decoupling and design of controllers for interacting multi variable systems.
3. Explain the control loops related to heat exchanger, Boiler, distillation column, reactor, pumps and compressors

**Course outcomes:** The students will be able to
1. Identify the characteristics of given process
2. Compare the features of different control strategies
3. Select appropriate control strategy for given application
4. Develop the instrumentation and control loops for various processes

**Unit 1: Multi-Loop Control & Nonlinear Systems (09)**
SLPC and MLPC features, Feedback, feed forward control, cascade control, ratio control, selective control, split-range control
Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues.

**Unit 2: Multivariable Control (09)**
Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and multiloop Control system. Multiloop control Performance through: Loop Paring, tuning, Enhancement through Decoupling, Single Loop Enhancements.

**Unit 3: Heat exchanger and Boiler controls (08)**

Types, gain and time constants, degrees of freedom. Basic controls in Heat exchangers, Steam Heaters, Condensers, fired heaters and vaporizers. Advanced Control Override, Feed forward Control.
Types, Components, Boiler controls like Drum level control (1,2,3,5 element), Air to fuel ratio control, Combustion controls, Steam temperature and pressure control, Safety interlocks, Burner management system, startup and shutdown procedures, boiler safety standards

**Unit 4: Distillation Column control (08)**
Mass and Energy balance, column feed control, column pressure control, control of overhead and bottom composition, distillate reflux flow control. Frequency response, lag in liquid and vapour flow, concentration lag, predicting the behaviour of control system

**Unit 5: Reactor and pumps and compressor control (08)**
Types of reactions and reactors, factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management.
Pumps: Types, Basic Controls, Multi pump system controls. Compressors: Types, Basic Controls.

**Text Books:**
1. Process Control Systems -F.G. Shinskey, TMH.
2. Instrument Engineers' Handbook: Process Control: B.G. Liptak, Chilton.
3. Optimization of Industrial Unit Processes - Bela G. Liptak

**Reference Books:**
1. Boiler Control Systems: David Lindsey, Mc GRAW-HILL

**Tutorials:**
**Minimum 8 assignments based on the theory syllabus**

## 20IN602 Industrial Automation

**Teaching Scheme:**
Lectures: 3Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Process Loop Components

**Course Objectives:**

1. Understand the basic concepts of automation and its requirements.
2. To develop an automation project and its documentation.
3. To learn and apply standards and recommended practices to automation.
4. To understand the activities followed in automation projects.

**Course Outcomes:** The student will be able to,

1. Classify and compare the different automation tools used in industry.
2. Select suitable communication protocol for the required automation system.
3. Develop the logic and communication for any PLC/DCS system.
4. Discuss various safety methods used in automation industries.

**Unit 1: Introduction to Industrial Automation (08)**

Introduction to industrial automation (Automation Pyramid according to industry 4), Introduction to automation tools (PLC, HMI, SCADA, DCS, Robotics and Drives), Introduction to automation tools performance criteria, Development of URS (User Requirement Specification) for automation and FDS (Functional Design Specification) for automation tools.

**Unit 2: Components and Hardware (07)**

Controllers: PLC, DCS, Embedded controllers; Operator Interfaces: Text based interfaces, graphical interfaces, Touch screens; Sensors: Discrete devices (sourcing and sinking concept, limit switches, proximity switches), Analog (pressure, flow, temperature sensing), Special purpose components: Encoders(high speed counter), vision sensors, bar code, RFID; Contactors, Starters, Circuit breakers, fuses, terminal blocks; Actuators and motion control : Pneumatic and hydraulic actuators, motors. Wiring of discrete, analog input and output devices.

**Unit 3: Industrial Protocols (08)**

Definition of protocols, Introduction to OSI model, Communication standards (RS232, RS485), Modbus (ASCII/RTU), Foundation fieldbus (H1/HSE), Profibus, Profinet, Industrial Ethernet, CAN, DeviceNet, ControlNet and HART protocols, Introduction to third party interface. Comparison between the protocols.

**Unit 4: PLC Based Automation (07)**

IEC 61131-3 standard, Logic development(Timer, Counter, Compare, Math, Conversion and Move instructions) Analog control loop (PID) configuration in PLC, PLC to PLC communication, PLC to HMI communication, PLC to other devices communication programs(servo motor and stepper motor logic in PLC)

**Unit 5: Distributed Control System (06)**

DCS introduction, Architecture of different makes: comparison and specification, Configuration of discrete and analog IO's and programming, Development and configuration of user interface, alarm management, diagnosis, security and user access management.

**Unit 6: Process Safety and Safety Management System (06)**

Introduction to process safety, hazardous area classification, process hazard analysis, safety integrity levels (SIL), Introduction to IEC61511 standard, SIS application for safety system.

**Text Books:**

1. S.K.Singh, "Computer Aided Process Control", PHI.
2. Garry Dunning, "Introduction to Programmable Logic Controllers", Thomson Learning.
3. Krishna Kant, "Computer Based Process Control", PHI.
4. Frank Lamb, "Industrial Automation Hands On", Mc Graw Hill.

**Reference Books:**

1. Samuel Herb, "Understanding Distributed Process Systems for Control", ISA.
2. Webb & Reis, "Programmable Logic Controllers: Principles and Applications", PHI.

**20IN603 System Engineering and Management**

**Teaching Scheme:**
Lectures: 3hrs/week
Tutorial: 1 Hr/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Mark
Credit: 4

**Prerequisites**: -

**Course Objectives:**
1. To Know the basic concepts of Project Engineering and Management.
2. To Understand various engineering documents.
3. To interpret and apply national and international standards, and recommended practices.
4. To Know the activities followed in instrumentation projects.

**Course Outcomes:** By the end of the course, students should be able to
1. Develop documentation for, work distribution, team, planning and scheduling for any project.
2. Apply national and international standards, and recommended practices
3. Develop instrumentation detailed engineering documents as per required standards
4. Develop testing and commissioning documentation

**Unit 1: Basic Concept of Project Management (08)**
Definition, Types and Life cycle phases of project, Basics of Project management, Project Planning, Scheduling, Tools and techniques of project management.

**Unit 2: Instrumentation Documentation and its Related Standards (07)**
Detailed discussion of ISA standards, FEED documents (PFD, Material balance, P&ID etc.) and DED documents (Process data sheets, instrument index, instrument specification sheet, calculation sheets like valve sizing, thermowell design, orifice design etc.).

**Unit 3: Panels and Wiring Documentation (08)**
Electrical Panels: Specification, GA drawings, Instrumentation Panels (Instrument panels, Marshalling panels) Terminal Strip reports, Power requirement calculation etc. Instrument Cable: Types, specification, Cable trays, Control room engineering.

**Unit 4: EPC Contracting and Procurement Activities (07)**
Introduction to EPC contracting, Vendor registration, requirements for qualification documents. Tendering and bidding process, requirement and qualification documents, Bid

evaluation (Role and knowledge required as an instrumentation engineer), Purchase orders etc..

**Unit 5: Installation (06)**

Understand, design and develop instrument Installation sketches for various instruments (Hook up drawings like Thermowell, Flow transmitter, Differential pressure transmitter, orifice, pitot tube, rotameter, DPT type level transmitter installation specification etc.

**Unit 6: Commissioning and testing (06)**

Inspection and Testing: Factory Acceptance Test (FAT) Team, Planning, documentation, Customer or Site Acceptance Test (CAT or SAT), Team, Planning, documentation. Test and inspection reports. Pre-commissioning planning activities, documents required for Cold Commissioning and hot commissioning, Performance trials and final hand over, Calibration records

**Text Books:**

1. Applied instrumentation in process industries by Andrew & Williams (Gulf Publishing)
2. Management systems by John Bacon (ISA)
3. Process control Instrument Engineers Handbook by Liptak.

**Reference Books:**

1. Instrument Installation Project Management (ISA).
2. Successful Instrumentation & Control Systems Design, by Michael D. Whitt (ISA)

**Tutorials:**

**Minimum 8 assignments based on the course contents**

**20HS601 HS – Management Information System**

**Teaching Scheme:**
Lectures: 3 Hr/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To introduce the students to the Management Information Systems
2. Its application in organizations and related technology
3. The course would expose the students to the managerial issues relating to information systems.
4. Help them identify and evaluate various options in Management Information Systems.

**Course Outcomes:**
1. Identify the functionalities and use of Management information system in industry.
2. Analyse various factors of Management Information System in organization e.g. sales, profit, digital marketing.
3. Develop various information system like ERP,CRM, data warehouse, etc
4. Analyse various parameters of technology solutions in any organization

**Unit 1: Introduction to Management Information Systems (07)**
Need, Purpose and Objectives - Contemporary Approaches to MIS, architecture of MIS, MIS as an instrument for the organizational change. Organizational levels, functional area. Automation pyramid, MIS in level 5 of industry 4.0.

**Unit 2: Information System in Business (08)**
Data and Information: Introduction, data and information- measuring data, information as a resource, information in organisational functions, types of information technology, types of information systems- transaction processing systems-management information systems

**Unit 3: Management Information Systems, Technology, and Strategy (08)**
Role of Information Technology in Organization, Plant Operation management and digitization. Information System and Strategy; Strategic Analysis and management. The Information Centre, Plant Operation management and digitization.

**Unit 4: Systems Analysis and Design (07)**
Systems Development Life Cycle (SDLC), Alternative System Building Approaches Prototyping, Rapid Development Tools, Agile, CASE Tools, Object Oriented Systems. MIS in renewable energy.

**Unit 5: Decision Support Systems** **(06)**
Understanding DSS- MIS and DSS-Decision making-types of decisions, Analytics and Business Intelligence- BI techniques. Group Decision Support Systems, Executive Information Systems, Executive Support Systems, Expert Systems and Knowledge Based Expert Systems, Artificial Intelligence in DSS.

**Unit 6: SCM, CRM, EIS and International Systems** **(06)**
Introduction, Supply Chain Management Systems, Customer Relationships Management Systems, Challenges of Enterprise Systems Implementations- Managing the implementation, International Information Systems-Outsourcing and off-shoring.

**Text Books:**
1. Management Information Systems, Laudon and Laudon, 7th Edition, Pearson Education Asia
2. Management Information Systems, Jawadekar, Tata McGraw Hill
3. Management Information Systems - Sadagopan, Prentice Hall
4. Analysis and Design of Information Systems, Rajaraman, Prentice Hall

**Reference Books:**
1. Decision Support Systems and Intelligent Systems, Turban and Aronson, Pearson Education Asia
2. Management Information Systems, Schultheiss, Tata McGraw Hill
3. Management Information Systems, Davis and Olson, Tata McGraw Hill 4. Management Information Systems - Jayant Oke

## 20PEIN601A Building Automation

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**
1. Enable students to understand basic concept of building automation
2. Learn to create safe, secure, comfortable, healthy, and sustainable environment in buildings
3. Learn to bring energy efficiency in building systems

**Course Outcomes:** The student will be able to
1. Delineate various HVAC system, fire and security system components and systems.
2. Investigate the system requirements to select HVAC system, fire and security system components.
3. Develop the HVAC air systems and water system operations and control philosophies
4. Develop the Fire Safety, Security and Access Control Systems.

**Unit 1: Introduction to Building Automation Systems (08)**
Intelligent buildings, its's architecture and structure - Evolution of intelligent buildings. Facilities management vs. intelligent buildings, Lifecycle of building. BAS System Hierarchy – Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS). Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS. Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design. BAS communication protocols and addressing concepts – BACnet and LON

**Unit 2: Comfort parameters and measurement in BAS system (08)**
Comfort parameters for human being - temperature, humidity, flow, pressure, clean air: Working Principle, Characteristics of different types of temperature sensors - RTD, Thermistor, Thermocouple, Bimetallic strip; Humidity, Specific Humidity, Relative Humidity, Dew point, Saturation point; Dry bulb & Wet bulb temperature, Working principle of Psychrometer; Pressure and Flow measurements in HVAC for air-side and water-side applications; Measurement of CO2 level in air, Air filtration techniques, ozonisation and UV; Other Parameters affecting building operation - Building load for Chilled water and hot water system, Working principal of BTU meter, BTU meter mounting.

**Unit 3: HVAC Water Systems (07)**

Chilled Water Systems: Concept of refrigeration cycle. Working, mechanical configuration of different types of components used in refrigeration cycle - evaporator, condenser, compressor, expansion valve. Difference between air-cooled chiller and water-cooled chiller. Working and mechanical configuration of different types of cooling towers. Concept and working of heat pump. Design, working of different types of chilled water system - single chiller system, series chiller system, parallel chiller system. Working of different components of chilled water system - decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps.

Hot Water Systems: Working and design of different types of boilers- fire tube, water tube, packaged boiler. Working and design of different types of heat exchanger. Design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input. Concept of geothermal system - Variable frequency drives: Use of VFD's for Pumps and Fans. Purpose and application of VFD.

**Unit 4: HVAC Air Systems (07)**

Air Handling Units and Terminal units - Concept of Air handling unit. Design, working of different components in AHU - damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier. Design and working of different types of AHU with combination of - 100% outdoor air, mixed air, constant volume, variable volume, dual duct, single duct. Operation of different modes in AHU - cooling, heating, humidification, dehumidification, static pressure control, volume matching, economizer mode. Heat recovery techniques - plate heat exchanger, heat recovery wheel and glycol heat recovery loop. Concept of Variable Air Volume (VAV) system - Design, working, use of different types of VAV- CAV, cooling only, with reheat, supply-exhaust VAV for critical areas (hospital and labs)

**Unit 5: Introduction to Fire Alarm System & Fire Detection (06)**

What is Fire? Fire alarm System-The History, FAS architecture & operation, Classification of Fire Alarm System, Conventional and Addressable Fire Alarm System, Important Codes-NFPA72, IS 2189, BS 5839, Critical fire & safety parameters in Facility Environment FAS Loops-Classification of Loops and Examples, Power Supply Requirement and its designing parameters. Battery Calculations. Network terminology for Fire Systems, Classification of Cables, Class of Cables, Types, and distance Supported specific to fire alarm system, Working Principles of Fire Alarm devices and its working Application in building safety, Components of fire detection system, SLC wiring and its classification, Concepts of Water leak detection system & Concepts of VESDA (Very early smoke detection system)

**Unit 6: Introduction to Building Security – Access Control & CCTV (06)**

Basic Concept of Access Control System it's benefits & architecture, Access Control System Devices –Its features and Working principles. Antipassback, Forgiveness, Two-man Rule, Time and Attendance, Guard Tour, Elevator Control, Secure and Non-Secure Concept, Card Technology Overview –Smartcard, Proximity Card, MI fare Cards, System Architecture of Access Control System, Basic of CCTV system, System Architecture of CCTV System, Types of Camera –Fixed, PTZ, Analog, Digital, Video Analytics, Camera Connectivity, Video Management System: DVR, DVM, NVR

**Text Books:**

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann , 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems , Elsevier Publications
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6. James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7. "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1. "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers
(product code: B0009 for online shopping)
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4. "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

**20PEIN601B Embedded Product Design**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Embedded system design, Knowledge of Assembly and C programming, Electronic instrumentation and system design

**Course Objectives:**
1. To give knowledge of interfacing analog and digital input devices to microcontrollers.
2. To give knowledge of interfacing analog and digital output devices to microcontrollers.
3. To implement different power optimization techniques for low power systems.
4. To give an overview of product design with case study.

**Course Outcomes:** Students will be able
1. Apply different methodologies to interface different sensors and devices to microcontrollers.
2. To apply different methodologies to interface different actuators to microcontrollers.
3. To explore and select proper power optimization techniques.
4. To design and test performance of a system.

**Unit 1: Programming and interfacing analogue input devices (07)**
Load cell, Temperature sensor, 2-wire transmitters, potentiometric sensors, LVDT, Linear opto IL300

**Unit 2: Programming and interfacing analogue output devices (08)**
Linear opto IL300, PWM based DAC, serial DAC, Voltage to current converter, Lamp/indicator, miniature DC motor,

**Unit 3: Programming and interfacing digital input devices (08)**
Key board, Proximity switch, incremental Encoders, Ultrasonic sensors, serial ADC, RTC-1307, Optocoupler MCT2E

**Unit 4: Programming and interfacing digital output devices (08)**
Alpha-numeric LCD, 7-Segment LED display, serial memories, Optocoupler MCT2E, printer, Stepper motor, relays (SSR and Electro-mechanical)

**Unit 5: Power efficient system and communication design (06)**

Design considerations for battery powered systems, communication based on RS-232, RS-485, Bluetooth, USB drives

**Unit 6: Small system design with case study (05)**

Embedded system design for Temperature data logger, Burglar alarm, Fire alarm, WSN based system, RFID based access control

**Text Books:**

1. Microcontrollers: Theory & Applications by Dr. A. V. Deshmukh, Tata McGraw Hill, Publications
2. Programming and Customizing the AVR Microcontroller by Dhananjay V. Gadre, Tata McGraw Hill Publishing Company Limited, 2003.
3. AVR microcontroller & Embedded System by A. Mazidi , Prentice Hall

**Reference Books:**

1. Internet resources for AVR:
2. Atmel AVR Page:. http://www.atmel.com/images/doc2502.pdf
3. http://www.atmel.in/Images/doc0856.pdf
4. Datasheets of ATmega 8535, ATtiny2313
5. Datasheets of IL300, RTC1307, MCT2E, serial ADCs, DACs

## 20PEIN601C MEMS

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Conventional sensors and materials, application of sensors

**Course Objectives:**
1. To introduce emerging MEMS field and importance of micro scaling to students
2. To provide knowledge of advanced materials, sensors and actuators
3. To learn advance micro fabrication techniques
4. To know advancement in instrumentation field of bio, automotive, aerospace field

**Course Outcomes:** The student will be able to,
1. Compare smart material based on their characteristics.
2. Select the appropriate micro sensor, micro actuator and type of microfluidic flow for given application.
3. Identify and define various phases of micro scaling and micro fabrication process.
4. Develop applications using MEMS devices.

**Unit 1: Introduction to MEMS (06)**
Introduction to MEMS, Introduction to micro sensors, Evaluation of MEMS, Application of MEMS

**Unit 2: Smart Material (08)**
Shape memory Materials, Electrostrictive Materials, Magnetostrictive Materials, Rheological Materials, Electro chromic Materials, Self-healing Material, Conducting polymer

**Unit 3: Micro Fabrication (09)**
Study of Silicon as a Material for Micromachining, Thin-film Deposition –Evaporation, Sputtering, Chemical Vapor Deposition, Epitaxial Growth of Silicon Thermal Oxidation, Lithography, Doping the Silicon Wafer: Diffusion and Ion, Implantation of Dopants, Etching. Dry Etching, Silicon Micromachining Bulk Micromachining, Surface Micromachining

**Unit 4: Micro Sensor and Micro Actuator (07)**
Micro sensor - Silicon Capacitive Accelerometer, Conductometric Gas Sensor, Fibre-Optic Sensors, Electrostatic Comb-Drive
Micro Actuator - Magnetic Micro relay, Microsystems at Radio Frequencies, Piezoelectric Inkjet Print Head, Portable Blood Analyzer, Micro mirror Array for Video Projection

**Unit 5: Microfluidics** **(06)**
Droplet Microfluidics, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers. Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.

**Unit 6: MEMS –Electronics, Packaging and Applications** **(05)**
Wafer Bonding & Packaging of MEMS Interface Electronics for MEMS

**Text Books:**

1. Micro And Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Atre : Wiley, India (2010).
2. Microfluidics and Microfabrication by Suman Chakraborty
3. Foundation of MEMS by Chang Liu
4. An Introduction to MEMS by Nadim Maluf and Kirt Williams

**Reference Books:**

1. Smart Material Systems and MEMS: Design and Development Methodologies, Vijay, K., Varadan K., Vinoy J. Gopalakrisham S. Willey 2006
2. Smart materials and new technologies, Addington, M. ,Schodek, Daniel L. Architectural Press, 2005.
3. Smart Structure and Materials, Brain Culshaw Artech House – Borton. London 1996
4. Smart Structure analysis and design, Srinivasan A.V., Michael McFarland D., Cambridge University Press, 2001
5. Fundamentals of Micro fabrication, Marc Madou

## 20OE601C Avionics

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Control Systems, Basics of Communication System

**Course Objectives:**
1. To integrate the digital electronics with cockpit equipment
2. To understand the various principles in flight desk and cockpit panels.
3. To understand the communication techniques used in aircraft.
4. To explain the modern era of flight control system

**Course Outcomes:** The student will be able to
1. Identify the mechanical and electronic hardware required for aircraft.
2. Compare the communication and navigation techniques used in aircrafts.
3. Disseminate the autopilot and cockpit display related concepts.
4. Compare and identify different actuators in avionics.

**Unit 1: Introduction to Avionics (08)**
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

**Unit 2: Digital Avionics Bus Architecture (07)**
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies

**Unit 3: Flight Deck and Cockpit (07)**
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

**Unit 4: Avionics Systems (06)**
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals-Certification-Military and civil aircrafts.

**Unit 5: On Board Navigation Systems (07)**

Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.

**Unit 6: Basics of Final Control Element (06)**

Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

**Text Books:**

1. R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.
2. N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

**Reference Books:**

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

**20OE601D Bioinformatics**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2. To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3. To understand the concepts and types of Phylogeny.

**Course Outcomes:** Students will be able
1. Apply basic concepts of bioinformatics to biological data analysis.
2. Classify different types of biological databases.
3. Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4. Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

**Unit 1: Introduction to Bioinformatics (06)**
Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

**Unit 2: Bioinformatics Databases (08)**
Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

**Unit 3: Algorithms for bioinformatics (08)**
Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

**Unit 4: Sequence Analysis (08)**

Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms

**Unit 5: Sequence Alignment** **(06)**

Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

**Unit 6: Phylogeny** **(06)**

Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

**Text Books/Reference Books:**

1. Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2. Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3. N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
5. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6. Mathematical Biology & Medicine), by SorinDraghici
7. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

**20IN602L Industrial Automation Lab**

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:** Students will be able to,
1. Develop URS and FDS documents for any automation project.
2. Develop PLC/ DCS logic for any given industrial application.
3. Simulate and test the developed logic for the given application.
4. Interface different devices with PLC/ DCS

**List of Practical Assignments:(any 8)**
1. Compare the applicability of different automation tools for the given application.
2. Preparing URS and FDS for any automation project.
3. Logic implementation of any automation project in PLC using ladder language.
4. Logic implementation of any automation project in PLC using FBD language.
5. Simulate digital and analog function blocks in DCS.
6. Tune PID controller for any loop using PLC/DCS.
7. Interface PLC and HMI for any automation project through OPC or suitable protocol.
8. Study the interfacing of PLC to PLC and PLC to other devices(Servo motor, stepper motor, printer, etc)
9. Develop Graphical User Interface in DCS for any control loop.
10. Study the application of different safety systems (Case study).

**Or similar type of practical assignments based on the course contents**

## 20IN603L System Engineering and Management Lab

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** By the end of the course, students should be able to
1. Develop Project Management documents
2. Apply national and international standards and recommended practices.
3. Create instrumentation detailed engineering documents as per specified standards
4. Create testing and commissioning documentation.

**List of Practical Assignments:**
1. Develop documents for SOW/WBS/Organization structure for any I&C Project
2. Interpret the Process flow diagram and Material Balance sheet.
3. Introduction Auto CAD like (smart sketch etc.) software.
4. Develop P&ID for given process
5. Develop Instrument Index sheet, I/O list for given P&ID
6. Develop Specification sheets for given instruments and P&ID
7. Develop GA drawings for a given panel (JB/Electrical/ PLC/DCS) .
8. Develop Hook up drawings (Control valve, Thermowell, orifice plate, rotameter etc..)
9. Create Loop Wiring Diagram/Logic diagram
10. Create documents for tests like FAT/SAT or CAT
11. Develop commissioning documents.

**Or similar type of practical assignments based on the course contents**

**20PEIN601LA Building Automation Lab**

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes**: Student will be able to,
1. Describe the various components of a Building Automation System.
2. Investigate the system requirements of a Building Automation System.
3. Design the various Building Automation System components.
4. Develop the various Building Automation System components.

**List of Practical Assignments:** (minimum eight)
1. To study Architecture of BMS & IBMS
2. To study Psychrometric chart and various parameters
3. To study different types of Air Handling Units
4. To study various terminal unit systems (CAV, VAV)
5. To study Chilled Water System and loops
6. To study Hot Water System and loops
7. To study FAS loops and classifications
8. To study SLC wiring, loops, classifications
9. To study cause and effect matrix-Fire alarm system
10. To study CCTV System Architecture and types of cameras

**Or similar type of practical assignments based on the course contents**

## 20PEIN601LB Embedded Product Design Lab

**Teaching Scheme:**
Practical: 2Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** The student will be able to
1. Verify and compare the performance of different displays
2. Design and interface various sensors to embedded controller
3. Select appropriate output devices for given application
4. Design and test embedded controller-based systems for industrial application.

**List of Practical Assignments: (minimum 5)**
1. Interfacing of Keyboard and LCD
2. Interfacing of 2-wire transmitter
3. Design of up-down counter and Interfacing of 7-segment LED display
4. Design and testing of an application based on power down mode of microcontroller

**(Any 1 from)**
5. Temperature indicator using LM35
6. Interfacing of proximity switch and relay using MCT2E optocoupler
7. Distance measurement using ultrasonic sensor HC-SR04

**(Any 1 from)**
8. Speed control of miniature DC motor
9. Intensity control of Lamp/Power LED
10. Programmable voltage to current converter

**Or similar type of practical assignments based on the course contents**

**20PEIN601LC MEMS Lab**

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| Practical: 2Hrs/Week | In Semester: 25 Marks |
| | Oral: 25 Marks |
| | Credit: 1 |

**Course Outcomes:**
1. Simulate a sensor design through software like COMSOL
2. Selection of appropriate sensor and actuator for the specified application
3. Characterization of simulated sensor design
4. Design a MEMS system based on the specified application

**List of Practical Assignments:**
1. Finite element simulation of MEMS sensor – COMSOL/ANSYS
2. Design of MEMS sensor – system on a chip approach
3. Fabrication of MEMS sensor – resistive/capacitive type
4. Characterization of MEMS sensor – resistive/capacitive type
5. Microfluidics – Design, simulation, fabrication and characterisation
6. Micromixers – Design, simulation, fabrication and characterisation
7. Paper microfluidics – Simulation, fabrication and characterisation

**Or similar type of practical assignments based on the course contents**

# 20IN604 Mini Project

**Teaching Scheme:**
Practical: 2 Hrs/week

**Examination Scheme:**
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

**Course Outcomes:** Students will be able to
1. Identify and define with proper study, problem statement related to industry, healthcare, society, laboratory.
2. Design various stages to solve the identified problem.
3. Implement and test the developed design or system or prototype
4. Prepare and present technical documentation of the developed system.

MKSSS's Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University)

**Autonomous Program Structure of**
**Final Year B. Tech. Eighth Semester**
**(Instrumentation & Control Engineering)**
**Academic Year: 2023-2024**
**onwards**

| Course Code | Course Title | Teaching Scheme Hours /Week | | | Examination Scheme | | | | Marks | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical | In Semester | End Semester | Oral | Practical | | |
| 20IN801 | Process Data Analytics | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEIN801 | Program Elective-IV | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20PEIN802 | Program Elective-V | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE801 | Open Elective-III | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20OE802 | Open Elective-IV* | 3 | 0 | 0 | 50 | 50 | 0 | 0 | 100 | 3 |
| 20IN801L | Process Data Analytics lab | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| 20PEIN801L | Program Elective– IV Lab | 0 | 0 | 2 | 25 | 0 | 25 | 0 | 50 | 1 |
| | **Total** | **15** | **0** | **4** | **300** | **250** | **50** | **0** | **600** | **17** |
| | **Grand Total** | **19** | | | **600** | | | | **600** | **17** |

| **Programme Elective-IV** | **Programme Elective-IV Lab** |
|---|---|
| 20PEIN801A Process Modelling and Optimization<br>20PEIN801B Artificial Intelligence and Machine Learning<br>20PEIN801C Medical Device Technology | 20PEIN801LA Process Modelling and Optimization<br>20PEIN801LB Artificial Intelligence and Machine Learning<br>20PEIN801LC Medical Device Technology |

| **Programme Elective-V** |
|---|
| 20PEIN802A Safety Instrumentation Systems<br>20PEIN802B Computer Techniques and Operating Systems<br>20PEIN802C Environmental Instrumentation |

mw

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

| **20OE801 Open Elective-III** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE801A | Big Data and Analytics | Y | Y | Y | Y | Y |
| 2 | 20OE801B | Cyber Physical Systems | Y | Y | Y | N | Y |
| 3 | 20OE801C | Digital Control | Y | N | N | Y | Y |
| 4 | 20OE801D | Industrial Engineering and Management | Y | Y | Y | Y | Y |
| 5 | 20OE801E | Introduction to Cyber-crime and Forensics | Y | Y | Y | Y | Y |
| 6 | 20OE801F | Instrumentation in Food and Agriculture | Y | Y | Y | Y | Y |
| 7 | 20OE801G | Medical IoT | Y | Y | Y | N | Y |
| 8 | 20OE801H | Quantum Computing | Y | Y | Y | N | Y |
| 9 | 20OE801I | Renewable Energy Sources | Y | Y | Y | Y | Y |
| 10 | 20OE801J | Soft Computing | Y | Y | Y | Y | Y |
| 11 | 20OE801K | Software Testing and Quality Assurance | Y | Y | Y | Y | Y |

| **20OE802 Open Elective-IV** | | | **Eligible Departments** | | | | |
|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Course Code** | **Course Title** | **EnTC** | **Comp** | **IT** | **Mech** | **Instru** |
| 1 | 20OE802A | Applied statistics with R Programming | Y | N | N | Y | Y |
| 2 | 20OE802B | Automobile Engineering | Y | Y | Y | N | Y |
| 3 | 20OE802C | Autonomous Robots | N | Y | Y | Y | N |
| 4 | 20OE802D | Building Automation and Energy Audit | Y | Y | Y | Y | N |
| 5 | 20OE802E | Data Analysis and Visualization | Y | N | Y | Y | Y |
| 6 | 20OE802F | Data Science using Python | Y | N | Y | Y | Y |
| 7 | 20OE802G | Industrial Drives and Control | Y | Y | Y | Y | N |
| 8 | 20OE802H | Smart Sensors and Systems | Y | Y | Y | Y | N |
| 9 | 20OE802I | Wireless Networks | N | Y | Y | N | Y |

**20IN801 Process Data Analytics**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To explore the statistical analysis techniques for various kinds of data.
2. To understand the concepts and types of Artificial Intelligence and Machine Learning Algorithms.
3. To be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

**Course Outcomes:** The student will be able to
1. Apply standard statistical inference procedures to draw conclusions from data analysis.
2. List and define the basic concepts of artificial intelligence and machine learning.
3. Compare and select various machine learning algorithms for solving practical problems.
4. Implement various machine learning algorithms to different domains.

**Unit 1: Introduction to data analytics (07)**

Need of data analytics in process industries, types of data analytics (Descriptive analytics, Diagnostic analytics, Preventative analytics and Prescriptive analytics), Application of each type of analytics in various process and manufacturing industries. Data types: Structured, unstructured data and challenges with unstructured data, numerical and categorical data.

**Unit 2: Data Acquisition and Preprocessing (07)**

Sources of data: internal and external. Data acquisition: data access, Data handling at different levels of data access modes, ownership of data, data security, data reliability

Data Preparation: Data restoration, Identification of tables/fields of interest, Importing into the analytical tool, Merging and splitting data files, Data cleaning, Missing values and other data preparation steps, Data integration: linking multiple databases.

**Unit 3: Descriptive Statistics (07)**

Compute measures of central tendency (mean, mode, median), measures of variability (Range, variance, standard deviation, degrees of freedom), normal distribution (Characteristics of normal distribution, skewness, kurtosis), confidence interval.

**Unit 4: Inferential Statistics (07)**

Hypothesis and hypothesis testing, Chi square test, t test, correlation, Linear regression, multi regression, Logistic regression, Goodness of fit, Analysis via linear models, Non-linear model: ANOVA, Test decision rules

**Unit 5: Supervised and Unsupervised Learning Methods (07)**

Compare supervised and unsupervised learning, Supervised learning algorithms: Neural networks, Naive Bayes, Linear regression, Logistic regression and random forest

Unsupervised learning methods: Clustering, Associative Rule Mining, Introduction to Big Data and Challenges for big data analytics. Case studies and applications of algorithms in process applications.

**Unit 6:Clustering and Classification (07)**

Basics of clustering and classification, classification metrics, classification via Bayes rule, Identifying clusters in your data, Clustering and classifying using nearest neighbors algorithm: Average nearest neighbor, k nearest neighbor , Decision trees. Case studies and applications of algorithms in process applications.

**Text Books:**

1. Montgomery, Douglas C. and Runger, George C. (2014) Applied Statistics
2. Probability for Engineers, 6 th edition, John Wiley & Sons, Inc (ISBN-978-1118539712).
3. An Introduction to R, by Venables and Smith and the R Development Core Team.
4. Data Analysis and Graphics Using R; An Example-based Approach, by John Maindonald and John Braun. Cambridge Series in Statistical and Probabilistic Mathematics, 2003.
5. Sheldon M. Ross,"Introduction to Probability and Statistics for Engineers and Scientists", $4^{th}$ edition, Academic Press; 2009.

**Reference Books:**

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2.Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A Hands-On Approach", VPT, 2016
3. E. Alpaydin, "Machine Learning", MIT Press, 2010.
4. K. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. C. Bishop, "Pattern Recognition and Machine Learning, Springer", 2006.
6. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
7. John Mueller and Luca Massaron, "Machine Learning For Dummies", John Wiley & Sons, 2016.

8. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015
9. Hastie, Trevor, et al. "The elements of statistical learning". Vol. 2. No. 1. New York: springer, 2009.
10. Montgomery, Douglas C., and George C. Runger. "Applied statistics and probability for engineers" John Wiley & Sons, 2

## 20PEIN801A Process Modelling and Optimization

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Process Instrumentation, Automatic Control System, Control system Design

**Course Objectives:**
1. Understand and develop system's mathematical models.
2. Learn the use of Numerical methods in solving the model equations.
3. To learn to various optimization techniques.

**Course Outcomes:** The student will be able to
1. Define and list types of mathematical models.
2. Develop mathematical model of process.
3. Simulate and analyse the system performance.
4. Apply the optimization techniques and analyse the results.

**Unit 1: Modelling Aspects & Mathematical Models (07)**

Definition of process model, physical and mathematical modelling, deterministic and stochastic process. Introduction, uses of mathematical models, classification of mathematical methods, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics

**Unit 2: Mathematical Modelling of Mechanical & Chemical Engineering Systems (08)**

Process models of some typical systems in differential equations form, , dead time, first and second order models, higher order models, Behaviour of first order and second order system

**Unit 3: Mathematical Models (08)**

Mathematical Models of Tanks in series, Tanks in parallel Reaction dynamics, Modelling the chemical reactions, CSTR models, Plug flow reactor model, modelling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

**Unit 4: Basic concept of Optimization (07)**

Optimization: Concept, need, Essential features of optimization Problem, Concepts of objective functions, Equality and Inequality Constraints, Payback period, Return of Investment, Net present Value, Internal Rate of Return. Classification of optimization problem, Continuity of functions, convex and concave functions, Convex Region, Extremum of the objective functions, quadratic approximation, Feasible region.

**Unit 5: Optimization of Unconstrained Functions & Linear Programming (06)**

One-Dimensional search numerical methods for optimizing a function of one variable , scanning and bracketing procedures, Newton, Quasi Newton and Secant methods, Runge Kutta method.

**Unit 6: Unconstrained Multivariable Optimization (06)**

Simplex method, Direct Methods, Indirect Methods, Steepest Descent method. Linear Programming: Basics of Linear Programming, Simplex Algorithm

**Text Books:**

1. W. L. Luyben, Process, Modelling, Simulation and Control for Chemical Engineers• by McGraw Hill, 1973.
2. Thomas Edgar, David Himmelblau, Optimization of Chemical Processes• Second edition, McGraw Hill, 2001.

**Reference Books:**

1. W. F. Stoecker, Design of Thermal Systems International Education, McGraw hill 1989.
2. J. Malley, Practical Process Instrumentation and Control • McGraw Hill.
3. Deo Narsingh ,System Simulation with digital Computer • Prentice Hall India, New Delhi.
4. Singiresu S.Rao,Engineering Optimization (Therory & Practice),third Edition,New Age International(p) Ltd,Publishers.

## 20PEIN801B Artificial Intelligence and Machine Learning

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Mathematics, Computational Techniques.

**Course Objectives:**
1. To explore the statistical analysis techniques for various kinds of data.
2. To understand the concepts and types of Artificial Intelligence and Machine Learning Algorithms.
3. To be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

**Course Outcomes:** The students will be able to
1. Explore Machine Learning Methodology
2. Analyse research-based problems using Machine Learning Techniques.
3. Formalize a given problem in the different AI methods.
4. Implement basic AI algorithms.

**Unit 1: Machine Learning (08)**
Machine learning -examples of machine learning applications
Types of Learning: Supervised, Unsupervised, Issues in machine learning. Hypothesis, Target Function, Cost Function, Gradient, Training, Testing, Cross-validation, Evaluating hypothesis accuracy.

**Unit 2: ML Algorithms (09)**
Classification Algorithms , Regression Algorithms, Clustering Algorithms,
Deep Learning,

**Unit 3: Fundamentals of Artificial Intelligence (08)**
Introduction, What is AI, Applications of AI, Types of AI, A.I. Representation, Non-AI & AI Techniques, Representation of Knowledge, Knowledge Base Systems, Production Systems, Problem Characteristics, Types of production systems.

**Unit 4: State Space Search (09)**
Search Algorithms: Depth Bounded DFS, Heuristic Search: Heuristic Functions, Best First Search, Hill Climbing, Optimal Search: A* algorithm, Iterative Deepening A*, AO* search.

**Unit 5: Applications of AIML (08)**
Case Study: Uber Alternative routing, Credit card fraud analysis, Sentiment Analysis, Camera Age Analysis, etc

**Text Books:**

1. Elaine Rich and Kevin Knight: "Artificial Intelligence." Tata McGraw Hil
2. Stuart Russell & Peter Norvig : "Artificial Intelligence : A Modern Approach", Pearson Education, 2nd Edition.
3. T. Mitchell, Machine Learning,", McGraw-Hill, 1997.
4. Anup Kumar Srivastava, Soft Computing, Alpha Science International limited. 2009.

**20PEIN801C Medical Device Technology**

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Physiology of human body organs

**Course Objectives:**
1. To study diagnostic and operating instruments
2. To study life saving devices
3. Get the knowledge of laser technology
4. To learn various instruments used for checking performance of sensory organs

**Course Outcomes:**
1. Suggest the use of life saving devices for cardiovascular diseases
2. Justify the need and working of continuous monitoring devices
3. Describe use of lasers for various medical applications
4. Summarise use of diagnostic instruments

**Unit 1: Cardiac Assistive and Coronary Care Devices: (06)**
Pacemaker, Types of pacemakers: External and Internal, Programmable Pacemaker, Defibrillators: AC and DC Defibrillator, Implantable defibrillator, Heart Lung Machine.

**Unit 2: Clinical Lab Instrumentation (06)**
Blood and its composition and function, Blood Cell Counters, Electrophoresis, Pulse Oximetry- principle, Invitro and In vivo Oximeter, Telemetry- Time division and Frequency division multiplexing, Telemedicine.

**Unit 3: Respiratory and Kidney Therapy Equipment (06)**
Spiro meters, Ventilators, Dialysis System- Haemodialysis and Peritoneal dialysis Artificial Kidney-types (Coil type, parallel plate type), Lithotripsy

**Unit 4: Laser Applications and Rehabilitation Engineering (06)**
Types of lasers, Properties of laser, Basic Endoscopes system and its characteristics ,Laser applications in ophthalmology- Diabetic Retinopathy, glaucoma and Retinal hole and detachment treatment , Dermatology- Tattoo, port wine treatment.
Orthotics & Prosthetic devices, overview of various orthotics and prosthetic devices along with its materials. Wheelchair types, material used in wheelchair.

Motor Rehabilitation: Functional Electrical Stimulation - Robotics in rehabilitation - Sports, stroke and geriatric Rehabilitation - Assistive technology for dyslexia - Computer & internet access for challenged people - Neural engineering in rehabilitation engineering -

**Unit 5: ICU Operating Room Instrumentation, Electrical & Fire Safety: (06)**
Drug Delivery System, ICU layout: organization, bedside monitor. Operating room instrumentation: Electro surgical Unit, Anaesthesia Machine. Sources of Shocks, Macro and Micro Shocks, monitoring and Interrupting the operation from leakage current-Elements of Fire, causes of fire and protection.

**Unit 6: Sensory Assist Devices (06)**
Basic Audiometer; Pure tone audiometer; Audiometer system Bekesy; Evoked response Audiometer system, Hearing Aids, Visual acuity, Slit Lamp, Tonometer, Ophthalmoscope, Perimeter.
Assistive Devices for Visual and hearing Impairments, application of DSP in hearing aids - Cochlear implants - Voice synthesizer, speech trainer - Ultra sonic, Infrared and LASER canes - Intra ocular lens - Braille Reader - Tactile devices for visually challenged - Text voice converter - Screen readers.

**Text Books:**
1. Medicine and Clinical Engineering by Jacobsons& Webster, PHI
2. Introduction to Biomedical Equipment Technology ByCarr& Brown
3. Biomedical Instrumentation and Measurements by Cromwell, PHI
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, TMH

**Reference Books:**
1. The Biomedical Engineering Handbook, Bronzino, IEEE Press
2. Applied Chemical Engineering Feenberg,
3. Principles of Medical Imaging.-By: K. Kirk Shung, Michael B. Smith, BenjaminTsui.-Pub: Academic Press.
4. Medical Laser Applications -By Carruth
5 .Biomedical Instrumentation and Measurement, R.Anandanatarajan

**20PEIN802A Safety Instrumentation Systems**

**Teaching scheme:**
Lectures: 3Hrs /week

**Examination scheme:**
In semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To make the students aware of basic concepts of safety instrumented system,
2. To make the students aware of standards
3. To make the students aware of risk analysis techniques.

**Course Outcomes:** The student will be able to
1. Differentiate between process control and safety control and identify the role of safety instrumented systems in the industry.
2. Identify and analyse the process hazards.
3. Select the Safety integrity level.
4. Analyse the performance of different logic system technologies and field devices with optimum risk levels.

**Unit 1: Introduction (07)**
Safety Instrumented System (SIS) - need, features, components, difference between basic process control system and SIS, Risk: how to measure risk, risk tolerance, Safety integrity level, safety instrumented functions, review of Standards and Regulations related to Safety,

**Unit 2: Safety Life Cycle (08)**
Hazard and risk analysis, allocation of safety functions to protective layers, develop safety requirements specification, SIS design & engineering, installation commissioning and validation, operations and maintenance, modifications, decommissioning.

**Unit 3: Determining the Safety Integrity Level (SIL) (07)**
Evaluating Risk, Safety Integrity Levels, SIL Determination Method: As Low As Reasonably Practical (ALARP), Risk matrix, Risk Graph, Layers of Protection Analysis (LOPA)

**Unit 4: Technology Selection (08)**
Covers the safety requirements specification (SRS) and the pros and cons of pneumatic, relay and microprocessor logic systems, PLC systems for safety system development. Issues

Relating to Field Devices: importance of field devices: impact of field devices such as sensors, final elements on system performance.

**Unit 5: Reliability of SIS (06)**

Covers reliability issues and helps make sense of the minimum hardware fault tolerance requirement, Likelihood analysis: estimation and statistical analysis, fault propagation, event tree analysis and fault tree analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities

**Unit 6: Case Study (06)**

The safety life cycle and its importance, furnace/fired heater safety shutdown system, scope of analysis, define target SILs, develop safety requirement specification (SRS), SIS conceptual design, life cycle cost analysis, verification of SIL satisfaction, detailed design, installation, commissioning and pre-start-up tests, operation and maintenance procedures.

**Reference Books:**

1. Paul Gruhn and H Jarry L. Cheddie, "Safety Instrumented systems: Design, Analysis and Justification", ISA, 2 nd edition, 2006.
2. Dr. Eric W Scharpf, Heidi J Hartmann, Harlod W Thomas, "Practical SIL target selection: Risk Analysis per the IEC 61511 Safety Lifecycle", exida, 2012.
3. Ed Marszal, Eric W Scharpf, "Safety Integrity Level Selection", ISA.

## 20PEIN802B Computer Techniques and Operating Systems

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To understand the functions of operating systems
2. To understand the software development cycle and its blocks
3. To learn the current trends in software engineering

**Course Outcomes:** The students will be able to
1. Illustrate functionalities of operating system
2. Compare parallel computer architecture and functions
3. Identify methods in software engineering
4. Compare trends and techniques used in software engineering

**Unit 1: Operating System Overview (07)**
Concepts of Operating System and its services, Types of operating systems
Process Management: Concept, scheduling, operations on process
CPU scheduling: Basic concepts, CPU scheduling algorithms
Deadlocks: Characterization, Handling, Recovery Disk scheduling algorithms

**Unit 2: Memory and File Management (08)**
Memory Management: Address Binding, Overlays, Swapping, Contiguous memory allocation, Paging, Segmentation
Virtual memory: Concept, Demand paging, Preparing, Page size considerations, Page replacement algorithms, Thrashing
File system management: Concept, file access methods, directory structures, file allocation methods

**Unit 3: RTOS, Parallel Computers (07)**
Real Time & embedded System OS: Concepts, Types, their differences, Handheld Operating Systems. Interrupt Routines in RTOS environment, RTOS Tasks and their Scheduling models, Strategy for synchronization between the processes,
Parallel Computers: Basic concepts, Types of parallelism, Intertask dependencies, classification of parallel computers, vector computers, Array processors, Systolic Arrays
Introduction to Tensor Processing Units

Data Compression, Encryption and decryption

**Unit 4: Introduction to Software Engineering (08)**

Nature of Software, software process model, Application domains, web applications, mobile applications Preliminaries: Discipline, layers, process, practice and myths

Process models: Generic, Process assessment and improvement, prescriptive models, specialized models

Software Development Life Cycle and its models:

a. Linear Sequential

b. Rapid development

c. Incremental

Component based Software Analysis, Software Design, Software Implementation

**Unit 5: Software Testing (06)**

Software Testing: fundamentals, white box, black box testing, control structure testing, specific environment testing, comparison testing, orthogonal testing, strategic approach to testing, unit testing, integrated testing, validation testing, system testing

Software debugging: Standard guidelines, debugging techniques use of break points, test macros, output files for sampled inputs, instruction set simulation, laboratory tools

Software maintenance: Preventive, Corrective, Adaptive, Enhancement, System Re engineering

**Unit 6: Trends in Software Engineering (06)**

CASE, Risk Management, Software Configuration Management Tools like GitHub

Agile Development Process, SCRUM, Cleanroom methodology

Project Management trends such as ERP, SAP, Global Software Development, Test-driven development

**Text books:**

1. Operating System Concepts by Silberschatz, Galvin, Gagne
2. Parallel Computer architecture and programming by V. Rajaraman, C. SivaRam Murthy, PHI
3. Introduction to Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc.
4. Software Engineering by Ian Somerville, 4th edition, Addison Wesley publication

**Reference Books:**

1. Computer Architecture and Parallel processing by Kai Hwang, Faye Briggs, McGraw Hill International Editions.

2. Operating Systems: Internals and Design Principles by William Stallings
3. Modern Operating Systems by Andrew S. Tanenbaum
4. Software Engineering: A practitioner's approach by Ian Somerville
5. A Gentle Introduction to Agile and Lean Software Development by Stephen Haunts

## 20PEIN802C Environmental Instrumentation

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| Lectures: 3 Hrs/week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credit: 3 |

**Prerequisites:** Sensor & Transducer, Analytical Instrumentation

**Course Objectives:**
1. To learn necessity of Instrumentation in Environmental Engineering.
2. To describe various components in Environmental Instrumentation.
3. To understand different types of Pollutions and various control strategies.

**Course Outcomes:** The student will be able to
1. Identify the Instrumentation related to Environment.
2. Analyse various aspects of disaster management and ecosystem
3. Select various sensors and instruments for measurement of weather parameters.
4. Select various sensors and instruments for measurement of air and water quality parameters

**Unit 1: Sensors, Detectors, Analysers for Environmental Instrumentation (08)**
Necessity of instrumentation & control for environment, sensor requirement for environment, Instrumentation methodologies: Detectors & Analyzer

**Unit 2: ICT- Automatic Weather Station (08)**
Instruments in Weather stations like Barometer, Rain gauge, Ceilometer etc. Global environmental analysis, Virtual Instruments in Environmental Engineering Laboratory, Rover Environmental Monitoring Station (REMS).

**Unit 3: Water Quality Parameters and Water Treatment (09)**
Standards of raw & treated water, sources of water & their natural quality, effects of water quality, Water quality parameters & their application, conductivity analysers & their application, Water treatment

**Unit 4: Air Pollution and Sound Monitoring Systems (09)**
Definitions, energy environment relationship, importance of air pollution, Air sampling methods & equipment, analytical methods for air pollution studies. Control of air pollution, Instruments used for air pollution control. Sound pollution: basics of sound pollution, its effect to environment. Acoustic noise measurement & monitoring, control methods

**Unit 5: Geoinformatics** **(08)**

Introduction to Geo-informatics, Role of Geo-informatics in Environmental Monitoring and Control

**Text Books:**

1. Water treatment technology by Walter J. Weber.
2. Air pollution engineering by M. N. Rao & H. V. N. Rao.
3. Air pollution control technology by Wark & Warner.
4. 'Environmental Engineering' by Peany Howard S, Donal R Rowe and George TachoBanoylous Teddy

**Reference Books:**

1. Environmental Instrumentation & Analysis Handbook by Randy D. Down.
2. Environmental Instrumentation & Analysis Handbook, by Randy D. Down & Jay H. Lehr, Wiley.
3. Environmental noise pollution by Patrick F. Cunniff, Wiley, May 1977
4. Environmental Engineering and Science by Gilber M Masters, Pearson Education (1997)

## 20OE801C Digital Control

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Control Systems

**Course Objectives:** To
1. Understand the basic components of a digital control system.
2. Design various Digital Controllers and Study response of those controllers.
3. Learn and understand the stability of the system in the Z plane.
4. Introduce Optimal Control Design and Its need.

**Course Outcomes:** Students will be able to
1. Analyse system design in various planes S-W-Z and its mapping.
2. Analyse system stability in the S and Z plane.
3. Design and analyse systems using classical methods and State Space.
4. Design Optimal Control for a Discrete System.

**Unit 1: Introduction to Discrete Time Control System (08)**
Basic building blocks of Discrete Time Control System, Sampling Theorem, Choice of Sampling Rate, Z Transform and Inverse Z Transform for applications of solving Differential Equations, Impulse Sampling, Reconstruction – Zero Order Hold

**Unit 2: Pulse Transfer Function and Digital Controllers (08)**
Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop System, Pulse Transfer Function of Digital PID Controller, Design of Deadbeat Controller

**Unit 3: Stability Analysis of Discrete Control System (08)**
Stability regions in S plane W plane and Z plane, Mapping between three planes, Stability Tests for Discrete Systems

**Unit 4: Design of Discrete Control System by State Space Approach (07)**
Different Canonical Forms, Relation between Pulse Transfer Function and State Equation, Solution of Discrete Time State Space Equations, Eigen Values, Eigen Vectors

**Unit 5: Pole Placement and Observer Design (07)**
Concept of Controllability and Observability, Pole Placement Design by State Feedback, Design of Feedback Gain Matrix by Ackerman's Formula, State Observer Types.

**Unit 6: Introduction to Optimal Control** **(05)**
Basics of Optimal Control, Quadratic Optimal Control, Performance Index.

**Text Books:**

1. K. Ogata, "Discrete Time Control Systems", Prentice Hall, Second Edition.
2. M. Gopal, "Discrete Control and State Variable Methods", Tata McGraw Hill.
3. Kannan Moudgalya, "Digital Control", John Wiley and Sons.

**Reference Books:**

1. G. F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, Third Edition.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern LTD.
3. Forsytheand W, Goodall R, "Digital Control".
4. Contantine H. Houpis, Gary B. Lamount, "Digital Control Systems", McGraw Hill International, Second Edition.

## 20OE801F Instrumentation in Food and Agriculture

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of sensors and transducers, knowledge of Unit operations and basics of process control, PLC and pneumatic and hydraulic instrumentation

**Course Objectives:**
1. To know the scope of Instrumentation in agriculture field
2. To know greenhouse, food packaging automation schemes
3. Understand sensors used in agriculture field and weather monitoring stations
4. To get acquainted with food quality standards

**Course Outcomes:** The student will be able to
1. Identify the different unit operations, process control equipments involved in different types of process industries
2. Select appropriate measurement techniques for measurement of various process parameters related to soil, green house, Dam and agro-metrology
3. Analyse and develop various control loops for processes involved in various food processing plants
4. Assess various automation tools to develop automation strategy to Dam, Green house, food processing and packaging in accordance to various food standards

**Unit 1: Process Control in Agriculture and Food Industries (08)**
Sensors in Agriculture (Hygrometers, Anemometers, fine wire thermocouple, etc), Sensors in Food (ph, temperature sensor for pasteurization, brix sensor, etc), Flow diagram of some continuous processes like sugar plant, dairy, juice extraction, etc & batch process (Fermentation)

**Unit 2: Instrumentation in Irrigation and Green House (09)**
SCADA for DAM parameters & control, irrigation canal management systems, Auto drip & sprinkler irrigation systems
Green House Automation: Construction of green houses, Sensors for greenhouse, Control of ventilation, cooling & heating, wind speed, temperature & humidity

**Unit 3: Instrumentation in Farm equipments, Food Safety and Sanitation (09)**

Instrumentation for farm equipment: Implementation of hydraulic, pneumatic and electronic control circuits in harvesters cotton pickers, tractors, etc; Classification of pumps, pump characteristics, selection and installation.

Food safety standards (Food safety and standards bill 2005, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products)

Sanitation regulatory requirements: Sanitation standards operating procedure (SSOP's), Sanitation performance standards (SPS), 11 principles of sanitary facility design, Sanitation best practices.

**Unit 4: Automation in Food Packaging (08)**

Ware house management, Cold Storage Units, PLC and SCADA in food packaging

**Unit 5: Smart Instrumentation in Agriculture and Food Industries (08)**

Wireless sensors, Application of IOT in agriculture and food industries, application of Image processing in agriculture and food industries, application of robots in agriculture and food industries, Case studies.

**Text Books:**

1. D. Patranabis, "Principles of Industrial instrumentation", TMH (2010), ISBN-13: 978-0070699717

2. Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677

3. Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015,Person, ISBN: 9789332549456, 9332549451

4. Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584

**Reference books:**

1. Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812

2. Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.

3. Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-084933862

# 20OE801G Medical IoT

**Teaching Scheme:**
Lectures: 3 Hrs/week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To understand smart Objects and IoT Architecture
2. To learn sensor Interfacing
3. To learn IoT Protocols
4. To build simple IoT based Health care system

**Course Outcomes:**
1. Ascent the basic concepts of IOT in healthcare
2. Relate the existing hardware platforms and sensor interfaces for various healthcare-based Applications
3. Comprehend the ways of communication between the client and the server in IOT
4. Build various applications in healthcare using IOT based approach with appropriate case studies.

**Unit 1: Medical Measurements (06)**
Cardiovascular system, respiratory system, nervous system etc. Measurement of Heart, Brain and Muscle activity using wearable sensors. Monitor health parameters like Blood Pressure, ECG, EMG, EEG, HR, RR, SPO2 etc.

**Unit 2: Sensors & Smart Patient Devices (08)**
Role of Wearables, Challenges and Opportunities, Future of Wearables, Social Aspects, Wearable Haptics, Intelligent Clothing, Industry Sectors' Overview – Sports, Healthcare, Military, Environment Monitoring, Mining Industry, Public Sector and Safety.

**Unit 3: Wearable mechatronics device (08)**
Accelerometers, Gyroscopic Sensors; In – Shoe Force and Pressure Measurement its applications. Physical Activity Monitoring: Human Kinetics, Cardiac Activity.
Cuffless Blood Pressure Monitor, Study of Flexible and Wearable Piezo resistive Sensors for Cuffless Blood Pressure Measurement, Wearable Pulse Oximeter, Wearable Sweat Analysis, Wearable Heart Rate Measurement.

**Unit 4: Device Connectivity and Security / Biomedical Sensors with Internet connectivity (08)**
Gateway, Embedded Systems for devices like RPi, Arduino, etc, Protocols as applied to medical devices.

Sensor interface: Temperature sensor, pressure sensor, optical sensor etc. Wireless body area network. IoT Privacy and Security.

**Unit 5: Data Analytics for Medical Applications (06)**
Real Time Data Analytics, Continuous IoT Monitoring, Approach to Predict and Diagnosis of Heart and Chest diseases, Alzheimer, Diabetic Retinopathy etc. through data analytics.

**Unit 6: IoT in Biomedical Applications - Case Studies (06)**
Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application development in mobile and cloud Environments.
Case Study1: Wireless Patient Monitor system; Design an IoT System for Vital Sign Monitors, Weight measuring device, Blood pressure measuring device, ECG, Blood glucose measuring, Heart rates measuring devices and Pulse Oximeters etc.
Case Study2: Wearable Fitness & Activity Monitor; Walking time measuring device ii. Step counting device iii. Speed measuring device iv. Calorie spent measuring device v. Time spent in rest or sleeping measuring device.

**Text Books:**
1. Joseph D. Bronzino, "Handbook of Biomedical Engineering", 2nd edition –Volume II, CRC press, 2010.
2. Edward Sazonov and Michael R. Neuman, "Wearable Sensors -Fundamentals, Implementation and Applications", Elsevier Inc., 2014.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by CRC Press.
4. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press.

**Reference Books:**
1. Subhas Chandra Mukhopadhyay and Tarikul Islam, "Wearable Sensors - Applications, design and implementation" IOP Publishing Ltd 2017.
2. Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, "Environmental, Chemical and Medical Sensors", Springer Nature Singapore Pte Ltd. 2018.
3. Dieter Uckelmann, Mark Harrison, Florian, "Architecting the Internet of Things", Springer.
4. "The Internet of Things: Key Applications and Protocols", by, Wiley
5. Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, "The
6. Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.

## 20OE802D Building Automation and Energy Audit

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Electronics and Instrumentation

**Course Objectives:**
1. To understand Need and Applications Building automation systems.
2. To understand the working of various Building automation components.
3. To Select and Implement Building automation with various applications.

**Course Outcomes:** The student will be able to
1. Investigate the system requirements for developing building automation systems.
2. Compare and choose the suitable building automation systems for the applications
3. Design building automation system for required application.
4. Evaluate the performance of the designed building automation system.

**Unit 1: Fire Alarm Systems I (08)**
Introduction: to BAS, Need and Applications of BAS, Block diagram of BAS.FAS: Need and Applications of FAS, Types of FAS, Block diagram of FAS, Fire, Fire Development Stages, Fire Signatures, Initiation Devices, Notification Appliances, IDC Placements, NAC Placements, Fire Suppression: Fire Extinguishers & Its Classification, Fire Suppression Systems.

**Unit 2: Fire Alarm Systems II (08)**
IDC, NAC, SLC, FAS Wiring Standards, FAS Communication Protocols, Voltage Drop Analysis, Battery Capacity Analysis, Cause & Effect Matrix.

**Unit 3: Access Control Systems (06)**
Introduction to Security Systems, Types of Security systems, Access Control Systems: Introduction, Applications, Concept, Generic Model, Components, Card Technologies, Communication Protocols for ACS, Biometrics for ACS, CCTV System Types: CCTV Components, Digital Video Management System

**Unit 4: HVAC- Air Systems (06)**
Human Comfort Parameters and Air Properties Need of HVAC System, HVAC Block Diagram. AHU: Concept, Working, AHU Functions, AHU Components: Dampers, Filters, Cooling coil, Heating coil, etc., AHU Configurations, AHU Locations, AHU Terminal Units: CAV, VAV, Measurement and Control Loops for Air Systems.

**Unit 5: HVAC- Water Systems** **(07)**

Cold Water System: Refrigeration Cycles, Chillers, Cooling Towers, Types of chilled water system, Concept of Free Cooling : Direct Waterside, Series Waterside, Parallel Waterside. Hot Water Systems: Heating Circuits, Boilers, Types of Boilers, Heat Exchangers: Steam Input and Hot Water Input, Solar Hot Water System, Measurement and Control Loops for Water Systems.

**Unit 6: Building Energy Management System** **(07)**

Overview of Building Energy Management Systems, BEMS Control systems overview, Benefits of BEMS, Energy System Monitoring, Application of Energy Efficient Strategies, Effective Energy management, Computerized Energy Management Systems.

**Text Books:**

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann, 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems, Elsevier Publications
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
6. James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
7. "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**

1. "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4. "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

## 20OE802G Industrial Drives and Control

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. To evaluate and select a suitable drive for a particular application.
2. To analyse the basic drive system dynamics
3. To develop the basic design of an electric drive system.

**Course Outcomes:**
1. Selection of appropriate drive for the given application
2. Selection of suitable control system scheme along with the interlocking for given application
3. Analysis of the control drive dynamics for the desired drive system
4. Design of the total electric drive system based on desired application

**Unit 1: Introduction to Industrial Drives (07)**
Concept of electric drive, Power modulators, Motors used in drives, types of loads choice of drives, classification of drives Multi quadrant operation of Drives.

**Unit 2: Introduction to Control Systems (07)**
Open and closed loop systems with examples, automatic control, speed control of motors

**Unit 3: Electrical Control of Machines (08)**
Manual control – Magnetic control – Semi-automatic and Automatic control of Modern machinery – Development of Control circuits–Two wire and Three wire control – Remote control –

**Unit 4: Interlocking of drives (08)**
Control circuit components –Symbols for control components–Fuses, Switches and Fuse Switch units.

**Unit 5: Dynamics and Control of Electric Drives (06)**
D.C. motor drives, Induction motor drives, Synchronous and Brushless D.C. motor drives.

**Unit 6: Industrial process and drives** **(06)**

Process flow diagram of paper mill, cement mill, sugar mill, steel mill, Hoists and cranes, centrifugal pumps and compressors, solar powered pump drives, selection of drives for the above processes

**Text Books:**

1. Electrical Motor Drives, R. Krishnan [PHI-2003]
2. Electric Drives, Vedam Subrahmaniam [TMH-1994]
3. Industrial Drives and Control, Sandeep M. Chaudhari, Nilesh R. Ahire [Nirali Prakashan]

**Reference Books:**

1. Control of Electric Drives,W. Leonard, [Springer- 2001]
2. Electrical Drives, Second Edition, S.A. Nasar, Boldea [CRC Press - 2006]

## 20OE802I Smart Sensors and Systems

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites**: -

**Course Objectives:**
1. Theoretical understanding of various physical phenomena behind the operation of different types of sensors and microsystems
2. Overview of micro/nano fabrication process
3. Develop a complete sensor or sensor system, MEMS device or microsystem

**Course Outcomes:**
1. Selection of suitable sensor along with the associated electronics and fabrication process for given application
2. Selection of appropriate smart sensors for the desired application in the field of Automobile, Biomedical, Military, Space and Défense.
3. Design of application-based sensors in the field of Military, Défense, Spacecraft and environment
4. Analysis of the system designed for applications in the field of Biomedical and Automobile

**Unit 1: Introduction to Smart Sensors and Systems (07)**
Principles of Sensing, Classification and Terminology of Sensors. Introduction to micromachining - Fabrication and miniaturization techniques
Digital Signal Controllers (Microcontrollers and Digital Signal Processors) for Smart sensors
Key features, Certain case studies - for eg: temperature, fingerprint recognition

**Unit 2: Microfabrication process (08)**
Fabrication and miniaturization techniques, Steps involved in fabrication

**Unit 3: Smart sensors in Biomedical field (08)**
Bio-analytical [sample preparation and detection of compound] sensors & systems, Transduction modes & classifications,
Hall Effect sensors and associated signal conditioning circuits, Sensors for displacement (linear and angular), velocity, acceleration, force, torque, vibration and shock measurements. Sensor measurements for conductivity and viscosity. Electrochemical transducer in Biology

and medicine Biochemical Transducer, Enzyme-based electrochemical biosensors, electronic tongue, few related Case studies

**Unit 4: Smart sensors in Automobile industry (07)**

Introduction to Modern Automotive Systems and need for electronics in Automobiles, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Sensors for chassis management, Powertrain sensors, Air Bag and Seat Belt Pre tensioner Systems, Case studies explaining the Modern Trends and Technical Solutions, Related communication systems

**Unit 5: Smart sensors related to Environment and in Spacecraft (06)**

Human Toxicology Ecotoxicology, Water and air pollution sources

E nose for Sensitive and Selective Chemical Sensing, Chemical sensors, Ocean environment

Smart sensors in spacecraft - in monitoring applications, Smart Instrumentation Point Bus (SIP), Solid state micro-gyroscopes, related Case studies

**Unit 6: Smart sensors in Military and Defence (06)**

Types of sensors (Accelerometers, Inertial Sensors, Pressure Sensors, Force Sensors, Motion Sensors, Gyroscopes, Temperature Sensor and Others), Device-based Sensor, Clothing-based Sensor, Application based sensors - Wrist Wear, Foot Wear, Eye Wear, Body Wear and Neck Wear, intelligent sensor technology for surveillance and electronic intelligence, Case studies, related communication systems

**Text Books:**

1. Understanding Smart Sensors, Randy Frank [Artech House, Boston London]
2. Smart Sensors for Environmental and Medical Applications, Hamida Halilil, Hadi Heidari [Wiley]
3. Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications, S Nihtianov, Antonio Luque [Science Direct]

**Reference Books:**

1. Smart Sensors and Systems, Lin, Y.-L., Kyung, C.-M., Yasuura, H., Liu, Y. [Springer]
2. Smart Sensor Systems, Gerard Miejer [Wiley]

## 20IN801L Process Data Analytics Lab

**Teaching Scheme:**
Practical: 2 Hrs/week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 marks
Credit: 1

**Course Outcomes:** The student will be able to

1. Apply standard statistical inference procedures to draw conclusions from data analysis.
2. Analysis of data using various statistical methods.
3. Develop programming logic for various machine learning algorithms.
4. Implement various machine learning algorithms to process industries.

**List of Practical Assignments:**

1. Introduction to linear and multiple regression function in MATLAB
2. Applying linear & multiple regression to process data from a typical process plant
3. Implement ANOVA for a database
4. Data Analysis using K nearest neighbour Regression
5. Introduction to programming in R
6. Linear regression in R
7. Implementation of Neural Networks for standard data set
8. Implementation of Fuzzy logic for classification of standard data set

**Or similar type of practical assignments based on the course contents**

**20PEIN801LA Process Modelling and Optimization Lab**

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** The student will be able to
1. Analyze the system model.
2. Identify mathematical models of processes.
3. Analyze the system performance.
4. Apply the optimization techniques and analyze the results.

**List of Practical Assignments:**
Students are expected to perform Minimum 8 Experiments
1. Analysis of first/second order systems by using step and ramp input.
2. Simulation of mathematical modeling of electrical/ mechanical systems by first principle.
3. Simulation of mathematical modeling of liquid level systems.
4. Study of distillation columns.
5. Study of Heat Exchanger.
6. Identification of second order process by prediction error method and compare it with modeling by first principle.
7. Obtaining unknown parameters of second order process by least square technique.
8. Obtaining Relative gain array of any MIMO physical system.
9. Obtaining inverse Nyquist array of any Physical system.
10. Design of optimal control system by using quadratic approximation.
11. Analysis and comparisons of Quasi Newton and secant methods.
12. Finding optimal solution using Simplex Method system

**Or similar type of practical assignments based on the course contents**

## 20PEIN801LB Artificial Intelligence and Machine Learning Lab

**Teaching Scheme:**
Practical: 2 Hrs/Week

**Examination Scheme:**
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

**Course Outcomes:** The students will be able to

1. Formalize a given problem in the different AI methods.
2. Implement basic AI algorithms.
3. Evaluate decision tree learning algorithms.
4. Analyse research-based problems using Machine Learning Techniques.

**List of Practical Assignments:**

Any Software/Programming Language: PROLOG/Matlab/Python etc

1. Write a program to implement simple Chat-bot.
2. Implement Tic-Tac-Toe using A* algorithm.
3. Implement alpha-beta pruning graphically with proper example and justify the pruning.
4. Write a python program to implement Water Jug Problem.
5. Use Heuristic Search Techniques to Implement Best first search (Best-Solution but not always optimal) and A* algorithm (Always gives optimal solution).
6. Use Heuristic Search Techniques to Implement Hill-Climbing Algorithm.
7. Write a program to implement Hangman game.
8. Write a program to solve the Monkey Banana problem.
9. Write a program to implement Simple Calculator program.
10. Write a program to POS (Parts of Speech) tagging for the given sentence using NLTK
11. Solve 8-puzzle problem using best first search.
12. Solve Robot (traversal) problem using means End Analysis.
13. Implementation of Image features Processing
14. Write a program to implement Naïve Bayes Algorithm
15. Implement Support Vector Machine algorithms on a dataset.
16. Implement Genetic algorithm algorithms on a dataset.
17. Implement K-means algorithms on a dataset.
18. Implement PCA algorithms on a dataset.

**Or similar type of practical assignments based on the course contents**

## 20PEIN801LC Medical Device Technology Lab

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| Practical: 2 Hrs/Week | In Semester: 25 Marks |
| | Oral: 25 Marks |
| | Credit: 1 |

**Course Outcomes:** The students will be able to
1. Identify various biomedical Instruments Involved in diagnosis, treatment and surgery.
2. Identify various controls of Instruments.
3. Record the response of the sensory organ.
4. Analyze and interpret the recorded data.

**List of Practical Assignments:**
1. Record and Monitor parameters using BSM.
2. Implementation of various modes using electrosurgical machine.
3. Design ECG telemetry system.
4. Recording and analysis of audiogram for different subjects using audiometer.
5. Design a signal conditioning to monitor and to remove the leakage current.
6. Develop an algorithm for Text to Voice Conversion in MATLAB/Suitable Language.
7. Develop an algorithm for Voice to Text Conversion in MATLAB/Suitable Language.
8. Design/Develop Ultrasonic Cane for Navigational Aid.
9. Pressure Measurement using In Shoe Pressure Sensor.
10. Fall Detection using Accelerometer and Flex Sensor
11. Hospital visit Report

# Rules & Scheme of evaluation for Internship / Project during 7th Sem

❖ **Preamble** : The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. In line with guidelines for AICTE and on the strong recommendations received through stake holder's feedback, CCEW have launched 6 months Internship program. Adopting an impactful internship based strategy at CCEW, Pune is with intent for creating a future talent pool for the industry. We expect, it will not only helps fresh passing-outs in gaining professional know-how but also benefits, corporate on fresh perspectives on business issues and even discovering future business leaders.

The main aim of this initiative is towards enhancement of the employability skills of the passing out students. At CCEW, we prepared a curriculum with the help of prominent academicians of the country so that our all programme could produce competent employable graduates as per the needs of the industries. The revised curriculum includes the internship for students of six months' duration in the 7th Semester of all programmes.

Keeping this in view, this developed this policy document is giving guidelines for organizing Internship. These guidelines comprise of Steps for Establishing, Maintaining & Fostering Internships. We hope, this internship experience will augment outcome based learning process and inculcate various attributes in a student in line with the graduate attributes defined by the NBA.

## I. Rules for internship / project during 7th semester:

1) Students can select and work on any option either project or internship (of any duration) as explained in Table 1. Credit and marks distribution and examination scheme for internship and project is discussed in Table 1.

**Table 1 Credits and marks distribution for internship and project work**

| Internship Industry (Months) | Project (In-house / Ind.) (Months) | Credits for Internship | Credits for Project | Marks for Internship | Marks for Project |
|---|---|---|---|---|---|
| 6 | -- | 15 | -- | 300 | -- |
| 5 | 1 | 13 | 02 | 250 | 50 |
| 4 | 2 | 11 | 04 | 200 | 100 |
| 3 | 3 | 08 | 07 | 150 | 150 |
| 2 | 4 | 05 | 10 | 100 | 200 |
| -- | 6 | -- | 15 | -- | 300 |

2) Students can opt for research internship but they need to follow college academic calendar.
3) Students need to report her decision about opting either project or internship (of any duration viz. 2, 3, 4, 5, 6 months) as an option to earn credits in 7th Semester to their respective department coordinator before 15th June of academic year.
4) In case, students opt for or need to work for Internship for plus project option then, they need to complete internship first and then only can work on selected project [change in this sequence is not permitted].
5) In case students (because of any reason) want to increase their project or internship duration, they need to take prior approval, 15 days before completion of their current(earlier) project or internship duration.
6) Students applying with excuse because of any reason(s) such as medical reason, personal tour etc. during internship duration will not be entertained.
7) Individual students can work on approved projects or a maximum of four students in a group can work on approved project work.
8) Interdepartmental /multidisciplinary projects are allowed. Further, students from different departments can form their project groups [in such case Guides from both the departments will guide the project & evaluate students' performances].
9) Students involved in co-curricular activities viz. BAJA / ROBOCON etc. can take up related and relevant technical tasks as their project. In such cases, to define project work content, prior approval and recommendations from authorities is required.

## II. Scheme of evaluation: Internship Option

- Credit distribution and examination scheme for internship option is discussed in Table 2.
- Further, Table 3 discusses Rubric parameters *[of equal weightage]* for evaluating student's performance evaluation during Internship duration.

## Table 2 Student performance evaluation during Internship duration and phase wise-marks distribution

| Internship Duration (Months) | Total Marks for Internship | ISE - I (Industry In-house / Mentor/ Guide ) | ISE - II (Industry In-house / Mentor/ Guide ) | ISE - III (Industry In-house / Mentor/ Guide ) | ISE (I+II+III) Total | ESE |
|---|---|---|---|---|---|---|
| **6** | 300 | 75 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **200** | **100** |
| **5** | 250 | 50 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **175** | **75** |
| **4** | 200 | 50 [Before ESE] | 40 [After 2 months] | 60 [After 3 months] | **150** | **50** |
| **3** | 150 | 30 [Before ESE] | 70 [After 2 months] | --- | **100** | **50** |
| **2** | 100 | 15 [Before ESE] | 35 [After 2 months] | --- | **50** | **50** |

**ISE= In-Sem. Exam., ESE= End-Sem. Exam.*

## Table 3 Rubric parameters for evaluating Student performance evaluation during Internship duration

| Criteria [Phase – I] | Criteria [Phase – II & III] |
|---|---|
| 1. Regularity | 1. Log Book (Weekly) (Identification Scheduling w.r.t. time Completion) |
| 2. Eagerness to learn | 2. Tools and Techniques |
| 3. Professional work ethics | 3. Problem Scope identification, Procedure / algorithm/methodologyfollowed |
| 4. Ability to work in a team | 4. Design/ Implement /Validate System (Components, Processes etc.) |
| 5. communication skills | 5. Presentation |

*Oral all points same except in place of Log Book add report

- Further, faculty mentor can decide Rubric parameters for evaluating student's performance evaluation of Internship duration during End Sem. Evaluation (ESE).

## III. Scheme of evaluation: Project Option

- Credit distribution and examination scheme for project option is discussed in Table 4.

**Table 4 Student performance evaluation, Project duration andphase wise-marks distribution**

| Project Duration (Months) | Total Marks for Project | *ISE: ISE - I (Industry & College Guide ) | *ISE: ISE - II (Industry & College Guide ) | *ISE (I+II) Total | **ESE (Industry& In-house Mentors ) |
|---|---|---|---|---|---|
| **6** | 300 | 50 [After 2 months] | 150 [After 4 months] | **200** | **100** [After 6 months] |
| **4** | 200 | 30 [After 1.5 months] | 120 [After 3 months] | **150** | **50** [After 4 months] |
| **3** | 150 | 20 [After 1 month] | 80 [After 2 months] | **100** | **50** [After 3 months] |
| **2** | 100 | 15 [After 1 month] | 35 [After 2 months] | **50** | **50** [After 2 months] |
| **1** | 50 | 10 [After 1 month] | 15 [After 1 month] | **25** | **25** [After 1 month] |

**ISE= In-Sem. Exam, **ESE= End-Sem. Exam.*

- Rubric parameters for evaluating student's performance evaluation during Project duration for ISE I, II and ESE will be defined by respective programmes.
- It is strongly recommended to add research publication criteria for projects of duration more than 4 months.
- Individual or maximum four students per group can work on one project work.
- Inter-department project group formation is allowed [Guides from both departments will guide the project and evaluate students' performance]
- Students involved in BAJA / ROBOCON / ADIRA / with pre-approval from their HoD.

## Reference

1. AICTE INTERNSHIP POLICY: GUIDELINES & PROCEDURES
https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf
2. EXAMINATION REFORM POLICY
https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf
3. MANUAL FOR ACCREDITATION OF UNDERGRADUATE ENGINEERING PROGRAMS (Tier I Institutions)
https://www.nbaind.org/files/NBA_UGEngg_Tier_I_Manual.pdf

# 20CE 801 Information Security

**Teaching Scheme**
Lecture: 3 Hours. /week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisite(s):** Computer Networks (20CE 501)

**Course Objectives:**
**To facilitate the learners to-**
1. Understand the fundamental concepts of security.
2. Know the basics of cryptography
3. Identify the role of security protocols at various layers.
4. Understand network security threats, security services and countermeasures.

**Course Outcomes:**
**By taking this course, the learner will be able to–**
1. Make use of principles of Cryptosystem for Data Protection
2. Identify various techniques to provide Data security and Integrity over the network
3. Choose appropriate security mechanisms to mitigate various security challenges
4. Identify security mechanisms for Network Perimeter and specific Applications

**Unit 1: Introduction to Security (06)**
Need and significance of Security, Architectures, Introduction to common attacks (e. DOS, Phishing, SQL injection, Cross site scripting etc), Active Vs Passive Attacks, A model for Network and Internetwork Security, TCP/IP security Architecture (services and Mechanism),Introduction to cryptography- Classical Cryptography.

**Unit 2: Introduction to Cryptography (07)**
Introduction to secrete key cryptography, Cipher Basics, Introduction to DES, DES Analysis, DES variants, Introduction to AES and IDEA, Block cipher modes of operations.

**Unit 3: Public Key Cryptography and Key Management (08)**
Introduction to Public Key cryptography, The RSA algorithm, Analysis of RSA, Key Management Basics, Diffie- Hellman Key exchange, Key distribution of Private and Public Keys.

**Unit 4: Message Integrity and Authentication (08)**
Need and Significance of Message Digest, One way hash functions and properties of hash functions, MD5, SHA, Message authentication, Introduction and overview of Digital Signatures: Implementation, Algorithms standards(DSS),Digital Certificates and X.509, Certificate structure, Certificate revocation.

**Unit 5: Network Security** **(07)**
Introduction to Network Layer Security- Overview of Firewall, Design principles of Firewalls, Various types of firewalls and their working principles, Concept of VPN,Tunnelling protocols, working of IPSEC. Introduction to transport Layer security – SSL/ TLS protocol.

**Unit6: Application Security and Authentication Mechanisms** **(06)**
Overview of Application Security, Overview of Wireless Security. User Authentication Mechanisms, Kerberos v4 and v5.Overview of Cloud security, Overview of IOT security,

**Text Books:**

1. William Stalling **'Cryptography and Network Security, principles and practices'**, 7th *Edition. Pearson* ISBN 978-93-325-8522-5

2 William Stalling, Lawrie Brown **'Computer Security: Principles and Practice,** 4th Edition, Pearson ISBN 978-9353438869

**Reference Books:**

**1.** Atul Kahate, **'Cryptography and Network Security'**, 4*rd edition McGraw Hill Publication.2019* ISBN 9789353163310

2. Bernard Menezes, **'Network Security and Cryptography'**, *Cengage Learning*. ISBN 978-8131513491

3. *Bruce Schneier:* **'Applied Cryptography –Protocols, Algorithm and Source Code in C'**, *Second Edition, John Wiley & Sons, New York,* ISBN 978-1-119-09672-6.

4. Charlie Kaufman, Radia Perlman and Mike Speciner, **'Network security, private Communication In a Public World'** ISBN978-0130460196

# 20PECE 801A Introduction to Natural Language Processing

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1. Understand various aspects of Natural Language Processing.
2. Learn Phonological, Morphological, Syntactic and Semantic processing
3. Understand issues related to ambiguity of Natural Language.
4. Understand the advanced applications of Natural Language Processing.

**Course Outcomes:**

After completion of the course, students will be able to

1 Identify importance of Natural Language Processing.
2 Apply the fundamental concepts and techniques of Natural Language.
3 Identify ambiguous structure of Language.
4 Analyze the advanced applications of Natural Language Processing.

**Unit I: Introduction to Natural Language Processing (6)**

The Study of Language, Applications of Natural Language Understanding, Evaluating language Understanding Systems, Different levels of Language Analysis.

**Unit II: Fundamentals of Phonics (7)**

Speech Sounds and Phonetic Transcription, Articulatory Phonetics, The Vocal Organs, Place of Articulation of Consonants, Manner of Articulation of Consonants, Vowels, Syllables, Phonological Categories and Pronunciation Variation, Phonetic Features, Predicting Phonetic Variation, Factors Influencing Phonetic Variation.

**Unit III: Fundamentals of Morphology (7)**

Concept of Morphology, Survey of English Morphology, Inflectional Morphology, Derivational Morphology, Cliticization, Non-Concatenative Morphology, Agreement, Finite-State Morphological Parsing, Construction of Finite-State Lexicon, Finite-State Transducers(FST), Sequential Transducers and Determinism, Finite-State Transducers for Morphological Parsing, Transducers and Orthographic Rules, Word and Sentence Tokenization.

**Unit IV: Semantic Analysis (8)**

Part-of-Speech Tagging, POS-Tagging Perspective, POS tagging and HMM, POS-Tag Set, Parsing Algorithms,Parsing in case of Ambiguity; Probabilistic Parsing .Parser Comparison, Grammar; Constituency, Dependency , Inside Probability; Parse Tree construction,language modelling

**Unit V: Discourse and Pragmatics (7)**

Discourse Structure and Reference, Relating Discourse Structure and Inference, Discourse Structure, Tense, and Aspect, Managing the Attentional Stack, Concept of Pragmatics

**Unit VI: Applications of Natural Language Processing (7)**

Machine Translation, Sentiment Analysis, Question Answering Systems, Cross Lingual Information Retrieval,Natural Language Interface to Database, Extractive and Abstractive Summarization Systems, Indian Language WordNets.

**Text Books:**

**1.** Jurafsky, David, James H. Martin, 'Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2014), ISBN: 987-93-325-1814-4.

**2.** James Allen, 'Natural Language Understanding', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2007), ISBN: 987-81-317.

**Reference Books:**

**1.** Manning, Christopher D., Hinrich Schütze, 'Foundations of Statistical Natural Language Processing', Cambridge Publication(1999), ISBN: 0262133601. 2. Steven Bird, ewan Klein, and Edward Loper, 'Natural Language Processing with Python', O'Reilly Media, 2009.

**2.** Flanagan, J. L. Speech Analysis, Synthesis and Perception. 2nd ed. New York, NY: Springer-Verlag,. ISBN: 9780387055619.

# 20PECE 801B User Experience Design (UX/UI)

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1. Understand the basic concepts of UI/UX Design in order to design with intention.
2. Achieve a deep understanding of the entire life-cycle of design process.
3. Provide a visual understanding of product to make user interaction as easy and efficient as possible.
4. Understand various design technologies for mobile and web to help avoid common mistakes and meet user requirements
5. Understand the advanced techniques of User Experience Design

**Course Outcomes:**

After completion of the course, students will be able to

1. Apply the concepts areas of study in UX to enhance the user experience
2. Apply the key psychological principles that underlie UX design principles
3. Construct the wireframes and prototypes for interactive products to establish the structure and flow of possible design solutions.
4. Apply the fundamental aspects of designing and evaluating the interfaces for mobile and web.
5. Compare the advanced techniques of User experienec Design

**Unit I: Introduction to User Experience** **(6)**

What is User Experience, Relationship Between UI and UX, Why is UX Design so Important, What is UX Design and Where is Used, Usability: A part of the User Experience, Understanding User Experience, Psychology of everyday actions, Concept of UX, Trends in UX, What is User Interaction, Mental Model, Cognitive Model in UX, Emerging Technologies in UX, Universal Design, User-centered design, Human Centered Design.

**Unit II: Design Thinking** **(8)**

Key elements of Design thinking, Design Thinking Skills-What are wicked problems and its solution, Good and poor design, Empathy Users- User research, Personas, Define problem, , Ideation- Identifying Customer Needs, Translate user needs into product specifications, Applied Creativity, Brainstorming, Prototyping, From Prototype to Product Development, Testing Design Solutions, Relation of Design thinking with UX, Design thinking applications, Applying design thinking to mobile and wed.

**Unit II: Interaction Styles (6)**

Design principles and rules, Shneiderman's golden rules, Normans seven principles, Nielsens ten heuristics with example of its use,Heauricstic evaluation.
Direct Manipulation – Windows Characteristics, Components, Presentation styles, Icons, Multimedia and colors, Menu selection, Form Fill-in and Dialog Boxes, Icons, Fitts'law and Hick-Hyman's law.

**Unit IV: UX Design Process (7)**

Elements of User Experience Design, Stages of UX design,
Visual Design - Vision and Memory,Visual Design Principles, Data Visualization, Wire framing & Storyboarding, Converting the wireframes into visual design, Prototyping, Various Prototyping Tools, Elements and Widgets. Gestalt Principles and Grids, Layout Expectations, Forms and Data Entry
Screen Design and Layout- Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully
UX Design Tools

**Unit V: UX Design for Mobile and Web (8)**

Mobile Usability Research – The Important Differences from the Desktop. Smartphone vs. Tablet, UI mobile components and patterns, Application frameworks: Types of Mobile Applications: Widgets, Applications, Mobile Design: Elements of Mobile Design
Web user Interface - The Gestalt Principles of Perceptual Organization, The Law of Similarity, Proximity, Familiarity/Meaningfulness, Symmetry, Continuity, The Principle of Closure, 'New' Grouping Laws, The Law of Element Connectedness, The Law of Common Region.
Types of Evaluation research, Usability Testing.

**Unit VI: Interaction Technologies (7)**

Explicit and Implicit Human Computer Interaction – Gesture interfaces, Speech Recognition, Tangible interfaces, Auditory Interfaces, Natural Language Interfaces, User Interfaces and Interaction for Four Widely Used Devices.
Hidden User Interface via Basic smart Devices, Hidden User Interface via Wearable and Implanted Devices, Virtual and Augmented Reality.

**Text Books:**

1. Interaction Design: Beyond Human-Computer Interaction: Book by Helen Sharp Jenny Preece, and Yvonne Rogers
2. Wilbert O. Galitz'Wiley The Essential Guide to User Interface Design' 3rd Edition Apr 2007

**Reference Books:**

1. Don Norman, 'The Design of Everyday Things', Basic Books, A member of the Perseus Books Group, (2013)
2. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, 'Designing the User Interface: Strategies for Effective Human-Computer Interaction', Pearson Education Limited (India),(2010)

**Online/Web/Other References:**

1. https://www.interaction-design.org/courses/user-experience-the-beginner-s-guide
2. https://www.coursera.org/learn/user-experience-design#syllabus

# 20PECE 801D Artificial Intelligence

**Teaching Scheme**

Lectures: 3 Hours / Week

**Examination Scheme**

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

**Course Objectives:**

To facilitate the learner to

1. Learn overview and basics of classic Artificial Intelligence.
2. Understand various intelligent searches and knowledge representation.
3. Understand types of learning used in artificial intelligence.
4. Study applications in Artificial Intelligence.

**Course Outcomes:**

After completion of the course, students will be able to

1. Build fundamental knowledge of AI, its applications and solve classical AI problems using different AI Techniques
2. Apply intelligent search algorithms on AI problems.
3. Make use of Knowledge Management techniques of AI for reasoning.
4. Make use of various learning techniques to solve the given problem.
5. Examine different topics with various methods of expert system, pattern recognition, natural language processing, nature inspired computing.

**Unit I: Introduction to AI (6)**

Definitions of Artificial Intelligence, History of Artificial Intelligence, Artificial Intelligence Problems, Present state of AI, Intelligent agents, Topics of Artificial Intelligence: Learning Systems, Knowledge Representation and Reasoning, Planning, Knowledge Acquisition, Intelligent Search, Logic Programming, Soft Computing, Management of Imprecision and Uncertainty, Branches and applications of Artificial Intelligence.

**Unit II: Uninformed search and modelling a search problem (7)**

Generate-and-Test, Search Techniques: Depth First Search, Breadth First Search, Production Systems: Traveling Salesman Problem, Water-Jug Problem, State Space Representation, State Space Search, Tic-Tac-Toe as a State Space.

**Unit III: Heuristic Search Techniques (8)**

Best First Search Algorithm, Hill Climbing, Simulated Annealing, A* Algorithm, Problem Reduction, AND–OR Graphs, The AO* Algorithm, Towers of Hanoi Problem, Constraints Satisfaction: crypt-arithmetic problem, mini-max algorithm.

**Unit IV: Knowledge Management (7)**

Knowledge Management, Types of Knowledge: Declarative Knowledge, Procedural Knowledge, Knowledge Representation, Approaches to Knowledge Representation, Issues in Knowledge Representation, First-order Logic: Basic Predicate Representations, Conversion of WFF to Clause Form, Resolution, Unification, Resolution Examples, Reasoning, monotonic and non-monotonic reasoning.

**Unit V: Learning (7)**

Types of Learning: Rote Learning, Learning by General Problem Solving, Concept Learning, Learning by Analogy, learning problems and designing the learning systems, Reinforcement learning.

**Unit VI: Applications in Artificial Intelligence (7)**

Game Playing, Expert Systems, Natural Language Processing, Pattern Recognition, Recommendation system, Nature Inspired Computing.

**Text Books:**

**1.** Vinod Chandra S. S., Anand Harendra S., 'Artificial Intelligence and machine learning', PHI, (2014), ISBN 978-81-203-4934-6.

**2.** Kulkarni P., Joshi P., 'Artificial Intelligence: Building Intelligent Systems', PHI Learning, (2015), ISBN 978-81-203-5046-5.

**Reference Books:**

**1.** Peter, Norvig, 'Artificial Intelligence: A Modern Approach', Pearson, (3rd edition), (2014), ISBN-0-13-103805-2.

**2.** Elaine Rich, Kevin Knight and Nair, 'Artificial Intelligence', Tata McGraw – Hill, (3rd edition), (2012), ISBN-978-0-07-008770-5.

3. Bratko I., 'Prolog Programming for Artificial Intelligence', Pearson Education, (3rd edition), (2004).

4. Tom M. Michell, 'Machine Learning', McGraw Hill Education, Indian edition (2013), ISBN-13: 978-1-25-909695-2.

5. Ethem Alpaydin, 'Introduction to Machine Learning', PHI, (2006), ISBN-81-203-2791-8.

**Online/Web/Other References:**

1. https://nptel.ac.in/courses/106/105/106105077/
2. https://nptel.ac.in/courses/106/106/106106126/
3. https://onlinecourses.nptel.ac.in/noc19_me71/preview
4. https://onlinecourses.nptel.ac.in/noc20_cs42/preview

# 20PECE 802C Information Retrieval

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

To facilitate the learner with

1. Concepts of information retrieval
2. Indexing techniques and information retrieval system
3. Text classification and vector space classification
4. The latest trends in information retrieval

**Course Outcomes:**

After completion of the course, students will be able to

1. Model the working of information retrieval search system
2. Analyze search strategies used in Information retrieval system
3. Design techniques for information retrieval system
4. Understand the latest trends in information retrieval

**Unit I: Introduction to Information Retrieval (7)**

Information retrieval process, Indexing, Processing Boolean queries, Term vocabulary and postings lists, document delineation and character sequence decoding, determining vocabulary of terms.

**Unit II: Scoring, term weighting and vector space model (7)**

Parametric and zone indexes, Term frequency and weighting, Vector space model for scoring, variant tf-idf functions, Components of an Information retrieval system.

**Unit III: Text classification -Naive Bayes and Vector space classification (7)**

Naive Bayes text classification, Bernoulli model, Properties of Naive Bayes, Feature selection, document representation and measures of relatedness in vector spaces, Rocchio classification, KNN, Linear vs Non linear classifiers, Classification with more than two classes, the bias variance tradeoff

**Unit IV: Evaluation in Information Retrieval** **(7)**

Information retrieval system evaluation, standard test collections, Evaluation of unranked retrieval sets, evaluation of ranked retrieval sets, Assessing relevance, System quality and user
utility, results snippets.

**Unit V: Web search basics and Link Analysis** **(7)**

Web characteristics, advertising as the economic model, The search user experience, Index size and estimation, Near duplicates and shingling, Web crawling and indexes, distributing indexes, connectivity servers. The web as a graph, Page rank, Hubs and authorities

**Unit VI: Trends in Information Retrieval** **(7)**

Case study: Google analytics, Search engine optimization, Ranking algorithms,Recommendation systems, Collaborative Filtering

**Text Books:**

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, Introduction to Information Retrieval, Cambridge University Press. 2008.

**Reference Books:**

1. Grigoris Antoniou and Frank van Harmelen, A semantic Web Primer, Massachusetts

**Online/Web/Other References:**

1. http://nlp.stanford.edu/IR-book/information-retrieval-book.html

# 20CE 801L Information Security Laboratory

**Teaching Scheme**
Practical: 4 Hours/week

**Examination Scheme**
In Semester : 25 Marks
Oral : 25 Marks
Credits: 2

**Course Objectives:**

**To Facilitate the Learners to:-**

1.Understand Basic CryptographyAlgorithms
2.Learn various techniques for secure data transmission
3.Recognize the need of Network Perimeter Security
4.4.Learn various techniques used for common attacks

**Course Outcomes:**

**By taking this course the learner will be able to**:-

1. Implement Standard CryptographyAlgorithms
2. Apply the digital signature for authentication
3. Apply packet filtering concept to configure Firewall
4. Demonstrate common attacks

**Sample /Suggested List of Assignments:**

1. Implement DES algorithm

2. Implement RSAalgorithms

3. Implement Message Digest Algorithm and demonstrate the collision resistance property

4. Implementation of Diffie Hellman Key exchange for sharing the secret key.

5. 2 users are doing business online. Develop and demonstrate suitable solutions which will take care of user authentication along with Non repudiation.

6. Simulation of packet Filtering concepts.

7. Create a small application to demonstrate attacks (e.g SQL injection ,Cross Site scripting)

8. Develop and demonstrate how the contents of the web site will be made secure against the common attacks.

9. Case Study - Enterprise network Security/ Wireless Security / Security Information and Event Management

# 20PECE 801LA Introduction to Natural Language Processing Laboratory

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Oral : 25 Marks
Credits: 1

**Prerequisite:**

**Course Objectives:**

To facilitate the learner to

1. develop problem solving abilities for natural language processing
2. apply algorithmic strategies while solving problems
3. develop time and space efficient algorithms

**Course Outcomes:**

After completion of the course, students will be able to

1. Develop programs for natural language processing applications.
2. Design test cases to solve problems for pervasiveness,embedded security and NLP applications.

## Suggestive List of Assignments

**Group A**

1. Write a program using Scala/ Python/ C++ using Eclipse to correct the spelling of English paragraphs.

**Group B (Any two)**

Using Programming language Python and Natural Language Tool Kit (NLTK) perform following

1. Apply Simple language processing for 10 phonetics Indian languages (Marathi or mother-tongue)
2. Lab on sentiment analysis
3. Lab on Cross Lingual information retrieval
4. Lab on document summarization

**Group C**

1. Study and implementation of research paper in Multidisciplinary NLP using open source tool.

# 20PECE 801LB User Experience Design Laboratory

| Teaching Scheme | Examination Scheme |
|---|---|
| Practical: 2 Hours / Week | In Semester: 25 Marks |
| | Oral : 25 Marks |
| | Credits: 1 |

**Prerequisite:**

**Course Objectives:**

To facilitate the learner to

1. Understand users' needs, experiences, behaviours and goals.
2. Learn how visual perception affects the viewing experience
3. Explain Why you made design decisions, through presentations of assignments

**Course Outcomes:**

After completion of the course, students will be able to

1. Discover the techniques used for understanding of users, what they need, what they value, their abilities, and also their limitations
2. Design innovative and user friendly interfaces for mobile and web applications.
3. Criticize existing interface designs, identify areas of improvement and then create better services and products to make user experience better.
4. Discover the industry-standard tools and specific project deliverables in UI/UX

## Suggestive List of Assignments

1. Design user persona for the users of selected product / system and Conduct a contextual inquiry for selected product / system.
2. Heuristic evaluation on a computer prototype developed by your classmates.
3. Design of User interface for the system using various interaction styles.
4. Design appropriate icons pertaining to a given domain. (Eg. Greeting cards)
5. Design a Mobile App/Website that can help people to sell their handmade products in metro cities

6. Improve Instagram with a new, innovative feature, which stands out from other image apps.
7. Redesign a page from the job portal you like (preferably a complex screen). Justify your selection and the changes/design you made. Document your design process on Notion.
8. ATM machine/KIOSK screen design for rural people
9. Tool exploration Adobe XD, Figma

# 20PECE 801LD Artificial Intelligence Laboratory

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Oral: 25 Marks
Credits: 1

**Prerequisite:**

**Course Objectives:**

To facilitate the learner to

1. Experiment Artificial Intelligence concepts from syllabus.
2. Experiment AI searches like A*, Min-max algorithm.
3. Understand monotonic and non-monotonic knowledge representation.
4. Experiment classification and clustering algorithms.

**Course Outcomes:**

After completion of the course, students will be able to

1. Implement various uninformed searching techniques.
2. Implement various Heuristic searching techniques.
3. Apply Knowledge Management techniques to implement Expert system.
4. Implement unification for the given expression.

## Suggestive List of Assignments

**Group A : (Mandatory)**

1. Implement DFS/BFS for graph problem.
2. Implement simple water jug problem using DFS or BFS.
3. Implement Best first search algorithm
4. Implement A* algorithm for graph problem

**Group B: (Any Two)**

1. Implement A* algorithm for 8 puzzle problem
2. Write a program to implement Min-max algorithm for game playing
3. Implement Unification algorithm

**Group C**

1. Represent knowledge using AIML/Prolog by implementing small expert system

## 20HDM801 Deep Learning and Applications

| Teaching Scheme | Examination Scheme |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

Prerequisite: 20CE404 Machine Learning

**Course Objectives:**

1. To be familiar with Deep learning algorithms and applications.
2. To get exposure to Convolutional Neural Networks
3. To gain advanced knowledge of Recurrent Neural Networks and LSTM for given data.
4. To get exposure to Deep learning algorithms in NLP Applications .
5. To gain advanced knowledge of Pretrained networks and advanced deep neural networks.

**Course Outcomes:**

At the end of this course, students will be able to:-

1. Make use of deep learning concepts and Popular open source libraries
2. Apply Convolutional Neural Networks algorithm for given problem
3. Experiment with concepts of Recurrent Neural Networks and LSTM for given data.
4. Experiment with Deep learning algorithms in NLP Applications .
5. Experiment with Pretrained networks and advanced deep neural networks

**Course Contents:**

**Section 1: Basics of Deep learning and Convolutional Neural Networks**

Linear Algebra, Artificial intelligence, machine learning, and deep learning, mathematical building blocks of neural networks, binary classification, a multiclass classification, Confusion Matrix for multi class classifiers. Understanding convolutional neural networks (convnets), Using a pre trained convnet, Visualizing what convnets learn

**Section 2: Deep learning for sequential data and Recurrent Neural Networks**

Working with text data, One-hot encoding of words and characters, Using word embeddings, Understanding recurrent neural networks, Understanding the LSTM and GRU layers, Deep Learning in Question Answering over Knowledge Base, Deep Learning in Machine Comprehension, Deep Learning in Sentiment Analysis

**Section 3: Deep Learning for Complex Problems and Aututoencoders**

Text generation with Long short term memory (LSTM) , Generative Adversarial Networks Generative recurrent networks, Text processing with LSTM, Generating images with autoencoders, Deep Learning for Board Games

**Text Books:**

1. "Deep Learning: A Practical Approach Using Python", François Chollet, ISBN : 13-9781617294433, MANNING publishing, Ist edition, 2021

2. "Python Deep Learning, Next generation techniques to revolutionize computer vision, AI, speech and data analysis", Valentino Zocca, Gianmario Spacagna, Daniel Slater, Peter Roelants, , Packt Publishing, Ist edition, 2017, ISBN: 13- 978-1786464453

3. "Deep Learning for Natural Language Processing", Jason Brownlee, 2017 Jason Brownlee. All Rights Reserved. Edition: v1.1 (eBook), ISBN : 9789352136094

4. "Deep Learning in Natural Language Processing", Li Deng , Yang Liu, Springer Nature, 2018, ISBN 978-981-10-5208-8 (eBook)

**Reference Books**:

1. "Deep Learning Using Python", S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, Wiley Publisher, 2019, ISBN: 13- 978-812657991
2. "Deep Learning", Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press Ltd., 2017, ISBN: 9780262035613
3. "Deep Learning – A Practitioner's approach", Josh Patterson and Adam Gibson, O'Reilly Publication, 1st edition , 2017 ISBN : 9789352136049

**Web resources:**

https://d2l.ai/d2l-en.pdf: Dive into Deep Learning Release 0.16.5, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola Jun,

http://ling.snu.ac.kr/class/AI_Agent/deep_learning_for_nlp.pdf: Deep Learning for Natural Language Processing, Jason Brownlee.

## 20HDM801L Deep Learning and Applications Laboratory

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Oral: 25 Marks
**Credit: 1**

The laboratory work for the Deep Learning and Applications (DLA) course includes implementation of deep neural network models for various applications. Students will work on image data and sequential data in the assignment. Students are encouraged to do variation in data for the assignments. Students will experiment with values of parameters/ hyper parameters and parameters in models for better accuracy.
DLA aspirants will select a deep neural network model and data of their interest implemented in earlier assignments to write one paper as a part of the last assignment. In this assignment they are expected to do literature study from similar domains and compare their results with already existing research done by other researchers.

### Suggestive List of Assignments

**Benchmark Datasets for Research:**
**https://www.kaggle.com/sudalairajkumar/novel-corona-virus-2019-dataset**
- **https://www.kaggle.com/imdevskp/corona-virus-report**
- **https://data.humdata.org/dataset**
- **https://ieee-dataport.org/open-access/corona-virus-covid-19-tweets-dataset**
- **https://data.world/datasets/covid-19Datasets**
- **https://github.com/datasets/covid-19**
- **https://www.dimensions.ai/news/dimensions-is-facilitating-access-to-covid-19-research/**
- **https://www.sirm.org/category/senza-categoria/covid-19/**
- **https://dev.to/anujgupta/google-s-25-million-datasets-a-perfect-gift-for-aspiring-datascientists-3ekh**
- **https://github.com/CSSEGISandData/COVID-19**
- **https://www.kaggle.com/manoj9april/imbd-sentiment-classification-dataset**
- **https://www.kaggle.com/c/digit-recognizer/data**

--Experiment with Data representations for neural networks:Manipulating tensors, tensor operations
--Training a convnet from scratch on a small dataset
--Experiment with pre trained convnet to visualizing what convnets learn: Implement CNN for given data : Classification of characters
–Implement model for word embeddings using IMDB data, train and evaluate
--Implement RNN for given data: Speech recognition or similar application
--Experiment with Pretrained networks/ autoencoders
--Prepare paper for: work with online/ real time data and any DL technique

# 20OE 801A Big Data And Analytics

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**
To facilitate the learner to
1 Understand the concepts, challenges and techniques of Big data and Big data analytics
2 Understand the concepts of Hadoop, Map Reduce framework , Spark for Big data analytics
3 Apply skills and tools to manage and analyze the big data
4 Understand latest big data trends and applications.

**Course Outcomes:**
After completion of the course, students will be able to
1 Apply basic concepts of big data for the various applications.
2 Apply data analytics life cycle to real-world big data applications
3 Choose Hadoop ecosystem components based on requirement of application
4 Compare Spark and Hadoop architecture
5 Compare various methods used in data Analytics and big data trends.

**Unit I: Introduction (6)**
Database Management Systems, Structured Data, SQL. Unstructured data, NOSQL, Advantages of NOSQL, Comparative study of SQL and NOSQL. Big data overview, characteristics of Big Data, Case study- SAP HANA.

**Unit II: Data Analytic Life Cycle (6)**
Data Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach. Data Analytic Life Cycle: Discovery, Data preparation, Model Planning, Model Building, Communicate Results, Opearationalize. Case Study: GINA

**Unit III: Big Data Architectures, Hadoop (8)**
Introduction to Big Data and Hadoop, Building blocks of hadoop: Ecosystem, HDFS, HBASE, YARN, Map Reduce working.

**Unit IV: Introduction to Spark (7)**
Spark Framework, Architecture of Spark, Resilient Distributed Datasets, Data Sharing using Spark RDD, Operations in Spark;

Introduction to Kafka: need, use cases, components.

**Unit V: Machine learning (8)**

Supervised, unsupervised learning; Classification, Clustering; Time series analysis, basic data analysis using python: libraries,functions.

Text Analysis: Text Pre-processing, Topic modelling algorithms, Text Similarity measure.

**Unit VI: Big Data Trends and applications (7)**

Exploratory data analysis, Big data Visualization using python;

IoT and big data, Edge computing, Hybrid cloud.

Applications of Big data, Case study: E-commerce, healthcare.

**Text Books:**

1 "Data Science and Big Data Analytics", Wiley, 1stEdition (January 2015)
2 "Big Data, Black Book" ,Dreamtech Press (27 May 2015),ISBN-13-978-9351197577

**Reference Books:**

1 Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game",MC Press(November 2012)
2 J.Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "Big Data for Dummies", 1st Edition (April 2013)
3 Tom White, "Hadoop: The Definitive Guide", O′Reilly, 3rdedition (June 2012)
4 Abraham Silberschatz, Henry Korth, S. Sudarshan, "Database System concepts",McGraw Hill Education, 6th Edition (December 2013).
5 Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing (November 2013)
6 Shiva Achari ,"Hadoop Essentials - Tackling the Challenges of Big Data with Hadoop" ,Packt Publishing(April 2015), ISBN:978-1-78439-668-8

**Online/Web/Other References:**

1 https://nptel.ac.in/courses/106/104/106104189/
2 https://hadoop.apache.org/docs/stable/
3 https://kafka.apache.org/documentation/
4 https://spark.apache.org/

## 20OE 801E Introduction to Cyber Crime and Forensics

| | |
|---|---|
| **Teaching Scheme** | **Examination scheme:** |
| Lectures**:** 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Course Objectives:**
**To facilitate the learners to-**

1 Learn fundamental concepts of cyber security
2 Understand Security challenges presented by mobile devices and information system access in cybercrime world
3 Learn tools used in Computer forensics and Cyber Applications
4 Understand risks associated with social media networking

**Course Outcomes:**
**By taking this course the learner will be able to-**

1 Classify Cyber Crimes
2 Identify threats and risks within context of Cyber Security
3 Outline Relevant laws and Acts in Cyber Security
4 Appraise various roles and tools used in Cyber Security/ Digital forensics

**Unit I: Introduction to Cybercrime: (7)**
Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Ethical dimensions of cybercrime,Ethics and Morality,Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes

**Unit II: Cyber Offenses**: **(7)**
How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Typical Cyber Crimes like Social Engineering, Cyber stalking, Cyber Defamation, Intellectual property Infringement Botnets: The Fuel for Cybercrime, Dark net

**Unit III: Cybercrime:Mobile and Wireless Devices** : **(8)**
Introduction, Trends in Mobility, Financial Frauds in Mobile and Wireless Computing, Security Challenges Posed by Mobile Devices, structure of Sim card, Sim card forensics, Sim card cloning, Organizational Measures for Handling Mobile,Mobile Apps and cybercrime, Whats app forward frauds, End point detection systems, End point detection systems in devices in organisation

**Unit IV: Methods Used in Cybercrime: (8)**
Introduction, Proxy Servers and Anonymizers,Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow

**Unit V: Digital Forensics- (6)**
Introduction to Digital Forensics, Forensics Software and Hardware, Evaluating computer forensic tools , Software tools and Hardware Tools, New Trends, Mobile forensics for android, Sample Case studies.

**Unit VI: Cyber Security Tools- (6)**
wireshark, Nmap, Nessus, Ncat, Burp Suite, Snort, Nikto Carer Opprtunities and trends in Cyber Security.

**Text Books:**

1 Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA. ISBN 978-81-265-2179-1
2 Information Security & Cyber Laws By Sarika Gupta, Gaurav Gupta,Khanna Publication ISBN: 978-93-810-6824-3 2019
3 Computer Forensics and Investigations Bill Nelson, Amelia Phillips and Christopher Stuart Cengage learning. ISBN 978-81-315-1946-2

**Reference Books:**

1 Intoduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group
2 Eoghan Casey,”Digital evidence and computer crime Forensic Science,Computers and the Internet , ELSVIER,2011 ISBN 978-0-12-374268-1

## 20OE 802F Data Science Using Python

**Teaching Scheme**
Lectures**:** 3 Hours / Week

**Examination scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites:**

1 Basic Mathematics
2 Basics of Python Programming

**Course Objectives:**
To facilitate the learners
1 To understand the data analytics and visualization as well as the statistics behind it.
2 To understand and analyze the machine learning methods used in data analysis
3 To understand the modern tools used for data analytics and visualization.

**Course Outcomes:**
By taking this course, the learner will be able to
1 Develop the knowledge of data science.
2 Identify the relevant Python method used in data science.
3 Select the appropriate data operation method for the application in hand.
4 Understand recent trends in data science and analysis.

**Unit 1: INTRODUCTION TO DATA (06)**
Introduction to Data, Data types and their relationships, Handling different types of data using Python, Handling numeric and categorical data using Python

**Unit 2: BASIC DATA Processing using NumPy, Pandas (08)**
Statistical operations, data cleaning, missing data, indexing, slicing, iterating, attribute selection, dimensionality reduction, Handling tabular data, time series
Case study, Python based examples

**Unit 3: MACHINE LEARNING using Sci-Kit, Tensorflow - I (08)**
Clustering, Classification, Regression, Outlier Detection
Case study, Python based examples

**Unit 4: MACHINE LEARNING using Sci-Kit, Tensorflow- II (08)**
Time Series Prediction, Anomaly Detection, Association, Recommendation Systems
Case study, Python based examples

**Unit 5: REGRESSION ANALYSIS AND PREDICTIVE ANALYSIS (06)**

Introduction to types of analysis - Predictive, descriptive and decision based, Regression analysis, types - linear, logistic, ridge, lasso

**Unit 6: DATA VISUALIZATION AND GRAPHICS USING Matplotlib / Seaborn (06)**

Basic visualization plots - Area, histogram, bar, Specialized plots - pie, box, scatter, bibble, Waffle, Word clouds, Seaborn, Regression plots
Introduction to Folium, maps with markers, choropleth maps, dashboards

**Text Books:**

1 Aurélien Géron, '**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**', O'Reilly Media (2017)
2 Samir Madhavan, '**Mastering Python for data science**', Packt (2015)
3 David Beazley, '**Python CookBook**', O'reilly (2013)
4 Dr. Ossama Embarak, **'Data Analysis and Visualization Using Python'**, aPress (2018)

**Reference Books:**

1 Wes McKenny, **'Python for Data Analysis'**, O'Reilly (2013)
2 Han and Kamber, **'Data Mining: Concepts and Techniques'**, The Morgan Kaufmann Series in Data Management Systems (2011)
3 Christopher Bishop, **'Pattern Recognition and Machine Learning'**, Springer (2010)
4 Edited by Chun-houh Chen, Wolfgang Härdle and Antony Unwin, **'Handbook of Data Visualization'**, Springer (2008)

**Web References:**

1 Academic use of Tableau - https://www.tableau.com/academic/teaching
2 NPTEL Courses
   a Python for Data Science https://nptel.ac.in/courses/106/106/106106212/
   b Introduction to Data Analytics https://nptel.ac.in/courses/110/106/110106064/

# 20PECE 601A DevOps Fundamentals

**Teaching Scheme**
Lectures: 3 Hours/Week

**Examination Scheme**
In Semester: 50 marks
End Semester: 50 marks
Credits: 3

**Prerequisites:** Software Design and Architecture (20CE 503)

**Course Objectives:**
To facilitate the learner to -

1. Understand and appreciate the need for the DevOps as a state-of-art software engineering practice.
2. Learn the basic concepts related to DevOps.
3. Get acquainted with the various tools which are used in different phases of DevOps model.
4. Get exposure to emerging trends in software development related to DevOps.

**Course Outcomes:**
By taking this course, the learner will be able to -

5. Apply the fundamental concepts and emerging trends of DevOps to software development.
6. Analyze the various concepts of application development such as agile software model, microservices to understand the need of DevOps based solution of a system.
7. Compare various concepts and tools of continuous integration, continuous delivery, continuous testing and monitoring for DevOps based realization of solution of a system.
8. Analyze the various deployment platforms as part of DevOps lifecycle.

**Unit 1: Introduction to DevOps (06)**
Overview, Features, Components, Why to use DevOps - Benefits, Business need for DevOps, Using DevOps to solve new challenges like enabling mobile applications, scaling agile and managing multitier applications; DevOps lifecycle - DevOps stages: Develop, Code/build, Test, Deploy; DevOps use cases DevOps techniques: Continuous improvement, Release planning, Continuous integration, Continuous delivery, Continuous testing, Continuous monitoring and feedback; DevOps tools.

**Unit 2: Application Development (07)**
Agile software development, User stories, Automating SDLC and DevOps, DevOps team. Serverless computing. Microservices and DevOps: Monolithic to microservices Project in terms of microservices, need/applicability of DevOps Microservices - what, characteristics, how are they used, nature in continuous release, architecture, services design.

**Unit 3: Continuous Integration Continuous Delivery (CICD) Pipeline (08)**

CICD pipeline - basics, Source code repository, Version control and source code management - GitHub, Git commands. Creating Automated build, Automated build frameworks like Maven, Ant for Java. Automated configuration and automated deployment, Configuration management with tools like Puppet and Chef, Ansible; Continuous integration with Jenkins.

**Unit 4: Continuous testing and Continuous monitoring (08)**

Continuous Unit testing and Integration testing, Test Driven Development (TDD), Release testing, Testing in development, Testing in production, Selenium: Introduction, Why to use, automating test cases for testing web elements, Creating test cases in Selenium WebDriver. Testing and Bug tracking Frameworks such as JUnit, TestNG and JIRA. Continuous monitoring and logging with tools like Nagios.

**Unit 5: Deployment Platforms (07)**

Containerization and DevOps: Virtualization, Application runtime environment, Application needs/dependencies, Containerization, Containerization Tools, Benefits of containers in enabling DevOps workflow.

Dockers for DevOps: Docker - Overview, Docker lifecycle, Docker Image, Docker file, Docker registry, Docker engine, Docker runtime container, Docker installation, commands, Namespaces, Docker layered approach, Docker applications/use cases. Container Orchestration: Kubernetes.

**Unit 6: DevOps - Applications, Case studies and Trends (06)**

Cloud's benefit to DevOps, Web Applications on Cloud Platform

Automation of infrastructure: Terraforms - Infrastructure as code (IaC) software tool.

DevSecOps: Agile security, DevOps and security, Low code solutions.

**Text books:**

1. Sanjeev Sharma and Bernie Coyne, 'DevOps for Dummies', IBM Limited Edition, John Wiley and Sons, Inc., ISBN- 978-1-119-04705-6, (2015).
2. Viktor Farcic, 'The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline with Containerized Microservices', CreateSpace Independent Pub, (2016).
3. Katrina Clokie, 'A Practical Guide to Testing in DevOps', Leanpub, (2017).

**Reference books:**

1. Bass, L., Weber, I.M., Zhu, L., 'DevOps: a software architect's perspective'. Pearson Education, ISBN: 9789332570375, (2016).
2. Davis J., Daniels K., 'Effective DevOps: Building a Culture of Collaboration, Affinity and Tooling at Scale', O'Reilly, ISBN- 9789352133765, (2018).

3. Farooqui S. M., 'Enterprise DevOps Framework: Transforming IT Operations', CA Press / Apress, ISBN- 9781484240618, (2019).
4. Sanjeev Sharma, 'The DevOps Adoption Playbook: A Guide to Adopting DevOps in a Multi-Speed IT Enterprise', Wiley, ISBN- 9788126569083, (2017).
5. Humble, J., Farley, D.: 'Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation'. 1st edn. Addison-Wesley Professional (2010).

**Web References:**

1. https://devops.com/
2. https://docs.docker.com
3. https://www.bmc.com/blogs/devops-basics-introduction/
4. https://www.ibm.com/in-en/cloud/devops
5. https://aws.amazon.com/devops/what-is-devops/

| Programme Elective-II |
| --- |
| 20PECE 502 (NPTEL / Swayam Course ) |

# 20PECE 502B Reinforcement Learning

**Teaching Scheme**
Lectures : 3 Hrs/Week

**Examination Scheme**
In Semester : 50 Marks
End Semester: 50 Marks
Credits: 3

**Prerequisites :**
Machine Learning (20CE404)

**Course Objectives:**
**To facilitate the learners to -**
1. Understand the need of Reinforcement Learning.
2. Understand the full reinforcement learning concepts and its techniques
3. Understand the basic mathematical foundations of reinforcement learning.
4. Understand the concepts of function approximation in reinforcement learning.
5. Have the knowledge of hierarchical reinforcement learning and applications.
6. Explore the current developments in the reinforcement learning field.

**Course Outcomes:**
**By taking this course, the learner will be able to -**
1. Apply the basic concepts of Reinforcement Learning in various domains/fields.
2. Make use of the techniques for full reinforcement learning.
3. Apply the fundamental mathematics for solving the problems of reinforcement learning.
4. Apply the knowledge of function approximation in reinforcement learning.
5. Apply the concepts of hierarchical reinforcement learning and its applications.
6. Interpret the recent advancements in the field of reinforcement learning.

- Introduction to RL
- RL Framework and Applications
- Introduction to Immediate RL
- Bandit Optimalities
- Value function based methods

- UCB 1
- Concentration Bounds
- UCB 1 theorem
- PAC bounds
- Median Elimination
- Thompson Sampling

- Policy Search
- REINFORCE
- Contextual Bandits
- Full RL Introduction
- Returns, value functions and MDPs
- MDP modeling

- Bellman Equation
- Bellman Optimality Equation
- Cauchy sequence and Green's equation
- Banach Fixed Point equation
- convergence proofs

- Lpi Convergence
- Value Iteration
- Policy Iteration
- Dynamic Programming
- Monte Carlo
- Control in Monte Carlo

- Off Policy MC
- UCT
- TD (0)
- TD (0) control
- Q-learning
- Afterstate

- Eligibility Traces
- Backwards view of Eligibility Traces
- Eligibility Trace control
- Thompson sampling Recap

- Function Approximation
- Linear Parameterization
- State Aggregation methods
- Function Approximation and Eligibility Traces
- LSTD and LSTDQ
- LSPI and Fitted Q

- DQN and fitted Q Iteration
- Policy Gradient Approach
- Actor critic and REINFORCE
- Theorem-1
- Policy Gradient Approaches with Function Approximation

- Hierarchical Reinforcement Learning
- Types of Optimality
- Semi Markov Decision Processes
- Options
- Learning with Options
- Hierarchical Abstract Machines

- MAXQ
- MAXQ value Function Decomposition
- Option Recovery

- Solving PODMP.

**Textbook:**
R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

**Course Link:**
https://onlinecourses.nptel.ac.in/noc22_cs75/preview
**Video Download link:**

https://archive.nptel.ac.in/courses/106/106/106106143/

**Transcript link:**

https://archive.nptel.ac.in/courses/106/106/106106143/

## 20PECE 501B Java Full Stack Technologies

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Lectures: 3 Hrs/week | In Semester: 50 marks |
| | End Semester: 50 marks |
| | Credits: 3 |

**Prerequisites:** Data Structures (20CE 302)

**Course Objectives:**
**To facilitate the learner to -**

1. Get exposure to full stack development in Java technologies.
2. Develop familiarity with the client side Java technologies.
3. Gain comprehensive knowledge about Java server side technologies for enterprise application development in practice.
4. Get familiar with the web services based approach for real-life application development.
5. Get acquainted with the database development technologies in Java.

**Course Outcomes:**
**By taking this course, the learner will be able to -**

1. Choose suitable client side Java technologies.
2. Analyze Java server side technologies for enterprise application development.
3. Analyze the characteristics of web services paradigm.
4. Analyze the role of Java database development technologies to realize their suitability for application development.

**Unit 1: Client Side Web Technologies (07)**

n-tier architecture, HTTP request - response, Web browser, HTML, CSS, XML, JSON, JavaScript (JS), Document Object Model (DOM), Introduction to jQuery, Asynchronous JavaScript And XML (AJAX).

**Unit 2: Server Side Java Web Technologies (07)**

Introduction to server side technology, Common Gate Interface (CGI), Java Servlets, Java Server Pages (JSP), Session tracking, JSP tags, Java Beans, MVC architecture.

**Unit 3: ReactJS (06)**

Overview of ReactJS: Introduction, Features, Advantages, Comparison with AngularJS, Introduction to Nodejs; ReactJS concepts like components, virtual DOM, JSX and APIs.

**Unit 4: Java 2 Enterprise Edition (J2EE) Technologies** **(08)**

Introduction to J2EE technologies, Enterprise Java Beans (EJB), Java Messaging Service (JMS), Remote Method Invocation (RMI).

**Unit 5: Java Web Services** **(07)**

Web Services: Overview; Service Oriented Architecture (SOA), Java Web services based on SOAP and REST, Java Web services API for SOAP and REST based web services:
JAX-WS, JAX-RS.

**Unit 6: Java Database Programming and Hibernate** **(07)**

Java Database Connectivity (JDBC), Java Transaction API (JTA), Java Persistence API (JPA), Hibernate: Overview, architecture, Object Relational (OR) Mapping.

**Text books:**

1. Kogent Learning Solutions Inc., **'Web Technologies: HTML, JS, PHP, Java, JSP, ASP.NET, XML, AJAX, Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-997-4, (2015).
2. Kogent Learning Solutions Inc., **'Java Sever Programming Java EE6 Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-936-3, (2013).
3. Stoyan Stefanov, **'React - Up & Running: Building Web Applications',** *O'Reilly,* ISBN: 9781491931820, (2016).
4. William Crawford, Jim Farley, **'Java Enterprise in a Nutshell'**, *O'Reilly*, ISBN-13: 978-0596101428, 3rd Edition, (2005).

**References books:**

1. Mark Tielens Thomas, **'React in Action'**, *Manning Publications*, ISBN: 978-1617293856, (2018).
2. Kevin Mukhar, Chris Zelenak, James L. Weaver and Jim Crume, **'Beginning Java EE5: From Novice to Professional'**, *Apress*, ISBN-13: 978-8181284020, (2006).
3. Kirupa Chinnathambi, **'Learning React: A Hands-on Guide to Building Web Applications Using React and Redux',** *Addison Wesley,* (2016).
4. Jim Keogh, **'The Complete Reference J2EE'**, *McGraw Hill Education*, ISBN: 978-0-07-052912-0, (2012).

**Web References:**

1. https://learn.jquery.com
2. https://docs.oracle.com/javaee/7/tutorial/
3. https://reactjs.org

## 20PECE 501LB Java Full Stack Technologies Laboratory

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Practical: 2 Hrs/week | In Semester: 25 Marks |
| | Oral : 25 Marks |
| | Credits: 1 |

**Course Objectives:**
**To facilitate the learners to -**

1. Understand the Installation and Configuration setting related aspects of web server, integrated development environments and various frameworks, in the development of web applications.
2. Understand the role of various technologies used for real-life application development.
3. Get exposure to full stack development in Java which includes client side and server side technologies, web services and database development technologies.
4. Gain practical knowledge about the various client side and Java server side technologies for application development in practice.

**Course Outcomes:**
**By taking this course, the learner will be able to -**

1. Make use of suitable client side Java technologies.
2. Experiment with various Java server side technologies like Java Servlets, Java Server Pages, Web services and JPA for web application development.
3. Make use of Java Sockets library and Java RMI framework for the development of sample client-server applications.
4. Build a sample web application using suitable technologies at various tiers.

**Preamble:**

Development of web applications need technologies at various levels, which play different roles in the overall web architecture. The intent of Java Full Stack Technologies Laboratory is to enable the understanding of the role of various technologies in full stack development and implementation of some real world application scenarios using these technologies. Assignment statements are in brief and should be implemented with Java web technologies. Motivation here is that students should be able to develop the user interface, business logic and the database programming parts of a typical web application, using the APIs/libraries provided by various client side and server side Java technologies. Faculty members are encouraged to expand problem statements with variations. Assignments can be framed and expanded in such a way that it explores concepts, logic of solution and simple application. Students will be encouraged to build solutions for real world business scenarios in different domains, to fulfil the end-user requirements. Faculty will appropriately adopt assignments on similar lines as the examples shown here. Group A assignments are on applying various client side technologies and basic server side technologies. Group B assignments are on exploring the use of technologies like EJB, Web services and Hibernate. Group C assignment is on the development of sample web application.

**Suggestive List of Assignments:**

**Group A: (Mandatory)**

1. Develop dynamic and interactive web client using HTML, CSS and JavaScript technologies. Make use of these technologies to develop suitable web forms, layout and to perform validation of form data, for this web client.

   Sample application scenario:
   Consider that a student needs to register for an online course portal. For this scenario, develop an HTML form for "Course Registration", make use of CSS for layout design of this form and perform validation on various fields of this form using JavaScript.

2. Develop dynamic and interactive web client using XML and AJAX technologies, to enable rich user experience.

   Sample application scenario for AJAX:
   Consider a web form for an administrator of an "Online Shopping Application". An administrator can select the name of a customer from the drop down list box on the web form. Then on the same page, the details of the customer such as shipping address should get displayed.

3. Develop dynamic and interactive web client using jQuery as a client side JavaScript library. For this web client, implement event handling and animation effects using jQuery.
4. Develop dynamic and interactive web client using ReactJS as a client side library. Make use of various features of ReactJS such as components, APIs etc.
5. Implement an application using Java RMI to understand distributed application environment. The remote object accesses database using JDBC.
6. Implement a sample web application scenario using Java Servlets, Java Server Pages and Java Beans as the server side dynamic content generation technologies. Make use of MVC architecture for this implementation and also show the appropriate usage of the various capabilities of these technologies such as session tracking, tag library, implicit objects, directives etc.

   Sample application scenario:
   Consider a simple web form where you give Student Roll number and get back Student Profile details from the database. Make use of MVC architecture, based on Java Servlet, JSP and Java Bean to implement this web based scenario.

**Group B: (Any One)**

1. Implement a sample EJB based scenario for any application like online movie ticket booking, online college admission portal, online railway reservation etc. Make use of various types of beans such as session beans and entity beans, for the implementation of business methods and persistence of data.
2. For a sample application scenario, implement and consume the suitable web services using SOAP or REST protocol.
3. Make use of JPA with Hibernate framework for performing the create, retrieve, update and delete (CRUD) operations on the backend database.

   Sample application scenario:
   Consider "Course Information Management" as a typical Database Application. This application may have database tables like Courses, Participants etc. Make use of JPA with Hibernate framework to access the data from the Courses table in this above application.

**Group C:**

1. Design and develop a typical web application like online cab booking, online food ordering application, online tours and travel portal etc. For the development of this application, choose the appropriate technologies for the client side aspects, server side business logic and database development.

# 20HS 601 Professional And Societal Awareness For Engineers

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

To facilitate the learner to

1. Understand professional ethics, communication and practices
2. Relate Intellectual property concepts to various documents , products
3. Study Sustainability issues and green computing in environmental context
4. Study social issues in the computing world

**Course Outcomes:**

After completion of the course, students will be able to

1. Apply professional and computing ethics
2. Relate Intellectual property basics to information management, storage and sharing
3. Apply sustainability paradigms to various computing centric issues
4. Relate green computing basics to IT systems
5. Apply sustainability principles to new world

**Unit I: Professional Ethics and communication (08)**

Morals, values and Ethics, Integrity, Work ethic, Civic virtue, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, stress management, Senses of Engineering Ethics, Kohlberg‟s theory, Gilligan‟s theory, Models of professional roles, Uses of Ethical Theories, Communicating professionally with stakeholders

**Unit II: Intellectual Property (08)**

Philosophical foundations of intellectual property, Intellectual property rights (cross-reference IM/Information Storage and Retrieval/intellectual property and protection) ,Intangible digital intellectual property (IDIP), Copyrights, patents, trade secrets, trademarks, Plagiarism, non disclosure agreement

**Unit III: Sustainability & CSR (09)**

Basics of sustainability in IT and computing, Global social and environmental impacts of computer use and disposal, Business Ethics, Ethics Vs Social Responsibility, A view of corporate social responsibility (Legal, Ethical, Economic, Philanthropic) and its importance, ESG(Environmental, Social and Governance standards), Evolution of ESG from CSR

**Unit IV: Green Computing (09)**

Green IT Fundamentals: Business, IT, and the Environment , Green computing: carbon footprint, scoop on power, Green IT Strategies: Drivers, Dimensions, and Goals , Environmentally Responsible Business: Policies, Practices, and Metrics, Virtualization of IT systems, Role of electric utilities, Telecommuting, teleconferencing and teleporting , Materials recycling , Best ways for Green PC, Green Data center, Green Grid framework.

**Unit V: Sustainability in Healthcare (08)**

Basics, Societal expectations, Sustainability and Pharmaceutical products-Role in Human health, Sustainable Concerns All Along the Life Cycle of the Health-care Industry, Global corporate governance and IT

**Text Books**

1. Bhuvan Unhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2014
2. Ming din, "Sustainable development for health care industry" , Springer
3. Niraja Pandey, Khushdeep Dharni, "Intellectual Property Rights", PHI
4. Caroline Whitbeck, "Ethics in Engineering Practice and Research", Cambridge Press, ISBN:978-1-107-66847-8

**Reference books**

1. Woody Leonhard and Katherine Murray, "Green IT for Dummies", Wiley Publications (2009),ISBN: 978-0-470-74349-2

**Online resources**

NPTEL on Professional Ethics :https://nptel.ac.in/courses/110/105/110105097/

# 20PECE 601A DevOps Fundamentals

**Teaching Scheme**
Lectures: 3 Hours/Week

**Examination Scheme**
In Semester: 50 marks
End Semester: 50 marks
Credits: 3

**Prerequisites:** Software Design and Architecture (20CE 503)

**Course Objectives:**
To facilitate the learner to -

1. Understand and appreciate the need for the DevOps as a state-of-art software engineering practice.
2. Learn the basic concepts related to DevOps.
3. Get acquainted with the various tools which are used in different phases of DevOps model.
4. Get exposure to emerging trends in software development related to DevOps.

**Course Outcomes:**
By taking this course, the learner will be able to -

5. Apply the fundamental concepts and emerging trends of DevOps to software development.
6. Analyze the various concepts of application development such as agile software model, microservices to understand the need of DevOps based solution of a system.
7. Compare various concepts and tools of continuous integration, continuous delivery, continuous testing and monitoring for DevOps based realization of solution of a system.
8. Analyze the various deployment platforms as part of DevOps lifecycle.

**Unit 1: Introduction to DevOps** **(06)**
Overview, Features, Components, Why to use DevOps - Benefits, Business need for DevOps, Using DevOps to solve new challenges like enabling mobile applications, scaling agile and managing multitier applications; DevOps lifecycle - DevOps stages: Develop, Code/build, Test, Deploy; DevOps use cases DevOps techniques: Continuous improvement, Release planning, Continuous integration, Continuous delivery, Continuous testing, Continuous monitoring and feedback; DevOps tools.

**Unit 2: Application Development** **(07)**
Agile software development, User stories, Automating SDLC and DevOps, DevOps team. Serverless computing. Microservices and DevOps: Monolithic to microservices Project in terms of microservices, need/applicability of DevOps Microservices - what, characteristics, how are they used, nature in continuous release, architecture, services design.

**Unit 3: Continuous Integration Continuous Delivery (CICD) Pipeline (08)**

CICD pipeline - basics, Source code repository, Version control and source code management - GitHub, Git commands. Creating Automated build, Automated build frameworks like Maven, Ant for Java. Automated configuration and automated deployment, Configuration management with tools like Puppet and Chef, Ansible; Continuous integration with Jenkins.

**Unit 4: Continuous testing and Continuous monitoring (08)**

Continuous Unit testing and Integration testing, Test Driven Development (TDD), Release testing, Testing in development, Testing in production, Selenium: Introduction, Why to use, automating test cases for testing web elements, Creating test cases in Selenium WebDriver. Testing and Bug tracking Frameworks such as JUnit, TestNG and JIRA. Continuous monitoring and logging with tools like Nagios.

**Unit 5: Deployment Platforms (07)**

Containerization and DevOps: Virtualization, Application runtime environment, Application needs/dependencies, Containerization, Containerization Tools, Benefits of containers in enabling DevOps workflow.

Dockers for DevOps: Docker - Overview, Docker lifecycle, Docker Image, Docker file, Docker registry, Docker engine, Docker runtime container, Docker installation, commands, Namespaces, Docker layered approach, Docker applications/use cases. Container Orchestration: Kubernetes.

**Unit 6: DevOps - Applications, Case studies and Trends (06)**

Cloud's benefit to DevOps, Web Applications on Cloud Platform
Automation of infrastructure: Terraforms - Infrastructure as code (IaC) software tool.
DevSecOps: Agile security, DevOps and security, Low code solutions.

**Text books:**

1. Sanjeev Sharma and Bernie Coyne, 'DevOps for Dummies', IBM Limited Edition, John Wiley and Sons, Inc., ISBN- 978-1-119-04705-6, (2015).
2. Viktor Farcic, 'The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline with Containerized Microservices', CreateSpace Independent Pub, (2016).
3. Katrina Clokie, 'A Practical Guide to Testing in DevOps', Leanpub, (2017).

**Reference books:**

1. Bass, L., Weber, I.M., Zhu, L., 'DevOps: a software architect's perspective'. Pearson Education, ISBN: 9789332570375, (2016).
2. Davis J., Daniels K., 'Effective DevOps: Building a Culture of Collaboration, Affinity and Tooling at Scale', O'Reilly, ISBN- 9789352133765, (2018).

3. Farooqui S. M., 'Enterprise DevOps Framework: Transforming IT Operations', CA Press / Apress, ISBN- 9781484240618, (2019).
4. Sanjeev Sharma, 'The DevOps Adoption Playbook: A Guide to Adopting DevOps in a Multi-Speed IT Enterprise', Wiley, ISBN- 9788126569083, (2017).
5. Humble, J., Farley, D.: 'Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation'. 1st edn. Addison-Wesley Professional (2010).

**Web References:**

1. https://devops.com/
2. https://docs.docker.com
3. https://www.bmc.com/blogs/devops-basics-introduction/
4. https://www.ibm.com/in-en/cloud/devops
5. https://aws.amazon.com/devops/what-is-devops/

## 20PECE 501B Java Full Stack Technologies

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Lectures: 3 Hrs/week | In Semester: 50 marks |
| | End Semester: 50 marks |
| | Credits: 3 |

**Prerequisites:** Data Structures (20CE 302)

**Course Objectives:**
**To facilitate the learner to -**

1. Get exposure to full stack development in Java technologies.
2. Develop familiarity with the client side Java technologies.
3. Gain comprehensive knowledge about Java server side technologies for enterprise application development in practice.
4. Get familiar with the web services based approach for real-life application development.
5. Get acquainted with the database development technologies in Java.

**Course Outcomes:**
**By taking this course, the learner will be able to -**

1. Choose suitable client side Java technologies.
2. Analyze Java server side technologies for enterprise application development.
3. Analyze the characteristics of web services paradigm.
4. Analyze the role of Java database development technologies to realize their suitability for application development.

**Unit 1: Client Side Web Technologies (07)**

n-tier architecture, HTTP request - response, Web browser, HTML, CSS, XML, JSON, JavaScript (JS), Document Object Model (DOM), Introduction to jQuery, Asynchronous JavaScript And XML (AJAX).

**Unit 2: Server Side Java Web Technologies (07)**

Introduction to server side technology, Common Gate Interface (CGI), Java Servlets, Java Server Pages (JSP), Session tracking, JSP tags, Java Beans, MVC architecture.

**Unit 3: ReactJS (06)**

Overview of ReactJS: Introduction, Features, Advantages, Comparison with AngularJS, Introduction to Nodejs; ReactJS concepts like components, virtual DOM, JSX and APIs.

**Unit 4: Java 2 Enterprise Edition (J2EE) Technologies (08)**

Introduction to J2EE technologies, Enterprise Java Beans (EJB), Java Messaging Service (JMS), Remote Method Invocation (RMI).

**Unit 5: Java Web Services (07)**

Web Services: Overview; Service Oriented Architecture (SOA), Java Web services based on SOAP and REST, Java Web services API for SOAP and REST based web services:
JAX-WS, JAX-RS.

**Unit 6: Java Database Programming and Hibernate (07)**

Java Database Connectivity (JDBC), Java Transaction API (JTA), Java Persistence API (JPA), Hibernate: Overview, architecture, Object Relational (OR) Mapping.

**Text books:**


1. Kogent Learning Solutions Inc., **'Web Technologies: HTML, JS, PHP, Java, JSP, ASP.NET, XML, AJAX, Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-997-4, (2015).
2. Kogent Learning Solutions Inc., **'Java Sever Programming Java EE6 Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-936-3, (2013).
3. Stoyan Stefanov, **'React - Up & Running: Building Web Applications',** *O'Reilly,* ISBN: 9781491931820, (2016).
4. William Crawford, Jim Farley, **'Java Enterprise in a Nutshell'**, *O'Reilly*, ISBN-13: 978-0596101428, 3rd Edition, (2005).


**References books:**


1. Mark Tielens Thomas, **'React in Action'**, *Manning Publications*, ISBN: 978-1617293856, (2018).
2. Kevin Mukhar, Chris Zelenak, James L. Weaver and Jim Crume, **'Beginning Java EE5: From Novice to Professional'**, *Apress*, ISBN-13: 978-8181284020, (2006).
3. Kirupa Chinnathambi, **'Learning React: A Hands-on Guide to Building Web Applications Using React and Redux',** *Addison Wesley,* (2016).
4. Jim Keogh, **'The Complete Reference J2EE'**, *McGraw Hill Education*, ISBN: 978-0-07-052912-0, (2012).


**Web References:**


1. https://learn.jquery.com
2. https://docs.oracle.com/javaee/7/tutorial/
3. https://reactjs.org

# 20PECE 501LB Java Full Stack Technologies Laboratory

**Teaching Scheme**
Practical: 2 Hrs/week

**Examination Scheme**
In Semester: 25 Marks
Oral : 25 Marks
Credits: 1

**Course Objectives:**
**To facilitate the learners to -**

1. Understand the Installation and Configuration setting related aspects of web server, integrated development environments and various frameworks, in the development of web applications.
2. Understand the role of various technologies used for real-life application development.
3. Get exposure to full stack development in Java which includes client side and server side technologies, web services and database development technologies.
4. Gain practical knowledge about the various client side and Java server side technologies for application development in practice.

**Course Outcomes:**
**By taking this course, the learner will be able to -**

1. Make use of suitable client side Java technologies.
2. Experiment with various Java server side technologies like Java Servlets, Java Server Pages, Web services and JPA for web application development.
3. Make use of Java Sockets library and Java RMI framework for the development of sample client-server applications.
4. Build a sample web application using suitable technologies at various tiers.

**Preamble:**

Development of web applications need technologies at various levels, which play different roles in the overall web architecture. The intent of Java Full Stack Technologies Laboratory is to enable the understanding of the role of various technologies in full stack development and implementation of some real world application scenarios using these technologies. Assignment statements are in brief and should be implemented with Java web technologies. Motivation here is that students should be able to develop the user interface, business logic and the database programming parts of a typical web application, using the APIs/libraries provided by various client side and server side Java technologies. Faculty members are encouraged to expand problem statements with variations. Assignments can be framed and expanded in such a way that it explores concepts, logic of solution and simple application. Students will be encouraged to build solutions for real world business scenarios in different domains, to fulfil the end-user requirements. Faculty will appropriately adopt assignments on similar lines as the examples shown here. Group A assignments are on applying various client side technologies and basic server side technologies. Group B assignments are on exploring the use of technologies like EJB, Web services and Hibernate. Group C assignment is on the development of sample web application.

**Suggestive List of Assignments:**

**Group A: (Mandatory)**

1. Develop dynamic and interactive web client using HTML, CSS and JavaScript technologies. Make use of these technologies to develop suitable web forms, layout and to perform validation of form data, for this web client.

   Sample application scenario:
   Consider that a student needs to register for an online course portal. For this scenario, develop an HTML form for "Course Registration", make use of CSS for layout design of this form and perform validation on various fields of this form using JavaScript.

2. Develop dynamic and interactive web client using XML and AJAX technologies, to enable rich user experience.

   Sample application scenario for AJAX:
   Consider a web form for an administrator of an "Online Shopping Application". An administrator can select the name of a customer from the drop down list box on the web form. Then on the same page, the details of the customer such as shipping address should get displayed.

3. Develop dynamic and interactive web client using jQuery as a client side JavaScript library. For this web client, implement event handling and animation effects using jQuery.
4. Develop dynamic and interactive web client using ReactJS as a client side library. Make use of various features of ReactJS such as components, APIs etc.
5. Implement an application using Java RMI to understand distributed application environment. The remote object accesses database using JDBC.
6. Implement a sample web application scenario using Java Servlets, Java Server Pages and Java Beans as the server side dynamic content generation technologies. Make use of MVC architecture for this implementation and also show the appropriate usage of the various capabilities of these technologies such as session tracking, tag library, implicit objects, directives etc.

   Sample application scenario:
   Consider a simple web form where you give Student Roll number and get back Student Profile details from the database. Make use of MVC architecture, based on Java Servlet, JSP and Java Bean to implement this web based scenario.

**Group B: (Any One)**

1. Implement a sample EJB based scenario for any application like online movie ticket booking, online college admission portal, online railway reservation etc. Make use of various types of beans such as session beans and entity beans, for the implementation of business methods and persistence of data.
2. For a sample application scenario, implement and consume the suitable web services using SOAP or REST protocol.
3. Make use of JPA with Hibernate framework for performing the create, retrieve, update and delete (CRUD) operations on the backend database.

   Sample application scenario:
   Consider "Course Information Management" as a typical Database Application. This application may have database tables like Courses, Participants etc. Make use of JPA with Hibernate framework to access the data from the Courses table in this above application.

**Group C:**

1. Design and develop a typical web application like online cab booking, online food ordering application, online tours and travel portal etc. For the development of this application, choose the appropriate technologies for the client side aspects, server side business logic and database development.

# Rules & Scheme of evaluation for Internship / Project during 7th Sem

❖ **Preamble** : The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. In line with guidelines for AICTE and on the strong recommendations received through stake holder's feedback, CCEW have launched 6 months Internship program. Adopting an impactful internship based strategy at CCEW, Pune is with intent for creating a future talent pool for the industry. We expect, it will not only helps fresh passing-outs in gaining professional know-how but also benefits, corporate on fresh perspectives on business issues and even discovering future business leaders.

The main aim of this initiative is towards enhancement of the employability skills of the passing out students. At CCEW, we prepared a curriculum with the help of prominent academicians of the country so that our all programme could produce competent employable graduates as per the needs of the industries. The revised curriculum includes the internship for students of six months' duration in the 7th Semester of all programmes.

Keeping this in view, this developed this policy document is giving guidelines for organizing Internship. These guidelines comprise of Steps for Establishing, Maintaining & Fostering Internships. We hope, this internship experience will augment outcome based learning process and inculcate various attributes in a student in line with the graduate attributes defined by the NBA.

## I. Rules for internship / project during 7th semester:

1) Students can select and work on any option either project or internship (of any duration) as explained in Table 1. Credit and marks distribution and examination scheme for internship and project is discussed in Table 1.

**Table 1 Credits and marks distribution for internship and project work**

| Internship Industry (Months) | Project (In-house / Ind.) (Months) | Credits for Internship | Credits for Project | Marks for Internship | Marks for Project |
|---|---|---|---|---|---|
| 6 | -- | 15 | -- | 300 | -- |
| 5 | 1 | 13 | 02 | 250 | 50 |
| 4 | 2 | 11 | 04 | 200 | 100 |
| 3 | 3 | 08 | 07 | 150 | 150 |
| 2 | 4 | 05 | 10 | 100 | 200 |
| -- | 6 | -- | 15 | -- | 300 |

2) Students can opt for research internship but they need to follow college academic calendar.
3) Students need to report her decision about opting either project or internship (of any duration viz. 2, 3, 4, 5, 6 months) as an option to earn credits in 7th Semester to their respective department coordinator before 15th June of academic year.
4) In case, students opt for or need to work for Internship for plus project option then, they need to complete internship first and then only can work on selected project [change in this sequence is not permitted].
5) In case students (because of any reason) want to increase their project or internship duration, they need to take prior approval, 15 days before completion of their current(earlier) project or internship duration.
6) Students applying with excuse because of any reason(s) such as medical reason, personal tour etc. during internship duration will not be entertained.
7) Individual students can work on approved projects or a maximum of four students in a group can work on approved project work.
8) Interdepartmental /multidisciplinary projects are allowed. Further, students from different departments can form their project groups [in such case Guides from both the departments will guide the project & evaluate students' performances].
9) Students involved in co-curricular activities viz. BAJA / ROBOCON etc. can take up related and relevant technical tasks as their project. In such cases, to define project work content, prior approval and recommendations from authorities is required.

## II. Scheme of evaluation: Internship Option

- Credit distribution and examination scheme for internship option is discussed in Table 2.
- Further, Table 3 discusses Rubric parameters *[of equal weightage]* for evaluating student's performance evaluation during Internship duration.

## Table 2 Student performance evaluation during Internship duration and phase wise-marks distribution

| Internship Duration (Months) | Total Marks for Internship | ISE - I (Industry In-house / Mentor/ Guide ) | ISE - II (Industry In-house / Mentor/ Guide ) | ISE - III (Industry In-house / Mentor/ Guide ) | ISE (I+II+III) Total | ESE |
|---|---|---|---|---|---|---|
| **6** | 300 | 75 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **200** | **100** |
| **5** | 250 | 50 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **175** | **75** |
| **4** | 200 | 50 [Before ESE] | 40 [After 2 months] | 60 [After 3 months] | **150** | **50** |
| **3** | 150 | 30 [Before ESE] | 70 [After 2 months] | --- | **100** | **50** |
| **2** | 100 | 15 [Before ESE] | 35 [After 2 months] | --- | **50** | **50** |

**ISE= In-Sem. Exam., ESE= End-Sem. Exam.*

## Table 3 Rubric parameters for evaluating Student performance evaluation during Internship duration

| Criteria [Phase – I] | Criteria [Phase – II & III] |
|---|---|
| 1. Regularity | 1. Log Book (Weekly) (Identification Scheduling w.r.t. time Completion) |
| 2. Eagerness to learn | 2. Tools and Techniques |
| 3. Professional work ethics | 3. Problem Scope identification, Procedure / algorithm/methodologyfollowed |
| 4. Ability to work in a team | 4. Design/ Implement /Validate System (Components, Processes etc.) |
| 5. communication skills | 5. Presentation |

*Oral all points same except in place of Log Book add report

- Further, faculty mentor can decide Rubric parameters for evaluating student's performance evaluation of Internship duration during End Sem. Evaluation (ESE).

## III. Scheme of evaluation: Project Option

- Credit distribution and examination scheme for project option is discussed in Table 4.

**Table 4 Student performance evaluation, Project duration andphase wise-marks distribution**

| Project Duration (Months) | Total Marks for Project | *ISE | | *ISE (I+II) Total | **ESE (Industry& In-house Mentors ) |
|---|---|---|---|---|---|
| | | ISE - I (Industry & College Guide ) | ISE - II (Industry & College Guide ) | | |
| **6** | 300 | 50 [After 2 months] | 150 [After 4 months] | **200** | **100** [After 6 months] |
| **4** | 200 | 30 [After 1.5 months] | 120 [After 3 months] | **150** | **50** [After 4 months] |
| **3** | 150 | 20 [After 1 month] | 80 [After 2 months] | **100** | **50** [After 3 months] |
| **2** | 100 | 15 [After 1 month] | 35 [After 2 months] | **50** | **50** [After 2 months] |
| **1** | 50 | 10 [After 1 month] | 15 [After 1 month] | **25** | **25** [After 1 month] |

*ISE= In-Sem. Exam, **ESE= End-Sem. Exam.

- Rubric parameters for evaluating student's performance evaluation during Project duration for ISE I, II and ESE will be defined by respective programmes.
- It is strongly recommended to add research publication criteria for projects of duration more than 4 months.
- Individual or maximum four students per group can work on one project work.
- Inter-department project group formation is allowed [Guides from both departments will guide the project and evaluate students' performance]
- Students involved in BAJA / ROBOCON / ADIRA / with pre-approval from their HoD.

## Reference

1. AICTE INTERNSHIP POLICY: GUIDELINES & PROCEDURES
https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf
2. EXAMINATION REFORM POLICY
https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf
3. MANUAL FOR ACCREDITATION OF UNDERGRADUATE ENGINEERING PROGRAMS (Tier I Institutions)
https://www.nbaind.org/files/NBA_UGEngg_Tier_I_Manual.pdf

# 20PECE 801A Introduction to Natural Language Processing

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1. Understand various aspects of Natural Language Processing.
2. Learn Phonological, Morphological, Syntactic and Semantic processing
3. Understand issues related to ambiguity of Natural Language.
4. Understand the advanced applications of Natural Language Processing.

**Course Outcomes:**

After completion of the course, students will be able to

1 Identify importance of Natural Language Processing.

2 Apply the fundamental concepts and techniques of Natural Language.

3 Identify ambiguous structure of Language.

4 Analyze the advanced applications of Natural Language Processing.

**Unit I: Introduction to Natural Language Processing (6)**

The Study of Language, Applications of Natural Language Understanding, Evaluating language Understanding Systems, Different levels of Language Analysis.

**Unit II: Fundamentals of Phonics (7)**

Speech Sounds and Phonetic Transcription, Articulatory Phonetics, The Vocal Organs, Place of Articulation of Consonants, Manner of Articulation of Consonants, Vowels, Syllables, Phonological Categories and Pronunciation Variation, Phonetic Features, Predicting Phonetic Variation, Factors Influencing Phonetic Variation.

**Unit III: Fundamentals of Morphology (7)**

Concept of Morphology, Survey of English Morphology, Inflectional Morphology, Derivational Morphology, Cliticization, Non-Concatenative Morphology, Agreement, Finite-State Morphological Parsing, Construction of Finite-State Lexicon, Finite-State Transducers(FST), Sequential Transducers and Determinism, Finite-State Transducers for Morphological Parsing, Transducers and Orthographic Rules, Word and Sentence Tokenization.

**Unit IV: Semantic Analysis (8)**

Part-of-Speech Tagging, POS-Tagging Perspective, POS tagging and HMM, POS-Tag Set, Parsing Algorithms,Parsing in case of Ambiguity; Probabilistic Parsing .Parser Comparison, Grammar; Constituency, Dependency , Inside Probability; Parse Tree construction,language modelling

**Unit V: Discourse and Pragmatics (7)**

Discourse Structure and Reference, Relating Discourse Structure and Inference, Discourse Structure, Tense, and Aspect, Managing the Attentional Stack, Concept of Pragmatics

**Unit VI: Applications of Natural Language Processing (7)**

Machine Translation, Sentiment Analysis, Question Answering Systems, Cross Lingual Information Retrieval,Natural Language Interface to Database, Extractive and Abstractive Summarization Systems, Indian Language WordNets.

**Text Books:**

**1.** Jurafsky, David, James H. Martin, 'Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2014), ISBN: 987-93-325-1814-4.

**2.** James Allen, 'Natural Language Understanding', Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. (Indian Subcontinent Version)(2007), ISBN: 987-81-317.

**Reference Books:**

**1.** Manning, Christopher D., Hinrich Schütze, 'Foundations of Statistical Natural Language Processing', Cambridge Publication(1999), ISBN: 0262133601. 2. Steven Bird, ewan Klein, and Edward Loper, 'Natural Language Processing with Python', O'Reilly Media, 2009.

**2.** Flanagan, J. L. Speech Analysis, Synthesis and Perception. 2nd ed. New York, NY: Springer-Verlag,. ISBN: 9780387055619.

# 20PECE 801B User Experience Design (UX/UI)

| Teaching Scheme | Examination Scheme |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | Credits: 3 |

**Course Objectives:**

To facilitate the learner to

1. Understand the basic concepts of UI/UX Design in order to design with intention.
2. Achieve a deep understanding of the entire life-cycle of design process.
3. Provide a visual understanding of product to make user interaction as easy and efficient as possible.
4. Understand various design technologies for mobile and web to help avoid common mistakes and meet user requirements
5. Understand the advanced techniques of User Experience Design

**Course Outcomes:**

After completion of the course, students will be able to

1. Apply the concepts areas of study in UX to enhance the user experience
2. Apply the key psychological principles that underlie UX design principles
3. Construct the wireframes and prototypes for interactive products to establish the structure and flow of possible design solutions.
4. Apply the fundamental aspects of designing and evaluating the interfaces for mobile and web.
5. Compare the advanced techniques of User experienec Design

**Unit I: Introduction to User Experience (6)**

What is User Experience, Relationship Between UI and UX, Why is UX Design so Important, What is UX Design and Where is Used, Usability: A part of the User Experience, Understanding User Experience, Psychology of everyday actions, Concept of UX, Trends in UX, What is User Interaction, Mental Model, Cognitive Model in UX, Emerging Technologies in UX, Universal Design, User-centered design, Human Centered Design.

**Unit II: Design Thinking (8)**

Key elements of Design thinking, Design Thinking Skills-What are wicked problems and its solution, Good and poor design, Empathy Users- User research, Personas, Define problem, , Ideation- Identifying Customer Needs, Translate user needs into product specifications, Applied Creativity, Brainstorming, Prototyping, From Prototype to Product Development, Testing Design Solutions, Relation of Design thinking with UX, Design thinking applications, Applying design thinking to mobile and wed.

**Unit II: Interaction Styles (6)**

Design principles and rules, Shneiderman's golden rules, Normans seven principles, Nielsens ten heuristics with example of its use,Heauricstic evaluation.
Direct Manipulation – Windows Characteristics, Components, Presentation styles, Icons, Multimedia and colors, Menu selection, Form Fill-in and Dialog Boxes, Icons, Fitts'law and Hick-Hyman's law.

**Unit IV: UX Design Process (7)**

Elements of User Experience Design, Stages of UX design,
Visual Design - Vision and Memory,Visual Design Principles, Data Visualization, Wire framing & Storyboarding, Converting the wireframes into visual design, Prototyping, Various Prototyping Tools, Elements and Widgets. Gestalt Principles and Grids, Layout Expectations, Forms and Data Entry
Screen Design and Layout- Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully
UX Design Tools

**Unit V: UX Design for Mobile and Web (8)**

Mobile Usability Research – The Important Differences from the Desktop. Smartphone vs. Tablet, UI mobile components and patterns, Application frameworks: Types of Mobile Applications: Widgets, Applications, Mobile Design: Elements of Mobile Design
Web user Interface - The Gestalt Principles of Perceptual Organization, The Law of Similarity, Proximity, Familiarity/Meaningfulness, Symmetry, Continuity, The Principle of Closure, 'New' Grouping Laws, The Law of Element Connectedness, The Law of Common Region.
Types of Evaluation research, Usability Testing.

**Unit VI: Interaction Technologies (7)**

Explicit and Implicit Human Computer Interaction – Gesture interfaces, Speech Recognition, Tangible interfaces, Auditory Interfaces, Natural Language Interfaces, User Interfaces and Interaction for Four Widely Used Devices.
Hidden User Interface via Basic smart Devices, Hidden User Interface via Wearable and Implanted Devices, Virtual and Augmented Reality.

**Text Books:**

1. Interaction Design: Beyond Human-Computer Interaction: Book by Helen Sharp Jenny Preece, and Yvonne Rogers
2. Wilbert O. Galitz'Wiley The Essential Guide to User Interface Design' 3rd Edition Apr 2007

**Reference Books:**

1. Don Norman, 'The Design of Everyday Things', Basic Books, A member of the Perseus Books Group, (2013)
2. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, 'Designing the User Interface: Strategies for Effective Human-Computer Interaction', Pearson Education Limited (India),(2010)

**Online/Web/Other References:**

1. https://www.interaction-design.org/courses/user-experience-the-beginner-s-guide
2. https://www.coursera.org/learn/user-experience-design#syllabus

# 20PECE 801D Artificial Intelligence

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

**Course Objectives:**

To facilitate the learner to

1. Learn overview and basics of classic Artificial Intelligence.
2. Understand various intelligent searches and knowledge representation.
3. Understand types of learning used in artificial intelligence.
4. Study applications in Artificial Intelligence.

**Course Outcomes:**

After completion of the course, students will be able to

1. Build fundamental knowledge of AI, its applications and solve classical AI problems using different AI Techniques
2. Apply intelligent search algorithms on AI problems.
3. Make use of Knowledge Management techniques of AI for reasoning.
4. Make use of various learning techniques to solve the given problem.
5. Examine different topics with various methods of expert system, pattern recognition, natural language processing, nature inspired computing.

**Unit I: Introduction to AI (6)**

Definitions of Artificial Intelligence, History of Artificial Intelligence, Artificial Intelligence Problems, Present state of AI, Intelligent agents, Topics of Artificial Intelligence: Learning Systems, Knowledge Representation and Reasoning, Planning, Knowledge Acquisition, Intelligent Search, Logic Programming, Soft Computing, Management of Imprecision and Uncertainty, Branches and applications of Artificial Intelligence.

**Unit II: Uninformed search and modelling a search problem (7)**

Generate-and-Test, Search Techniques: Depth First Search, Breadth First Search, Production Systems: Traveling Salesman Problem, Water-Jug Problem, State Space Representation, State Space Search, Tic-Tac-Toe as a State Space.

**Unit III: Heuristic Search Techniques (8)**

Best First Search Algorithm, Hill Climbing, Simulated Annealing, A* Algorithm, Problem Reduction, AND–OR Graphs, The AO* Algorithm, Towers of Hanoi Problem, Constraints Satisfaction: crypt-arithmetic problem, mini-max algorithm.

**Unit IV: Knowledge Management (7)**

Knowledge Management, Types of Knowledge: Declarative Knowledge, Procedural Knowledge, Knowledge Representation, Approaches to Knowledge Representation, Issues in Knowledge Representation, First-order Logic: Basic Predicate Representations, Conversion of WFF to Clause Form, Resolution, Unification, Resolution Examples, Reasoning, monotonic and non-monotonic reasoning.

**Unit V: Learning (7)**

Types of Learning: Rote Learning, Learning by General Problem Solving, Concept Learning, Learning by Analogy, learning problems and designing the learning systems, Reinforcement learning.

**Unit VI: Applications in Artificial Intelligence (7)**

Game Playing, Expert Systems, Natural Language Processing, Pattern Recognition, Recommendation system, Nature Inspired Computing.

**Text Books:**

**1.** Vinod Chandra S. S., Anand Harendra S., 'Artificial Intelligence and machine learning', PHI, (2014), ISBN 978-81-203-4934-6.

**2.** Kulkarni P., Joshi P., 'Artificial Intelligence: Building Intelligent Systems', PHI Learning, (2015), ISBN 978-81-203-5046-5.

**Reference Books:**

**1.** Peter, Norvig, 'Artificial Intelligence: A Modern Approach', Pearson, (3rd edition), (2014), ISBN-0-13-103805-2.

**2.** Elaine Rich, Kevin Knight and Nair, 'Artificial Intelligence', Tata McGraw – Hill, (3rd edition), (2012), ISBN-978-0-07-008770-5.

3. Bratko I., 'Prolog Programming for Artificial Intelligence', Pearson Education, (3rd edition), (2004).

4. Tom M. Michell, 'Machine Learning', McGraw Hill Education, Indian edition (2013), ISBN-13: 978-1-25-909695-2.

5. Ethem Alpaydin, 'Introduction to Machine Learning', PHI, (2006), ISBN-81-203-2791-8.

**Online/Web/Other References:**

**1.** https://nptel.ac.in/courses/106/105/106105077/
**2.** https://nptel.ac.in/courses/106/106/106106126/
**3.** https://onlinecourses.nptel.ac.in/noc19_me71/preview
**4.** https://onlinecourses.nptel.ac.in/noc20_cs42/preview

## 20HS701- Economics and Personal Finance

**Teaching Scheme**
Lectures: 2 Hrs/Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 2**

**Prerequisite:** Nil

**Course Objectives:**

1. To enable students to acquire knowledge and develop an understanding of basic concepts and principles of Economics & Finance
2. To make students acquaint with standard concepts and tools that they are likely to find useful in their profession when employed in the firm/industry/corporation in public or private sector
3. To sensitize students to the current economic issues of the nation
4. To develop an understanding of the role of institutions in the functioning of an economy
5. To understand Markets and behaviour of the firm
6. To enhance financial literacy of engineering students.

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Demonstrate the importance of National and International economy in ones economic life |
| CO2 | Analyse the behaviors of consumer, firms and market and its impact on corporate finance |
| CO3 | Apply financial techniques to evaluate companies and investments |
| CO4 | Develop Personal Financial strategies using various investment options and taxation |

**Unit I: Macro Economics : Understanding Indian Economy- Domestic and International (03)**

Economics for Engineers, Definition and classification of Economics, Basic Economic Problems and Economic Systems, India Economy: Mixed economy, Sector-wise contributors Gross Domestic Product (GDP) of India, GDPs of other nations, Macroeconomics, Per Capita Income, Employment, Inflation calculation : Consumer Price Index (CPI), Wholesale Price Index (WPI), Fiscal Policy, Fiscal Deficit, Government expenditure and Taxation, Concept of Goods and Service Tax (GST), Monetary policy, Central Bank- Reserve Bank of India (RBI), Statutory Liquidity Ratio (SLR), Prime Lending Ratio (PLR), Cash Reserve Ratio (CRR).

**Unit II: Microeconomics : Understanding behaviors of Consumers, Firms and Markets (05)**

Consumer Behaviour, Concept of Demand and Supply, Determinants of Demand and Supply, Price Elasticity of Demand and Supply, Market Equilibrium and it's applications, Market and Market Structures- Perfect Competition, Monopolistic Competition, Oligopoly and Monopoly Cost Concepts, Product Costing and Pricing strategy.

**Unit III: Personal Finance and Taxation I : Personal Financial strategies Background Concepts (06)**

Financial analysis of a business firm: Statement of Profit and Loss, Balance Sheet, Analyzing various business firms though Ratio Analysis, Time value of money, Annuities. Calculations in Excel, International Trade and Comparative Advantage, International Financing : Foreign Exchange (FOREX) market and Exchange rates, Balance of Payment.

**Unit IV:** **Personal Finance and Taxation II :** Personal Financial strategies **(07)**
**Goal Setting and Tax, Credit and Risk Management**

Understanding Personal Finance : Financial Goal, Importance, Opportunity Costs in Decision Making, The Time Value of Money, Basics of Financial Planning, Personal financial statements, Cash flow and debt management, Tax Management : Taxes, Direct and Indirect, Income Tax slabs and sections, Other taxes, Credit Management : Consumer Loans, Credit cards, Credit Rating, Credit Information Bureau (India) Limited (CIBIL), Interest Rates, Understanding Monetary Policy, Risk Management : Insurance- Life and General, Types of life Insurance, Unit Linked Insurance Plan (ULIPS), Health Insurance, Vehicle Insurance and other major types, Understanding Insurance riders and decision making while buying insurance.

**Unit V:** **Personal Finance and Taxation III : Personal Financial strategies** **(07)**
**Investments in Bonds, Stocks and Mutual Funds, Retirement Planning**

Investment in Government Securities : Bank Accounts, Government Securities, Bonds, Fixed Deposits, Gold Bonds, Investment in Stock Market : Introduction to Stock Market, Stock Exchange Sensitive Index (SENSEX), National Stock Exchange (NSE), Dematerialised account (Demat) Account, How to select stocks- Price per Earning (P/E) ratio, Fundamentals analysis, Investment in Mutual Funds : What is Mutual Fund, Types, Exchange Traded Funds, Net Asset Value (NAV), Factors for selection of Mutual Funds, Retirement Planning : Public Provident Fund (PPF), Employee Provident Fund (EPF) , National Pension Scheme (NPS) and other Pension Funds, Annuity calculations.

**Text Books:**

1. Paul A Samuelson, "**Economics"**, Indian Adaptation, Sudip Chaudhari,Anindya Sen, *Mc Graw Hill* (2010), 19th edition
2. Lawrence J Gitman, "**Principles of Managerial Finance"**, *Pearson*.(2016) 11th edition
3. Prasanna Chandra , "**Finance Sense: Finance for Non-finance Executives**", 5th edition, CFMTMH professional series in Finance
4. Monika Halan , "**Let's Talk Money**" Harper Business 2018
5. P V Subramanya, **"Retire Rich"** TV18 Broadcast Ltd., 2019
6. Abhishek Kumar, "**The Richest Engineer"**, Manjul Publishing House, 2016

**Reference Books:**

1. Lipsey, R.G. & Chrystal, K.A., "**Economics"**, 11th Edition, Oxford University Press, 2007
2. K.K.Dewett, "**Modern Economic Theory"**, S.Chand, 2005

**Online Resources:**

1. www.economicshelp.org
2. www.rbi.org
3. www.khanacademy.org

# 20EC801 BROADBAND COMMUNICATION SYSTEMS

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC402 Analog and Digital Communication

**Course Objectives:**
1. To comprehend the components of fibre optic communication system
2. To understand the system design issues and the role of WDM components in advanced light wave systems
3. To describe optical network architectures
4. To explain the concepts of new services and applications to be supported in future satellite networks

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Describe the effect of propagation characteristics of Optical communication system
CO2 Apply system design considerations for optical link
CO3 Describe optical access networks
CO4 Design WDM optical network
CO5 Identify and access sources for recent trends in Broadband Communication

**Unit I: Fiber optic communications system (08 )**
Electromagnetic Spectrum and Optical spectral bands, Key elements of fiber optic communications system, Ray theory of propagation: Fiber types, Transmission characteristics of optical fibers, Intra modal Dispersion, Intermodal dispersion. Introduction to optical sources: Wavelength and Material Considerations, LEDs and semiconductor LASERs: principle of working and their Characteristics, Material Considerations, PIN, Avalanche photodiodes.

**Unit II: Design considerations in optical links and Wavelength Division Multiplexing(WDM) (06)**
Point to point Links: System design considerations, Link Power budget, Rise Time budget, Overview of WDM, WDM Components: Fiber Coupler, Optical Isolators and Circulators, Optical Fiber Applications.

**Unit III: Optical Network Architectures (07)**
Architectural choices of next generation transport networks, Designing transmission layer using-SDM, TDM, WDM, Unidirectional versus Bidirectional WDM systems, SONET Layering, Frame Structure, Physical network topologies, Access Networks- PON, Optical Interconnects, Data Centers ,Optical communication for Wireless Fronthauling.

**Unit IV: WDM Network Design (07)**
Cost Trade-Offs: A Detailed Ring Network, Light path Topology Design, Routing and Wavelength Assignment(RWA), Wavelength Conversion, Dimensioning Wavelength-Routing Networks, Online RWA in Rings, Long Haul Network case study, Metro Ring Network Case study.

**Unit V: Multiprotocol Label Switching (MPLS) Networks (07)**

Introduction to MPLS, MPLS and Traffic Engineering, Integrated service Internet, RSVP, Differentiated service Internet, Voice over IP, Metro Ethernet Access networks.

**Unit VI: Next Generation Internet (NGI) Over Satellite (07)**

Overview of satellite communication, New Services and Applications, Traffic Modeling and Characterization, IPv6 Networks over Satellites, Future Development of Satellite Networking.

**Text Books:**


1. Gerd Keiser, **"Optical Fiber Communications",** *Tata McGraw Hill*, (5th Edition), (2013).
2. John M. Senior, **"Optical Fiber Communications: Principles and Practice",** *PHI*, (3rd Edition), (2008).
3. Anthony S. Acampora, "**An Introduction to Broadband Networks LANs, MANs, ATM, B-ISDN, and Optical Networks for Integrated Multimedia**", *Springer US* (1st Edition), (1994).
4. Rajiv Ramaswami, Kumar N. Sivarajan, and Galen H. Sasaki, "**Optical Networks: A Practical Perspective",** *Morgan Kaufmann Publishers Inc*, (3rd Edition), (2010).
5. C. Siva Ram Murthy and Mohan Guruswamy, **"WDM Optical Networks: Concepts, Design and Algorithms"**, *PHI*, (1st Edition), (2001).
6. Zhili Sun, **"Satellite Networking Principles and Protocols"**, *John Wiley & Son*, (2nd Edition), (2014).


**Reference Books:**


1. Djafar K. Mynbaev and Lowell L. Scheiner,**"Fiber Optic Communications Technology",** *Pearson Education*, (1st Edition), (2000).
2. Govind P. Agrawal, **"Fiber Optic Communication Systems",** *Wiley India*, (3rd Edition), (2002).
3. Dennis Roddy, **"Satellite Communications",***McGraw Hill*, (4th Edition), (2017).


**Online Resources:**

1. NPTEL Course "**Fiber Optic Communication Technology"**
   https://nptel.ac.in/courses/108/106/108106167/
2. NPTEL Course **"Satellite Communication Systems"**
   https://nptel.ac.in/courses/117/105/117105131/
3. NPTEL Course **"Broadband Networks: Concepts and Technology"**
   https://nptel.ac.in/courses/117/101/117101050/

# 20PEEC 801A MICROWAVE AND RADAR ENGINEERING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC601 Wave Theory and Antenna

**Course Objectives:**
1. To study the basics of waveguides and various microwave components
2. To analyze microwave components using scattering parameters
3. To study various microwave measurement techniques
4. To explain different types of Radars and its applications

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Discuss the advantages and applications of microwaves
CO2 Analyze different modes of propagation in waveguides
CO3 Derive and analyze S parameters for different microwave components
CO4 Explain the operation of different microwave tubes
CO5 Calculate and analyze parameters at microwave frequencies
CO6 Discuss the principle of Radar and compare different types of Radars

**Unit I: Microwave Transmission Lines (08)**
Introduction of Microwaves and their applications, Rectangular waveguides, Solution of Wave equation in TE and TM modes, Power transmission and Power losses, Planar transmission lines.

**Unit II: Waveguide Components (08)**
Scattering matrix representation of networks, Rectangular cavity resonator, Waveguide Tees, Directional couplers, Faraday rotation principle, Circulators and isolators.

**Unit III: Microwave Tubes (08)**
Introduction to conventional vacuum tubes, High frequency limitations of conventional tubes, Klystron tubes, Magnetron, TWT and their applications.

**Unit IV: Microwave Measurements (06)**
Introduction to microwave measurements, Measurement methods of parameters such as Frequency, Power, Attenuation, Phase shift, VSWR, Impedance, Insertion loss, Q of a cavity resonator.

**Unit V: Radar Fundamentals (06)**
Radar block diagram and operation, Radar range equation, Prediction of range performance, Minimum detectable signal, Radar cross section of targets, Pulse repetition frequency and Range ambiguities, Radar Displays.

**Unit VI: Types of Radar and Applications (06)**
Types of Radars, Doppler effect, CW radar, basic principle and operation of FMCW radar, MTI and Pulse Doppler Radar.

**Text Books:**

1. S.Y. Liao**, "Microwave Devices and Circuits",** *Prentice Hall India*, (2nd Edition), (2014).
2. M. Kulkarni**, "Microwave and Radar Engineering",** *Umesh Publications***,** (4th Edition), (2013)**.**
3. M. I. Skolnik, "**Introduction to Radar Systems",** *McGraw Hill, (*3rd Edition), (2008).

**Reference Books:**

1. David M. Pozar, **"Microwave Engineering"**, *John Wiley and Sons*, (5th Edition), (2014).
2. NadowLevanon, **"Radar Principles"**, *John Wiley and Sons*, (5th Edition), (1989).

**Online Resources:**

1. NPTEL Course on **"Microwave Theory and Techniques"**
   https://onlinecourses.nptel.ac.in/noc19_ee57/preview
2. NPTEL Course on **"Basic Blocks of Microwave Engineering"**
   https://nptel.ac.in/courses/117105130/

# 20PEEC801B REMOTE SENSING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite**: PEEC 501 Digital Image Processing, 20EC403 Machine learning with Python

**Course Objectives:**
1. To understand basic concepts, principles and applications of remote sensing
2. To provide knowledge related to remote sensing data collection, reading and analysis
3. To perform image pre-processing, classification and clustering on remote sensing data
4. To learn multidisciplinary applications of remote sensing

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Explain geometric and radiometric principles, Digital Image Processing techniques for pre-processing of Remote Sensing image data

CO2 Illustrate atmospheric and energy interaction, scanning mechanism on earth surface

CO3 Interpret data products from different satellites and calculate image statistics

CO4 Apply machine learning algorithms for dimensionality reduction, clustering and classification on satellite images

CO5 Analyze performance of different machine learning algorithms on multispectral and hyperspectral images

CO6 Demonstrate multidisciplinary applications of remote sensing

**Unit I: Introduction to Remote Sensing (08)**
Energy sources and radiation principles, Energy interactions in the atmosphere, Characteristics and Physics of Remote Sensing systems, Electromagnetic spectrum, Effects of Atmosphere, Scattering and Absorption, Atmospheric window, Energy interaction with surface features: Spectral reflectance of Vegetation, Soil and Water, Atmospheric influence on spectral response patterns.

**Unit II: Multispectral, Thermal, and Hyperspectral Sensing (08)**
Platforms used for Remote Sensing data acquisition and characteristics, Different types of aircrafts, Manned and Unmanned spacecrafts, Sun-synchronous and geo-synchronous satellites, Types and characteristics of different platforms, Opto-mechanical and electro-optical sensors: across-track and along-track scanners, Multispectral scanners and Thermal scanners, Imaging spectroscopy.

**Unit III: Data Representation and Preprocessing (09)**
Resolution: spatial, spectral, radiometric and temporal resolution, Data products and their characteristics, Visual and digital interpretation, Image statistics, Basic principles of data processing: Radiometric correction, Geometric correction, Atmospheric errors and corrections, Image enhancement.

**Unit IV: Data Analysis (09)**
Dimensionality reduction techniques, Image classification: Supervised classification, Unsupervised classification, Classification accuracy assessment, Image segmentation.

**Unit V: Applications of Remote Sensing** **(08)**

Hyperspectral image analysis, Multispectral image analysis, Time Series Analysis using machine learning techniques in different application areas as urban planning, agricultural, forestry and disaster management.

**Text Books:**

1. Lillesand T.M., and Kiefer, R.W.,"**Remote Sensing and Image interpretation**", *John Wiley & Sons*, ($6^{th}$ Edition), (2000).
2. John R. Jensen, **"Introductory Digital Image Processing: A Remote Sensing Perspective"**, *Pearson*, ($4^{th}$ Edition), (2016).
3. George Joseph, **"Fundamentals of Remote Sensing",** *Universities Press*, ($2^{nd}$ Edition), (2005).

**Reference Books:**

1. John A. Richards, **"Remote Sensing Digital Image Analysis"**, *Springer–Verlag*, ($5^{th}$ Edition), (2013).
2. Charles Elachi and Jakob J. Van Zyl, **"Introduction to The Physics and Techniques of Remote Sensing"**, *Wiley Series in Remote Sensing and Image Processing*, ($2^{nd}$ Edition), (2006).
3. JianGuo Liu, Philippa J. Mason,**"Image Processing and GIS for Remote Sensing: Techniques and Applications"**, *John Wiley & Sons, Ltd.*, ($2^{nd}$ Edition), (2016).

**Online Resources:**

1. NPTEL Course**"Remote Sensing and Digital Image Processing of Satellite Data"** https://nptel.ac.in/courses/105/107/105107160/
2. NPTEL Course**"Remote Sensing Essentials"** https://nptel.ac.in/courses/105/107/105107201/
3. https://www.iirs.gov.in

# 20PEEC801C INDUSTRIAL AUTOMATION

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**

**Course Objectives:**
1. To introduce the basics of process control and automation systems
2. To explain the essential elementsas required  for a process control system
3. To introduce the basics of P.L.C. programming and P.L.C. programming standard
4. To familiarize with SCADA and DCS

**Course Outcomes:**
After completion of the course, students will be able to :

CO1 Explain the basics of  a Process Control System and Automation System
CO2 Design subsystems of a Process Control application
CO3 Develop P.L.C. ladder diagram for process control application
CO4 Explain communication in P.L.C. (Programmable Logic Control), SCADA(Supervisory Control and Data acquisition) and DCS (Distributed Control System)

**Unit I: Process Control and Automation (08)**
Process control principles, Servomechanisms, Control System Evaluation, Analog control, Digital control, Types of Automation, Architecture of Industrial Automation Systems, Advantages and Limitations of Automation.

**Unit II: Transmitters and Signal Conditioning (08)**
Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire and 3-Wire transmitters, Analog and Digital signal conditioning for R.T.D., Thermocouple, Differential Pressure Transmitter ( D.P.T.) , Smart and Intelligent transmitters.

**Unit III: Controllers and Actuators (09)**
PID Controller, Cascade PID control, Microprocessor Based control, PAC(Programmable Automation Controller), Mechanical switches, Solid state switches, Electrical Actuators: Solenoids, Relays and Contactors, A.C. Motor, V.F.D., D.C. Motor, B.L.D.C. Motor, Stepper Motor, Servo Motor, Pneumatic and Hydraulic actuators.

**Unit IV: Programmable Logic Controller (09)**
Functions of P.L.C., Types of PLCs, Advantages, Architecture, Working of P.L.C., Selection of P.L.C., Networking of P.L.C.s, Ladder Programming basics, Ladder Programming examples, Interfacing Input and Output devices with P.L.C., P.LC. Programming standard IEC61131.

**Unit V: Industrial Automation Technologies : Supervisory Control And Data Acquisition (S.C.A.D.A.) and Distributed Control System (D.C.S.), Industrial Communication (08)**
Introduction to S.C.A.D.A. (Features, MTU-functions of MTU, RTU-Functions of RTU, Applications of S.C.A.D.A., Communication in S.C.A.D.A.: types, methods and Media used), Introduction to DCS (Architecture, Input and Output modules, Communication module,

Specifications), Industrial Communication: Devicenet, Interbus , Device network : Foundation Fieldbus -H 1, HART, CAN, PROFIBUS-PA, Control network: ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP.

**Text Books:**


1. Curtis Johnson, **"Process Control Instrumentation Technology"**, Pearson Education, (8th Edition), (2013).
2. S. Sen, S. Mukhopadhyay, A. K. Deb, **"Industrial Instrumentation Control and Automation"**, Jaico Publishing House, (1st Edition), (2013).
3. Madhuchhanda Mitra, Samarjit Sengupta, **"Programmable Logic Controllers and Industrial Automation"**, Penram International Publishing India Pvt. Ltd., (2nd Edition), (2012).
4. Stuart A. Boyer, **"SCADA (Supervisory Control and Data Acquisition)"**, ISA Publication, (4th Edition), (2010).


**Reference Books:**


1. John W. Webb, Ronald A. Reis, **"Programmable Logic Controllers, Principles and Applications"**, Prentice Hall of India Pvt. Ltd., (5th Edition), (2016).
2. Kilian, **"Modern Control Technology:  Components & Systems"**, Cengage India, (3rd Edition), (2021).
3. BelaG. Liptak, **"Process Software and Digital Networks"**, CRC Press, (3rd Edition), (2011).


**Online Resources:**

1. **NPTEL Course on Industrial Automation and Control**
   https://onlinecourses.nptel.ac.in/noc21_me67/preview

# 20PEEC801D EMBEDDED AND RTOS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester:50 Marks
**Credits: 3**

**Prerequisite:** 20EC503 Advanced Processors, 20ES02 Fundamentals of Programming Language I

**Course Objectives:**
1. To discuss embedded system design challenges
2. To explain Operating System (OS) requirement for embedded systems
3. To describe real time operating system concepts
4. To discuss features of Linux OS
5. To interface real world input and output devices

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Identify and analyze design metrics for development of embedded systems
CO2 Compare and contrast different types of software development model for a given application
CO3 Explore the structures, task services, states and other basic operations of the real time operating systems
CO4 Apply real time system concepts for developing embedded systems
CO5 Explain Linux kernel configuration and bootloader

**Unit I : Introduction to Embedded Systems (07)**
Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Embedded processor technology: IC technology, Design technology, Software development life cycle (SDLC) models like Waterfall, Spiral, V, Rapid Prototyping models and comparison.

**Unit II: Structure of µCOS II (07)**
Kernel Structure: Foreground and background systems, Pre-emptive and Non-Preemptive, Starting the OS, Tasks, Task States, Task Control Blocks (TCB), Ready list, Task Scheduling, Task Level, Multitasking , Context Switching, Idle Task, Statistics Task, Task Management: Creating/Deleting and Suspending/Resuming Task, Task Stacks and checking, Changing Task's Priority.

**Unit III : Synchronization in µCOS II (07)**
Critical Session, Shared resources, Inter task communication, Mutual exclusion, Semaphore Management: Creation/Deletion, Pending/Posting/Acceptance/Query, Mutual Exclusion Semaphores: Creation/Deletion, Pending/Posting/Acceptance/Query, Event Flag Management: Internals, Creation/ Deletion of Event Flag groups, Waiting/Setting/Clearing/Looking for/Querying an Event Flag Group.

**Unit IV: Structure of µCOS II (07)**
Static and Dynamic Priorities, Priority inversion, Synchronization mechanism, Interrupts: Latency, Response and Recovery, Clock Tick, Memory requirements. Schedulers, Locking and unlocking of scheduler, Interrupts, Clock Tick, Initialization, Time Management: Delaying/Resuming task, System

Time.

**Unit V: Communication in μCOS II (07)**

Message Mailbox Management: Creating/Deleting a Mailbox, Waiting/ Sending /Getting without waiting a Message from Mailbox, Status of Mailbox, and Alternate uses of Mailbox, Message Queue Management: Creating/Deleting/Flushing a Message Queue, Waiting/Sending/Getting without waiting a Message from Queue, Status and Alternate use of Message Queue, Memory Management: Memory Control Block(MCB), Creating a partition, Obtaining /Returning/Waiting for a memory Block, Partition Status, Porting of μCOS-II: Development tools, Directories and Files, Configuration and testing of Port.

**Unit VI: Linux Kernel Construction (07)**

Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS Versus Boot loader Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration, Role of a Bootloader, Bootloader Challenges, A Universal Bootloader: Das U-Boot, Porting U-Boot.

**Text Books:**


1. Jean J. Labrosse, **"MicroC OS II, The Real-Time Kernel",** *CMP Books*, (2nd Edition), (2011).
2. Christopher Hallinan, **"Embedded Linux Primer - A Practical, Real-World Approach",** *Prentice Hall Pvt.*, (2nd Edition), (2010).
3. Raj Kamal, **"Embedded Systems –Architecture, Programming and Design",** *McGraw Hill*, (2nd Edition), (2008).


**Reference Books:**


1. Dr. K. V. K. K. Prasad **"Embedded / real time System: Concepts, Design, & Programming - Black Book",** *Dreamtech Press Publication*, (2nd Edition), (2003).
2. Frank Vahid and Tony Givargis, **"Embedded System Design – A Unified hardware/ Software introduction"**, *Wiley Publication*, (3rd Edition), (2006).


**Online Resources:**

1. NPTEL Course on "**Real Time Operating System"**
   https://onlinecourses.nptel.ac.in/noc20_cs16/
2. NPTEL Course on "**Real-Time Systems"**
   https://onlinecourses.nptel.ac.in/noc21_cs98/

# 20PEEC802A ADVANCED VLSI DESIGN

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC502 VLSI Design

**Course Objectives:**

1. To discuss the coverage of timing analysis
2. To study the fundamentals of static timing analysis
3. To understand logic fault models and learn test generation for sequential and combinational logic circuits
4. To learn power distribution and power optimization techniques

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Apply the timing constraints, including clocks and external delays for performance improvement

CO2 Apply Static Timing Analysis(STA) checks for timing closure

CO3 Analyze the faults in digital circuits

CO4 Analyze the design for testability methods for combinational and sequential circuits

CO5 Describe power distribution and power optimization techniques

**Unit I: Introduction to Timing Analysis (08)**

Performance axes, Design flow, Static versus dynamic methods, Intrinsic and extrinsic delays, Delay factors, Path delays, Combinational paths, Synchronous paths, Pipelining and analysis, Clock definitions: Skew, Frequency and phase, Clock distribution.

**Unit II: Static Timing Analysis (08)**

True paths, Transitions, Multi-cycle operations, Clock specification, Interface specification, Timing checks, Timing constraints, Design rule constraints, Wire-load model, Gate delay, Net delay, Timing reports, Back annotation, Delay Formats: Standard Delay Format (SDF).

**Unit III: Basics of Testing (08)**

Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits, Current sensing based testing, Classification of sequential ATPG methods, Fault collapsing and simulation.

**Unit IV: Design for Testability (DFT) (08)**

Scan design, Partial scan, Use of scan chains, Boundary scan, DFT for other test objectives, Memory Testing. Built-in self-test (BIST): Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

**Unit V: Power Analysis and Clock Synthesis (10)**

Introduction, Power Basic, Key Factors in Accurate Power Estimation, Power Estimation Early in the Design Cycle, Simulation Based Power Estimation, Best Practices for Power Estimation, Supply and ground bounce, Power distribution techniques, Power optimization, Clock Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Interconnect routing techniques.

**Text Books:**


1. J. Bhasker, Rakesh Chadha, **"Static Timing Analysis For Nano-meter Designs: A Practical Approach"**, *Springer*, (1st Edition), (2009).
2. Jan M. Rabaey, **"Digital Integrated Circuits Design Perspective"**, *Prentice Hall of India Pvt. Ltd.*, (2nd Edition), (2002).


**Reference Books:**


1. Srivastava Ashish, Sylvester Dennis, Blaau David, **"Statistical Analysis and Optimization for VLSI: Timing and Power"**, *Springer*, (1st Edition), (2005).
2. Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, **"VLSI Test Principles and Architectures: Design for Testability"**, *Elsevier*, (1st Edition), (2006).
3 M. L. Bushnell and V. D. Agrawal, **"Essential of Electronic Testing for Digital, Memory, and Mixed Signal VLSI Circuits"**, *Springer*, (1st Edition), (2005).


**Online Resources:**

1. NPTEL Course **"Advanced VLSI Design"**
   https://nptel.ac.in/courses/117/101/117101004/
2. NPTEL Course **"VLSI Physical Design"**
   https://nptel.ac.in/courses/106/105/106105161/

# 20PEEC802B ARTIFICIAL INTELLIGENCE

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester:50 Marks
**Credits: 3**

**Prerequisite:** 20EC403 Machine  Learning with Python

**Course Objectives:**
1. To explain the basics of Artificial Intelligence
2. To introduce various types of algorithms useful in Artificial Intelligence
3. To explain the types of reasoning
4. To explain the code of ethics for Artificial Intelligence

**Course Outcomes:**
After completion of the course, students will be able to
1. Explain the components of intelligent agents and expert systems
2. Apply knowledge representation techniques and problem solving strategies to Artificial Intelligence applications
3. Explain and analyze the search and learning algorithm along with the reasoning
4. Describe the code of ethics for the Artificial Intelligence systems

**Unit I: Basics of Artificial Intelligence (05)**
Categories of Artificial Intelligence (AI), Applications of AI, Intelligent agents, Agents and environments, Good behavior, The nature of environments, Structure of agents. Applications of Artificial Intelligence, Game Playing, Expert Systems, Natural Language Processing, Image Understanding, Robotics, Pattern Recognition, Virtual Reality, Computer Vision, Intelligent Control

**Unit II: Problem Solving (07)**
Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic function, Local search algorithms and optimistic problems, Optimal decisions in games, MINIMAX algorithm, Alpha Beta Pruning, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP.

**Unit III: Knowledge Representation (07)**
Logic, Propositional logic, First order logic, Knowledge engineering in first order logic, inference in first order logic, Prepositional versus first order logic, Forward chaining, backward chaining, Resolution , Knowledge representation, Uncertainty and methods, Bayesian probability and Belief network.

**Unit IV: Reasoning (06)**
Types of Reasoning, Non-monotonic Inference Methods Non-monotonic Reasoning, Truth Maintenance Systems, Reasoning with Fuzzy Logic,  Fuzzy Sets, Fuzzy Reasoning, Rule-based Reasoning, Diagnosis Reasoning, Case-based Reasoning Systems, Model-based Reasoning Systems

**Unit V: Learning** **(07)**

Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Statistical learning, Hidden Markov Models, Association Learning: Apriori Algorithm, Eclat Algorithm, Fuzzy Network, Fuzzy Systems, Info Fuzzy Networks, Fuzzy Neural Systems

**Unit VI: Expert systems and Ethics for Artificial Intelligence** **(10)**

Introduction to Expert System, Architecture and functionality, Examples of Expert system, Basic steps of pattern recognition system, Object Recognition- Template Matching theory, Prototype Matching Theory, Pattern Mining.

Ethics of AI : Privacy and Surveillance, Manipulation of Behavior, Opacity of AI Systems, Bias in Decision Systems, Human-Robot Interaction, Automation and Employment, Autonomous Systems, Machine Ethics, Artificial Moral Agents Privacy

**Text Books:**


1. Vinod Chandra S. S., Anand Hareendran S., "**Artificial Intelligence and Machine learning**", *PHI*, (1st Edition) (2014).
2. Stuart Russell, Peter Norvig, **"Artificial Intelligence", A Modern Approach '**, *Pearson Education/Prentice Hall of India*, (3rd Edition), (2010).
3. Elaine Rich, Kevin Knight and Shivshankar Nair, **"Artificial Intelligence"**, *Tata McGraw Hill*, (3rd Edition), (2009).
4. Paula Boddington**, "Towards a Code of Ethics for Artificial Intelligence", ***Springer international Publishing***,** (1st Edition), (2017).


**Reference Books:**


1. Nils J. Nilsson, **"Artificial Intelligence: A new Synthesis"**, *Morgan Kaufmann Publishers*, (1st Edition), (1998).
2. George F. Luger, **"Artificial Intelligence: Structures and Strategies for Complex Problem Solving",** *Pearson Education***,** (6th Edition), (2008).


**Online Resources:**

1. NPTEL Course **"Artificial Intelligence"**
   http://nptel.ac.in/courses/106105077/
2. https://plato.stanford.edu/entries/ethics-ai/
3. https://intelligence.org/files/EthicsofAI.pdf
4. https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf

# 20PEEC 802C STATISTICAL SIGNAL PROCESSING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC501 Digital Signal Processing

**Course Objectives:**

1. To explain concepts of statistical signal processing that have been used in many applications fields such as communications, speech signal processing, image processing
2. To describe Signal Modeling methods and its importance in signal processing
3. To explain Parametric and non-parametric spectral estimation methods
4. To introduce Linear prediction and optimum filters and its necessity for noise filtering
5. To explore necessity of adaptive filters and algorithms for real time noise filtering

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Apply statistical models for analysis of signals using Stochastic processes |
| CO2 | Design Optimum filters for prediction and filtering of real world signals |
| CO3 | Analyze real world signals by estimating its power spectral densities using parametric and non-parametric spectral estimation methods |
| CO4 | Apply Adaptive filtering algorithms for real world signals |

**Unit I: Signal Modeling (08)**

Random processes, Introduction to signal modeling, Signal modeling using Least Square methods, Pade' method, Prony's method, Signal modeling using MA(q), AR(p) , ARMA(p,q) models.

**Unit II: Linear Prediction of Signals (08)**

Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters, Linear Minimum Mean-Square Error (LMMSE) Filtering.

**Unit III: Wiener Filter (08)**

Wiener Hoff Equation, Causal and Non Causal FIR filter, Linear Prediction using FIR Filter, Lattice representation of FIR filter, Causal IIR Wiener filter, Application of Wiener Filter as Noise Canceller.

**Unit IV: Adaptive Filtering (10)**

Principle and Applications, Steepest Descent Algorithm Convergence characteristics, LMS algorithm, Convergence, Excess mean square error, Leaky LMS algorithm, Application of Adaptive filters, Kalman filtering**:** State-space model and the optimal state estimation problem, Discrete Kalman filter, Extended Kalman filter.

**Unit V: Spectral Analysis (08)**

Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing, Periodogram: Parametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

**Text Books:**

1. Charles W. Therrien, **"Discrete Random Signals and Statistical Signal Processing",** *Prentice Hall Signal Processing Series*, (1st Edition), (2004).
2. Monson H. Hayes, **"Statistical Digital Signal Processing and Modeling"**, *John Wiley and Sons, Inc, Singapore*, (1st Edition), (2002).

**Reference Books:**

1. Simon Haykin, **"Adaptive Filter Theory",** *Prentice Hall*, (5th Edition), (2013).
2. J. G. Proakis, **"Algorithms for Statistical Signal Processing",** *Pearson Education*, (1st Edition), (2002).

**Online Resources:**

1. NPTEL Course **"Statistical Signal Processing"**
   https://nptel.ac.in/courses/108/103/108103158/

# 20PEEC 802D MOBILE COMMUNICATION

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC 402 Analog and Digital Communication

**Course Objectives:**
1. To explain the fundamentals of cellular system design and the techniques used to maximize the capacity of cellular network
2. To describe the basics of multi-path fading and various parameters used to characterize small scale fading
3. To explain various multiple access techniques
4. To explore the architecture and call processing of GSM and CDMA system

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Explain the basics and design challenges of cellular networks
CO2 Analyze signal propagation issues and their impact on the communication system performance
CO3 Compare and determine capacity of different multiple access techniques
CO4 Describe the architecture, operation and call processing of GSM system
CO5 Describe CDMA system and analyze it's design parameters

**Unit I: Cellular Fundamentals (10)**
Introduction to wireless Communication Systems, Evolution in cellular standards, Cellular concepts, Frequency reuse, Channel assignment, Handoff, Interference and System capacity, Trunking and Grade of service, Improving coverage and capacity.

**Unit II: Mobile Radio Propagation (10)**
Propagation mechanism, Free space path loss, Fading and Multipath, Small scale multipath propagation, Impulse response model of multipath channel, Parameters of mobile multipath channels, Types of small scale fading, Equalization techniques.

**Unit III: Coding and Multiple Access Techniques for Wireless Communications (06)**
Selection of Speech Coders for Mobile Communication, Linear Predictive Coders, Vocoders, GSM Codec, Multiple Access Techniques, Orthogonal Frequency Division Multiplexing(OFDM), OFDM applications.

**Unit IV: Global System for Mobile Communications (08)**
Evolution of Mobile standards, System Overview, The air interface, Logical and Physical channels, Synchronization, GMSK modulation, Call establishment, Handover.

**Unit V: Code Division Multiple Access (08)**
Basics of spread spectrum, Orthogonal codes, Physical and logical channels of IS-95, Handover mechanism, Factors affecting the performance of CDMA system, Comparison of WCDMA and CDMA 2000, Overview of LTE Standard, Architecture and Frame structure of LTE, Introduction to 5G standard, Comparison between 4G and 5G.

**Text Books:**

1. Theodore S Rappaport**, "Wireless Communications Principles and Practice",** *Pearson Education*, (2nd Edition), (2010).
2. Andrea Goldsmith**, "Wireless Communications",** *Cambridge University Press***,** (1st Edition), (2005)**.**
3. William C.Y. Lee, **"Mobile Communications Engineering: Theory and applications"**, *McGraw-Hill Education*, (2nd Edition), (2017).

**Reference Books:**

1. Vijay K. Garg, Joseph E. Wilkes, **"Principles and Applications of GSM"**, *Pearson Education*, (6th Edition), (2009).
2. *Vijay K. Garg*, **"IS-95 CDMA and CDMA 2000 Cellular/PCS Systems Implementation"**, *Pearson Education*, (1st Edition), (2000).
3. R. Blake, "**Wireless Communication Technology",** *Thomson Delmar*, (1st Edition), (2015).

**Online Resources:**

1. NPTEL Course on **"Introduction to wireless and cellular communication"** https://onlinecourses.nptel.ac.in/noc20_ee61/

# 20OE801B CYBER PHYSICAL SYSTEM

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC404 Embedded System, 20EC603 Control Systems

**Course Objectives:**
1. To introduce modeling of the Cyber Physical System (CPS).
2. To analyze the CPS.
3. To explain the software modules.

**Course Outcomes:**
After completion of the course, students will be able to
1. Categorize the essential modeling formalism of CPS
2. Analyze the functional behavior of CPS based on standard modeling formalisms
3. Apply specific software for the CPS using existing synthesis tools
4. Design CPS requirements based on operating system and hardware architecture constraints

**Unit I: Cyber Physical Systems (CPS) applications and Characteristics (07 )**
CPS in the real world, Basic principles of design and validation of CPS, CPS: From features to software components, Mapping software components to Electronic Control Unit (ECU), CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal methods for Safety Assurance of CPS.

**Unit II: CPS physical systems modeling (07)**
Stability Analysis: CLF (Common Lyapunov function), MLF (Multiple Lyapunov function), stability under slow switching, Performance under Packet drop and Noise.

**Unit III: CPS computer systems modeling (07)**
CPS SW Verification: Frama-C, C Bounded Model Checker (CBMC), Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Hybrid Automata Modelling: Flow pipe construction using Flowstar (Flow*), Polyhedral Hybrid Automaton Verifier (Phaver) tools (Reliability testing).

**Unit IV: Operating systems and hardware architecture support for CPS (07)**
CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques, CPS HW platforms: Processors, Sensors, Actuators, CPS Network.

**Unit V: Analysis and verification of CPS (07)**
Advanced Automata based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, Reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

**Unit VI: CPS case studies (07)**

Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

**Text Books:**


1. Lee, Edward Ashford, and SanjitArunkumarSeshia,**"Introduction to embedded systems: A cyber physical systems approach**", MIT Press, (2nd Edition), (2017).
2. Rajeev Alur, "**Principles of Cyber-Physical Systems**". *MIT Press*, (1st Edition), (2015).
3. Wolf, Marilyn, **"High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing".** *Elsevier*, (1st Edition), (2014).


**Reference Books:**


1. P. Tabuada, **"Verification and control of hybrid systems: a symbolic approach",** Springer-Verlag, (1st Edition), **(**2009).
2. Raj Rajkumar, Dionisio De Niz , and Mark Klein, **"Cyber-Physical Systems**", *SEI Series in Software Engineering*, (1st Edition), (2018).
3. André Platzer, **"Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics",** *Springer*, (1st Edition), (2010).
4. Jean J. Labrosse, **"Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C",** *CRC Press*, (2nd edition), (2011).


**Online Resources:**

1. Coursera course**, Cyber Physical system modelling**
   https://www.coursera.org/learn/cyber-physical-systems

# 20OE801H QUANTUM COMPUTING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS04 Physics, 20BS01 Linear Algebra & Univariate Calculus,20BS03 Multivariate Calculus

**Course Objectives:**
1. To give an introduction to quantum computation
2. To explain the basics of quantum mechanics
3. To analyze quantum circuits using qubit gates
4. To elaborate difference between classical and quantum information theory
5. To explain quantum algorithms
6. To explain noise and error correction

**Course Outcomes:**
After completion of the course, students will be able to
- CO1. Describe the basics of quantum computation
- CO2. Apply the concepts of quantum mechanics
- CO3. Design of quantum circuits using qubit gates
- CO4. Comparison between classical and quantum information theory
- CO5. Utilize quantum algorithms
- CO6. Apply noise and quantum error correction

**Unit I: Introduction to Quantum Computation (03)**
Quantum bits, Bloch sphere representation of a qubit, multiple qubits.

**Unit II: Background Mathematics and Physics (08)**
Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics, Measurements in bases other than computational basis.

**Unit III: Quantum Circuits (08)**
Single qubit gates, Multiple qubit gates, Design of quantum circuits.

**Unit IV: Quantum Information and Cryptography (08)**
Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Quantum Cryptography, No cloning theorem.

**Unit V: Quantum Algorithms (07)**
Classical computation on quantum computers, Relationship between quantum and classical complexity classes, Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.

**Unit VI: Noise and error correction (08)**
Graph states and codes, Quantum error correction, fault-tolerant computation.

**Text Books:**

1. Michael Nielsen and Isaac Chuang, **“Quantum Computation and Quantum Information”**, *CambridgeUniversity Press, UK*, ($10^{th}$ Edition), (2012).
2. Phillip Kaye, Raymond Laflamme and Michele Mosca,**“An Introduction to Quantum Computing”**, *Oxford University Press, UK*, ($1^{st}$ Edition), (2007).

**Reference Books:**

1. N. David Mermin, **“Quantum Computer Science An Introduction”**,*Cambridge University Press*, UK, ($1^{st}$ Edition), (2007).
2. NosonYanofsky and MircoMannucci, **“Quantum Computing for Computer Scientists”**, *Cambridge University Press*, ($1^{st}$ edition), (2008).

**Online Resources:**

**1.** NPTEL Course **“Quantum Computing”**
https://onlinecourses.nptel.ac.in/noc19_cy31/

# 20OE802C AUTONOMOUS ROBOTS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To explain fundamentals of robotic system
2. To introduce kinematics, dynamics and control for robotics systems
3. To introduce trajectory planning for motion
4. To describe application of robots in automation

**Course Outcomes:**

After completion of the course, students will be able to

- CO1 Explain and classify different components used in developing autonomous robot
- CO2 Select sensors, actuators and grippers for autonomous robot
- CO3 Apply formulations to obtain kinematics, dynamics and trajectory planning of autonomous robot
- CO4 Develop path planning and navigation algorithm for autonomous robot
- CO5 Design robot for automation

**Unit I: Introduction to Robotics (10 )**

Definition of robotics, Types of robots, Components of Robot system, Classification of robots , Robot architecture, Robot locomotion, Specification of robot, Robot sensors for position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and robot vision, Actuators and end effectors.

**Unit II: Introduction to Mechanics of Robotic Arm (10)**

Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and inverse kinematic analysis, Dynamics and inverse Dynamics of robots, Newton–Eller formulation, Trajectory and Path planning, Application of robotic arm.

**Unit III: Mobile robot Kinematics and Dynamics (08)**

Forward and inverse kinematics, holonomic and nonholonomic constraints, Kinematic models of simple car and legged robots, Dynamic simulation of mobile robots.

**Unit IV: Localization (06)**

Odometric position estimation, Belief representation, Probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, Positioning beacon systems.

**Unit V: Introduction to Planning and Navigation (08)**

Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm, A-star, D-star, Voronoi diagrams, Probabilistic Road Maps (PRM), Rapidly exploring Random Trees (RRT), Markov Decision Processes (MDP), Stochastic Dynamic Programming (SDP).

**Text Books:**

1. R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).
2. Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).
3. Robin R. Murphy, **"Introduction to Artificial Intelligence for Robotics"**, *The MIT Press*,(2nd Edition), (2000).
4. S. K. Saha, **"Introduction to Robotics"**, *Tata McGraw Hill*, (2nd Edition), (2014).

**Reference Books:**

1. K. S.Fu, R. C. Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence" ,** *Tata McGraw Hill* **,** (2nd Edition), (2008).
2. Robert J. Schilling, **"Fundamentals of Robotics- Analysis and Control",***Prentices Hall India*, (1st Edition), (2008).

**Online Resources:**

1. NPTEL Course **"Wheeled Mobile Robot"**
   https://nptel.ac.in/courses/112/106/112106298/

# 20OE802I Wireless Networks

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks

**Prerequisite:** Nil

**Course Objectives:**
1. To explain the importance of wireless communication and multiple access techniques
2. To elaborate the behavior of communication system for indoor and outdoor wireless networks
3. To introduce 3G, 4G cellular network components and 5G future wireless network
4. To explain MIMO technology
5. To introduce visible light communications

**Course Outcomes:**

After completion of the course, students will be able to
CO1 Explain fundamentals of wireless communication and multiple access techniques
CO2 Analyze the behavior of communication system for indoor and outdoor wireless networks
CO3 Apply 3G, 4G cellular network standards and describe 5G future wireless network
CO4 Interpret MIMO technology its advantages and limitations
CO5 Explain LiFi networking and technology for indoor network access

**Unit I: Introduction to wireless communication (08)**
Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Media, Spread spectrum, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA.

**Unit II: Wireless indoor and outdoor networks (08)**
WLAN, WiFi, Bluetooth, Zigbee, Ultra Wideband communication, Infrared, UHF narrowband, WiMax, Limitation of indoor networks.

**Unit III: Cellular Network (08)**
Spectrum reuse and re-framing, Cell cluster concept, Co-channel and adjacent channel interference, Cell site, call blocking and delay, Channel allocation strategies, 3G and 4G standard.

**Unit IV: Future Wireless networks (10)**
Introduction to 5G, Modulation techniques for 5G, Architecture, MIMO, Massive MIMO, Limitations and applications.

**Unit V: Visible Light Communications (08)**

LiFi Technology, LiFi Networking, LiFi technology for indoor network access, Applications.

**Text Books:**


1. T. Rappaport, "**Wireless Communications - Principles and Practice**", *Prentice Hall* , ($2^{nd}$Edition) , (2011).

2. Vijay Garg, "**Wireless Communications and networking**", *Elsevier*, (1st Edition), (2007).
3. Jonathan Rodriguez, **"Fundamentals of 5G Mobile Networks"**, *Wiley*, (1st Edition),(2015).
4. Mohamed Gado, Doaa Abd El-Moghith, "**Li-Fi Technology for Indoor Access**", *LAMBERT Academic Publishing*, (1st Edition), (2015).

**Reference Books:**

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "**3G Evolution HSPA and LTE for Mobile Broadband"**, *Academic Press*, (2ndEdition) , (2008).
2. Anurag Kumar, D.Manjunath, Joy kuri, "**Wireless Networking**", *Elsevier*, (1st Edition), (2011).
3. Simon Haykin, Michael Moher, David Koilpillai, "**Modern Wireless Communications**", *Pearson Education* , (1st Edition), (2013)
4. Aditya K. Jagannatham, "**Principles of Modern Wireless Communications Systems**", *McGraw Hill Education (India) Private Limited*, (1st Edition), (2016).

**Online Resources:**

1. NPTEL Course on **"Introduction to Wireless and Cellular Communications",** https://nptel.ac.in/courses/108/106/106106167/#
2. NPTEL Course on **"Advanced 3G and 4G Wireless Mobile Communications**", https://nptel.ac.in/courses/117/104/117104099/

# 20EC 801L BROADBAND COMMUNICATION SYSTEMS LAB

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Practical: 2 Hours / Week | In Semester: 25 Marks |
| | Oral : 25 Marks |
| | **Credits: 1** |

**Course Objectives:**

1. To interpret performance parameter of optical fiber
2. To interpret characteristics parameter for optical source and detector
3. To understand aspects of optical fiber communication link
4. To understand satellite communication link

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Compute parameters of optical fiber: Numerical Aperture (NA), attenuation and bending losses

CO2 Illustrate characteristics parameters of optical source and detectors

CO3 Simulate power budget and rise time budget of optical link

CO4 Simulate Satellite scenario to measure BER and PER

**List of Experiments:**

1. Measure numerical aperture of optical fiber.
   Program to compare the acceptance angle for meridional ray and skew rays which change direction by 100 degrees at each reflection.
2. Program to Estimate the a) delay difference between the slowest and fastest modes at the fiber output b) the rms pulse broadening due to dispersion c) the maximum bitrate and bandwidth supported.
3. Program to determine the total carrier recombination lifetime, the power internally generated. Plot V-I characteristics of LED used in optical fiber communication.
4. Program to determine Quantum efficiency and responsivity of photodiodes .
   Compare performance of APD for different load resistors and biasing voltage.
5. Simulate Power budget and Rise time budget analysis of optical fiber system
6. Program to design wavelength channel plan for
   (a) 8 band, 32 channel dense WDM Interleave Waveband Filter band.
   (b) The overall bandwidth of the filter in each case.
7. End-to-End DVB-S2 Simulation with RF Impairments and Corrections.
8. Satellite link design/ Model, Visualize, and Analyze Satellite Scenario.

# 20PEEC 801LA MICROWAVE AND RADAR ENGINEERING LAB

**Teaching Scheme**
Lectures: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To learn reciprocal and non reciprocal passive microwave components.
2 To learn the characteristics of active devices like reflex klystron and Gunn diode.
4. To learn the nature of standing waves formed due to impedance mismatch.
5. To learn the working principle of Radar.

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Measure and Analyze the characteristics of reciprocal and non-reciprocal passive microwave components.
CO2 Analyze the characteristics of various microwave sources like Reflex Klystron and Gunn Diode.
CO3 Analyze Standing waves for various terminations.
CO4 Simulation of Radar to measure range and speed of the target.

**List of Experiments:**

1. Measure and plot mode characteristics of the Reflex klystron.
2. Measurement of the free space wavelength of the microwave (for TE 10 mode) with the help of the X-band microwave test bench and verify with its theoretical calculation.
3. Measure VI characteristics of Gunn Diode and study of PIN modulator.
4. Measure and verify port characteristics of microwave tees (E, H, E-H or magic tee).
5. Measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
6 Measure and verify port characteristics of Isolator and Circulator. Calculate insertion loss and isolation in dB.
7. Measure wavelength of the microwave using a microwave test bench and verify with its theoretical calculations.
8. Plot a standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using a slotted section with probe carriage.
9. To simulate the operation of Radar.

## 20PEEC801LB REMOTE SENSING LAB

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Practical: 2 Hours / Week | In Semester: 25 Marks |
| | Practical: 25 Marks |
| | **Credits: 1** |

**Course Objectives:**

1. To introduce Geographic information system (GIS) software and operations on geo data using Quantum GIS (QGIS)
2. To provide knowledge about collecting and reading remote sensing data
3. To develop programming skills for satellite image analysis
4. To apply digital image processing and machine learning techniques on multispectral and hyperspectral images

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Apply QGIS software for geospatial data analysis

CO2 Choose and apply image pre-processing and enhancement techniques on satellite images

CO3 Collect data from different satellites and apply data analysis steps using Python

CO4 Develop algorithms for clustering and classification of multispectral and hyperspectral images

**List of Experiments:**

1. (a) Introduction to Quantum GIS (QGIS) software, (b) Read and display satellite images, Process raster data and create composites.
2. Implement image enhancement techniques for satellite images.
3. Implement pan-sharpening algorithm on satellite data.
4. Develop an algorithm to perform data analysis on satellite images (Sentinel/Landsat)- Read data, Visualize bands, Plot histogram, Calculate vegetation and soil indices.
5. Develop an algorithm to perform dimensionality reduction and clustering in hyperspectral images.
6. Develop an algorithm for supervised classification in multispectral/hyperspectral images.

# 20PEEC801LC INDUSTRIAL AUTOMATION LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives :**

1. To demonstrate the measurement& control of a physical variable using an appropriate measurement and control circuit
2. To plot the response of Proportional (P), Proportional and Integral (PI) and PID Controllers
3. To introduce interfacing of I/O devices with PLC
4. To develop Ladder Program for Process Control Applications
5. To interface PLC with SCADA

**Course Outcomes :**

After completion of the course, students will be able to

CO1 Detect & control a physical variable using an appropriate measurement & control circuit
CO2 Plot the response of a Proportional, Proportional & Integral and PID Controllers
CO3 Interface I/O devices for a process control application with PLC
CO4 Develop PLC Ladder Programs for Process Control Applications
CO5 Interface PLC with RTU (Remote Terminal Unit) and SCADA

**List of Experiments:**

1. Temperature detection & control using RTD.
2. Temperature detection & control using Thermocouple.
3. Plotting step response of Proportional, Proportional & Integral and PID Controllers ( Matlab based )
4. Interfacing of I/O devices ( eg. Mechanical Switches, Relays ) with PLC
5. Controlling the speed of Servo Motor using an analog voltage of 0-10V
6. Interfacing of PLC to Pneumatic Circuit
7. Developing PLC Ladder Programs for basic logical operations
8. Developing PLC program for a given Process Control Application
9. Interfacing PLC with RTU & SCADA at remote location.

## 20PEEC801LD EMBEDDED AND RTOS LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**
1. Interface real world input and output devices
2. Discuss use of µCOS-II RTOS functions in programming
3. Explain porting of Linux OS

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Interface real world input and output devices
CO2 Apply RTOS concepts to external peripheral devices
CO3 Write C program using RTOS functions
CO4 Port Linux OS in embedded system

**List of Experiments:**
1. Port µCOS-II RTOS on ARM7.
2. Multitasking in µCOS-II RTOS using min 4 tasks on ARM 7
3. Semaphore as Signaling and Synchronizing on ARM 7.
4. Mailbox implementation for message passing on ARM 7.
5. Implement MUTEX on ARM 7.
6. Use OS service(s) to accept keyboard input and display/transmit.
7. Building tool chain for embedded Linux and porting Kernel on ARM 9 target board.
8. Write a program ‘Hello world; using embedded Linux on ARM 9.

# 20PEEC501B MECHATRONICS

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks<br>End Semester: 50 Marks<br>**Credits: 3** |

**Prerequisite:** 20ES 01Basic Electrical and Electronics, 20EC301Electronics Circuit and Applications

**Course Objectives:**
1. To discuss the concepts and key elements of Mechatronics system
2. To explain principles and characteristics of Sensors and Transducers
3. To describe working principle of Hydraulic and Pneumatic systems and its applications
4. To give example of applications of Mechatronics Systems

**Course Outcomes:**
After completion of the course, students will be able to:

CO1 Classify , Compare and Explain functionality of components used to develop Mechatronics systems

CO2 Select specific component such as sensors/transducers and actuators used to develop Mechatronics systems

CO3 Analyze performance, approaches, procedures and results related to components used in Mechatronics System

CO4 Design signal conditioning circuit from the given components for specific task

CO5 Interface Hydraulics and Pneumatics circuit from the given components for specific task

CO6 Design a Mechatronics system for a given task

**Unit I: Elements of Mechatronics Systems (07 )**

Introduction to Mechatronics, Key element/components, Level of Mechatronics system, Phases of Mechatronics design process, Integrated design approach, Advantages, and Disadvantages of Mechatronics systems, Mechanical components: Cam, Gears, Gear-train, Servomechanism and its application.

**Unit II: Sensors and Transducers (12)**

Overview of Sensors and Transducers, Classification and their Characteristics, Temperature measurement using Thermistor, RTD, Themocouple, Semiconductor (AD590, LM35, LM75), Force and Pressure measurement using Strain gauge, Load Cell, Piezoelectric, Differential Pressure Sensor, Displacement and Position measurement using Potentiometer, LVDT, RVDT, Proximity, Optical Encoder, Ultrasonic transducer, LDR and IR Sensors, Level and Flow measurement using Float Level, Capacitive Level sensor, IR Level Sensor, Ultrasonic transducer, Turbine type and Ultrasonic transducer, Vibration and acceleration measurement using Piezoelectric accelerometer, MEMS ICs.

**Unit III: Signal Conditioning (08)**

Signal conditioning: its necessity, Amplification, Filtering and Impedance Matching, Protection, 4-20mA Transmitters and receivers. Design of signal conditioning circuits for sensors and transducers.

**Unit IV: Hydraulic and Pneumatic System** **(06)**

Introduction to Hydraulic and Pneumatic Actuating system, Physical Components of Hydraulic and Pneumatic systems, Types of Actuators/Cylinders and their applications, Comparison of hydraulic and pneumatic systems, Pressure relief Valve, Pressure regulator valve and Directional Control Valve.

**Unit V: Electric Actuators** **(05)**

Selection criteria and specifications of stepper motors, DC motors, Servomotors, Solenoid valves, Solid State relays and Electromechanical relays, Electro-Pneumatic and Electro-Hydraulics Directional Control Valve, Driving circuit for electric actuators and interfacing with microcontrollers.

**Unit VI: Mechatronics Systems Applications** **(04)**

Mechatronics Systems in Automobile, Engine Management systems, Antilock Brake systems (ABS), Washing machine, Pick and place robot, Mobile robot, and Case studies on real life application.

**Text Books:**


1. Bolton W., **"Mechatronics - Electronic systems in Mechanical and Electrical Engineering"**, *Pearson Education Ltd.*, (6th Edition), (2016).
2. K. P. Ramachandran, G. K. Vijayaraghavan and M.S. Balasundaram, **"Mechatronics-Integrated Mechanical Electronic Systems"**, *Wiley Publication*, (1st Edition), (2008).
3. David Alciatore and Maichael B. Histand, **"Introduction to Mechatronics and Measurement Systems"**, *Tata McGraw Hill*, (4th Edition), (2013).


**Reference Books:**


1. Doeblin E.O., **"Measurement System-Application and Design",** *Tata McGraw Hill, New Delhi*,(4th Edition), (2004)
2. Mahalik N. P., **"Mechatronics - Principles, Concepts and Applications",** *Tata McGraw Hill, New Delhi,* (2th Edition), (2014)


**Online Resources:**

1. **NPTEL Course "Mechatronics"**
   http://nptel.ac.in/courses/112103174/
2. **NPTEL Course " Mechatronics"**
   https://nptel.ac.in/courses/112/107/112107298/

# 20PEEC501C DIGITAL IMAGE PROCESSING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BSEC301 Calculus and Probability. 20EC302 Signals and Systems.

**Course Objectives:**
1. To understand the basic concepts of image processing like relations between pixels, distance measures, statistical parameters, colour models, noise models and operations on images
2. To study different image enhancement, segmentation, representation and restoration techniques
3. To study image analysis in spatial and transform domains for image compression and filtering
4. To study different applications of Image processing

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO 1 | Explain basic concepts of image processing, transform domain filtering, image restoration, color models and compression basics |
| CO 2 | Compute distance measures and perform arithmetic, logical, geometric, set and spatial transformation operations on images |
| CO 3 | Apply and analyze spatial domain image enhancement and compression techniques |
| CO 4 | Perform image representation, image segmentation and image classification techniques |
| CO 5 | Apply morphological operations on an image and select appropriate image processing modules to develop an image processing application |

**Unit I: Digital Image Fundamentals and Operations on Images (08)**

Components of Image Processing System, Basic image processing classes, Element of Visual Perception, Sampling and Quantization, Relationship between pixels and Distance Measures, Statistical parameters, Basic operations on images, Morphological image processing, dilation, erosion, opening, closing.

**Unit II: Image Enhancement (09)**

Image Enhancement in Spatial Domain, Point, mask and global operations, Basic Gray Level transformations, Histogram, histogram equalization, Basics of Spatial Filtering, Smoothing, linear and non-linear filters, Sharpening filters, First and Second order derivatives, Image filtering in Frequency Domain, Low pass, High pass, Correspondence between Filtering in Spatial and Frequency Domain.

**Unit III: Image Transforms and Colour Models (08)**

Colour Image Processing, Colour Fundamentals, Colour Models, Pseudocolouring, Converting Colours to different models, Need for compression, Data Redundancies, Image Compression Model, Lossy and Lossless compression, 2-D Discrete Fourier Transform, Discrete Cosine Transform, JPEG compression.

**Unit IV: Image Segmentation, Representation and Classification (09)**

Image analysis, Detection of discontinuities, edge linking and boundary detection, thresholding, region-based segmentation, image representation, boundary representation by chain codes, Fourier descriptors, Shape number, Signatures, Types of classification algorithms, K-Nearest Neighbours, K-means, Decision Tree.

**Unit V: Image Restoration and Applications of Image Processing (08)**

Image restoration, Restoration model, Degradation causes, Noise models, Inverse filter, Weiner filter, Fingerprint recognition, Character recognition, Face recognition, Medical applications, Remote sensing, CBIR.

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, "**Applications of Image Processing and Morphological Image Processing**", *Pearson Education*, (2nd Edition), (2012).
2. S. Jayaraman, Esakkirajan, Veerakumar, **"Digital Image Processing"**, *McGraw Hill Education*, (1st Edition,), (2012).

**Reference Books:**

1. Anil Jain, **"Fundamentals of Digital Image Processing"**, *Prentice Hall*, (1st Edition), (1989).
2. Pratt W. K**, "Digital Image Processing",** *John Wiley*, (2nd Edition), (2001).

**Online Resources:**

1. **NPTEL Course "Digital Image Processing"**
   http://nptel.ac.in/courses/117/105/117105135/
2. **NPTEL Course " Digital Image Processing"**
   https://nptel.ac.in/courses/117/105/117105079/

# 20PEEC501D INTRODUCTION TO INTERNET OF THINGS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC404 Embedded Systems

**Course Objectives:**

1. To explore various components of Internet of Things such as Sensors, internetworking and cyber space
2. To design Internet of Things circuits and solutions

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Apply concepts to explain Internet of Things (IoT) architecture, protocols, models and devices used to develop IoT systems
CO2 Identify appropriate protocols, models and devices to develop IoT system
CO3 Compare and contrast IoT and M2M, IoT physical devices, networking and protocols techniques
CO4 Design IoT system for the given application

**Unit I: Introduction to Internet of Things (07)**
Internet of Things fundamentals: Sensing, Actuation, Internet of Things (IOT) Architecture and protocols: Communication Protocols, Sensor Networks, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Challenges in IOT, Communication models and APIs; IoT Enabling Technologies.

**Unit II: Machine to Machine to Internet of Things (08)**
The Vision-Introduction, From machine to machine (M2M) to Internet of Things (IoT), M2M towards IoT-the global context, Case study, Differing characteristics between M2M and IoT, Definitions, M2M Value Chains, Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards consideration, IoT Value Chains, Industrial IoT (IIoT).

**Unit III: IOT Physical Devices and Objects (08)**
Introduction to IoT tools, Implementation of IoT with Arduino and Raspberry-Pi, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

**Unit IV: IOT Networking and Addressing techniques (07)**
RFID technology, Wireless Sensor Networks, IPv6 Protocol Overview, comparison of IPv4 and IPv6, IPV6 tunneling, IPsec in IPv6, Quality of Service in IPv6

**Unit V: IOT Protocols and Cloud offerings (07)**
IoT Access Technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, LoRaWAN, MQTT protocol, Introduction to cloud storage models and communication API's, web services for IoT.

**Unit VI: Domain Specific Applications of Internet of Things** **(05)**

Home automation - hardware approach - Industry applications, Surveillance applications.

**Text Books:**


1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, **"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",** *Academic Press*, **(**1st Edition), (2014).
2. Vijay Madisetti and Arshdeep Bahga, **"Internet of Things (A Hands-on-Approach)",** *VPT* , (1st Edition), (2014).
3. Francis da Costa, **"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything",** *Apress Publications*, (1st Edition), (2013).
4. Cuno Pfister, "**Getting Started with the Internet of Things**", *O'Reilly Media*, (1st Edition), (2011).


**Reference Books:**


1. Honbo Zhou, **"The Internet of Things in the Cloud: A Middleware Perspective",** *CRC Press*, (1st Edition), (2012)
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), **"Architecting the Internet of Things",** *Springer*, (1st Edition), (2011)
3. Olivier Hersent, David Boswarthick, Omar Elloumi , **"The Internet of Things – Key Applications and Protocols",** (1st Edition), *Wiley*, (2012)


**Online Resources:**

1. NPTEL Course "**Introduction to IOT"**
   https://nptel.ac.in/courses/106/105/106105166/

# 20PEEC501LC DIGITAL IMAGE PROCESSING LAB

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 2 Hours / Week | In Semester: 25 Marks |
| | Practical :25 Marks |
| | **Credits: 1** |

**Course Objective**

1. To practice the basic image processing techniques
2. To explore digital image enhancement techniques in spatial and transform domain
3. To understand image compression, colour model conversions, segmentation and restoration techniques
4. To explore the applications using image processing techniques

**Course Outcome**

After completion of the course, students will be able to

CO1 Perform basic operations and computations on images
CO2 Implement algorithms for image enhancement and image filtering
CO3 Perform image compression and colour model conversion
CO4 Apply image segmentation and restoration techniques
CO5 Develop an algorithm/application using various image processing techniques

**List of Experiments: Matlab/Python**

1. Perform basic operations on images (Create image/ operations/ distance measures).
2. Perform a) Histogram equalization b) Spatial domain filtering.
3. Perform a) DCT of an image b) Colour model conversion.
4. Perform Image segmentation (thresholding/region based) techniques
5. Perform Morphological operations on images / Wiener filtering.
6. Implement a Mini project (Application/algorithm) in image processing.

# 20EC501LD INTRODUCTION TO IOT LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
ISE: 25 Marks
Practical:25 Marks
**Credits: 1**

**Course Objectives**

1. To learn use of sensors and actuators in IOT
2. To learn IOT devices and protocols
3. To build an IOT application

**Course Outcome**

After completion of the course, students will be able to

CO1 Select sensors and actuators in IOT application
CO2 Interface sensors and actuators with IoT development module
CO3 Develop a program to monitor and control by using web server
CO4 Develop an IOT system for given application

**List of Experiments:**

1. Introduction to various sensors and various actuators & its Application.
   a) PIR Motion Sensor.
   b) Float Sensor.
   c) Moisture Sensor.
   d) Temperature Sensor.
   e) Touch Sensor.
   f) Infrared Sensor.
   g) Servo Motor
   h) RFID Sensor
   i) Humidity sensor
2. Introduction to ESP32 and Arduino IDE/Visual Studio Code.
3. Write a program to measure sensor data and display on serial monitor.
4. Write a program to control Actuators.
5. Write a program to control Actuators based on real time sensor data.
6. Implement a standalone web server using of ESP32.
7. Develop a web application through ESP32.
8. Mini Project: Develop an IoT system for given application.

# 20PEEC601A ROBOTICS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To explain fundamentals of robotic system
2. To introduce kinematics, dynamics and control for robotics systems
3. To introduce trajectory planning for motion
4. To describe application of robots in automation

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Classify, Compare and Explain functionality of components used to develop robots |
| CO2 | Select sensors, actuators and grippers for developing robots. |
| CO3 | Apply formulations to obtain kinematics, dynamics and trajectory planning of manipulator |
| CO4 | Explain path planning algorithms for robotic system |
| CO5 | Analyze components, robot mechanics and algorithm used to develop robots |
| CO6 | Build a Robotic system to perform a given task. |

**Unit I: Introduction to Robotics (06 )**
Definition of robotics, Components of Robot system, Classification of robots based on co-ordinate systems, Degrees of freedom, Links and Joints, Robot Specifications

**Unit II: Robotic Sensors, Actuators and End Effectors (10)**
Classification of sensors, Internal and External sensors, Position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and Robot vision, Overview of actuators: Electric, Pneumatic and Hydraulic actuators, Classification of End Effectors and Types of Gripper.

**Unit III: Transforms and Kinematics (07)**
Pose of rigid body, Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and Inverse Kinematic Analysis.

**Unit IV: Dynamics and Trajectory (07)**
Dynamics and Inverse Dynamics of robots, Link inertia tensor and manipulator inertia tensor, Newton – Eller formulation. Trajectory planning, Joint space planning, Cartesian space planning and Position and Orientation trajectories.

**Unit V: Robot Programming Methods (08)**
Robot language classification, Robot language structure, Online and Offline Programming, Line Following Algorithms, Robot Navigation, Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm.

**Unit VI: Application of Robot in Automation (04)**

Application in Manufacturing: Material Transfer, Material handling, loading and unloading processing, spot and continuous arc welding & spray painting, Robot application in Medical, Progressive advancements in robots, Present trends and future trends in robotics.

**Text Books:**

1. S.K. Saha, **"Introduction to Robotics",** *Tata McGraw Hill*, (2nd Edition), (2014).
2. R. K. Mittal, I. J. Nagrath**, "Robotics and Control",** *Tata McGraw Hill, New Delhi"***,** (1st Edition), (2003).
3. K.S. Fu, R.C .Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence",** *Tata McGraw Hill* **,** (2nd Edition), (2008).
4. R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).

**Reference Books:**

1. Robert Schilling, **"Fundamentals of Robotics: Analysis and Control",** *PHI. New Delhi*, (1st Edition), (2003).
2. S. R. Deb**, "Robotics Technology and Flexible Automation",** S. Deb, Tata McGraw Hill, (1st Edition), (2010).
3. Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).

**Online Resources:**

1. **NPTEL Course " Mechanics and Control of Robot Manipulator"**https://onlinecourses.nptel.ac.in/noc21_me108/
2. NPTEL Course **" Wheeled Mobile Robot"** https://nptel.ac.in/courses/112/106/112106298/

## 20PEEC601B  BIOMEDICAL ELECTRONICS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC302Signals and systems, 20EC404Embedded Systems, 20EC302Digital signal processing

**Course Objectives:**
1. To explain and analyse important organ systems in a human body
2. To understand different diagnostic and lifesaving biomedical equipment
3. To introduce AI/ML techniques used in Biomedical Applications
4. To explore signal conditioning and processing system for real life biosignals

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Explain and analyse important organ systems in a human body
CO2 Compare different diagnostic and lifesaving biomedical equipment
CO3 Develop a signal conditioning and processing system for real life biosignals
CO4 Select the appropriate AI/ML techniques for Reference biomedical signals

**Unit I: Human Anatomy and Biomedical Electronic System (04 )**
Organ systems: Cardiovascular System, Nervous System and Respiratory System, Cell, Nerve cell, Action Potential, Introduction to Biomedical Electronics system, its advantages and applications.

**Unit II: Biomedical Sensors, Signal Acquisition and Processing (10)**
Transducers and Sensors: Temperature transducers, Infrared radiation thermometers, Clinical thermometers, Pressure transducers: Strain Gauge for pressure measurement, SpO2 sensor, Sources of Biomedical Signals, Classification of Biomedical Signals, Bioelectric signals like ECG, EEG, EMG and EOG. Recording Electrodes, Motion artefacts, Electrodes for EEG, ECG and EMG, Isolation amplifiers, Differential Amplifiers, Instrumentation Amplifiers, Analysis of non-stationary signals, Time-variant system, Short time Fourier transform, Multi resolution Analysis (Wavelet), Introduction to Adaptive filters and its applications.

**Unit III: Cardiovascular System (06)**
Anatomy of Heart, Conducting system of the heart, Lead Configuration to acquire ECG, Einthoven Triangle, ECG Machine, Normal rhythm and Rhythm Abnormality (Arrhythmia), Heart Sounds (Phonocardiograph), Blood Pressure Measurement, Echocardiography.

**Unit IV: Central Nervous System(CNS) and Peripheral Nervous System(PNS) (06)**
Functional Components of a Human Nervous System, Electroencephalogram (EEG), Types and Significance of EEG Signal, 10-20 Electrode Placement System, Evoked Potential, EEG Machine, EEG Amplifier and Filters, EEG applications: Epilepsy, Sleep disorder and Human Brain-Computer Interface (HCI/BCI), Sensory (Pain, temp, touch, pressure) and Motor components , Muscles and EMG.

**Unit V: Biomedical Equipment (08)**

ICU equipment: Bedside Monitors, Central Monitoring System, Diagnostic Equipment: Block diagram of X-Ray machine, CT Scan and MRI machines, Ultrasound Imaging, Life saving equipment: Pacemakers, Defibrillators and Ventilators

**Unit VI: Applications of AI and ML Techniques in Biomedical Field (08)**

Overview of AI/ML (SVM, Clustering, KNN) techniques and Neural Networks, Representation of biomedical signals, Data exploration and processing, Applications to image analysis (X-rays) and Time-series (ECG and EEG signals)

**Text Books:**

1. Joseph J. Carr and John M. Brown, **"Introduction to Biomedical Equipment Technology"**, *Prentice Hall India*, ($4^{th}$ Edition), (2000).
2. R. Rangayyan, **"Biomedical Signal Analysis"**, *Wiley India Pvt. Limited*, ($1^{st}$ Edition), ( 2002).
3. R. S. Khandpur**, "Handbook of Biomedical Instrumentation",** *Tata McGraw Hill*, ($2^{nd}$ Edition), (2003).

**Reference Books:**

1. D. C. Reddy **"Biomedical Signal Processing: Principles and techniques",** *Tata McGraw*, ($1^{st}$ Edition), (2005).
2. Bruce, **"Biomedical Signal Processing & Signal Modeling",** *Wiley India Pvt. Limited*, (Wiley student edition), (2009).
3. John L. Semmlow, **"Bio-signal and Medical Image Processing",** *CRC Press*, ($2^{nd}$ Edition), (2009).

**Online Recources:**

1. NPTEL Course **"Biomedical Signal Processing"** https://nptel.ac.in/courses/108/105/108105101/:

# 20PEEC601C POWER ELECTRONICS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To explain the power devices structure and characteristics
2. To study electrical motors and use power converters to control motor speed
3. To analyze the power converters
4. To calculate the performance parameters of power converters
5. To explain power converter applications

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Describe the structure of power devices and their characteristics
CO2 Explain the construction and characteristics of electrical motors
CO3 Analyse power converters and determine their performance parameters
CO4 Select and justify the use of suitable power converter for the given application

**Unit I: Power Devices (07)**

SCR, Power MOSFET, IGBT: Construction, Turn on mechanism, Static and Dynamic Characteristics, Gate drive circuits, Isolation techniques, SCR specifications and ratings, Gate-cathode characteristic, Line and Forced commutation.

**Unit II: Introduction to Motors (06)**

DC motors (Shunt and Series): Working principle, Load characteristics, Speed-torque characteristic, Field control of series motor, Motoring and braking principle, Induction motor: Speed-torque characteristic, Operation of induction motor from non-sinusoidal supply, Basic blocks of drives.

**Unit III: Phase Controlled Rectifiers (10)**

Analysis of single-phase semi converters and full converters for R and R-L, R-L-E load, Quadrant operation of converter, Effect of freewheeling diode, Performance parameters, Fourier analysis of supply current, Three phases converters for R load, Speed control of dc motor using phase-controlled rectifiers.

**Unit IV: AC Voltage Controllers (05)**

Single Phase AC voltage controller for R and R-L load, Three Phase AC voltage controller for R load, Light dimmer, Induction heating.

**Unit V: Inverters (08)**

Single-phase half bridge and full bridge inverters for R and R-L load and their performance parameters, Three phase bridge inverters for R load (120° and 180° mode operation),
PWM inverters, Single pulse and multiple pulse inverters, Stator voltage control and variable frequency control of induction motors using VSI, ONLine and OffLine UPS.

**Unit VI: Choppers** **(06)**

Step-down chopper with R and R-L load, Step-up chopper for R load, Control strategies for output voltage control, Two quadrant and Four quadrant choppers, Motoring and braking of dc motor using chopper, SMPS.

**Text Books:**


1. M. H. Rashid, **"Power Electronics Circuit, Device and Application",** *Prentice Hall* **(***PHI),* (3rd Edition), (2009).
2. M. D. Singh and K. B. Khanchandani, **"Power Electronics",** *Tata McGraw-Hill,* (2nd Edition), (2008).
3. Nagarath, D. P. Kothari, "**Electrical machines"**, *Tata McGraw-Hill,* (3rd Edition), (1998).
4. Ned Mohan, T. M. Undeland, and W.P. Robbins, **"Power Electronics Converter Application and Design",** *John Wiley and Sons,* (3rd Edition), (2009).
5. Vedam Subramhanyam, **"Electric drives-Concepts and Applications",** *Tata McGraw-Hill,* (2nd Edition), (2011).


**Reference Books:**


1. M. S. Jamil Asghar, **"Power Electronics",** *Prentice Hall* **(***PHI), New Delhi,* (1st Edition), (2011).
2. P. C. Sen, **"Power Electronics"**, *John Wiley and Sons,* (1st Edition), (2008).


**Online Resources:**

1. **NPTEL Course "Power Electronics"** https://nptel.ac.in/courses/108/105/108105066/
2. **NPTEL Course "Fundamentals of Electric Drives"**https://nptel.ac.in/courses/108/104/108104140/

# 20PEEC601D DEEP LEARNING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC403 Machine  Learning with Python

**Course Objectives:**

1. To introduce basic concepts and learning algorithms of Artificial Neural Networks
2. To become familiar with feedforward and recurrent neural networks
3. To build CNN model and elaborate effects of hyperparameters on its performance
4. To get detailed insight of deep learning algorithms and their applications to solve real world problems

**Course Outcomes:** *

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain basic concepts of neural network and its learning algorithms |
| CO2 | Calculate feature map dimensions and learnable parameters in Convolutional Neural Network (CNN) |
| CO3 | Analyze effects of hyperparameter tuning on the performance of L-layer deep networks and interpret results |
| CO4 | Solve image recognition and classification problems using pretrained CNN architectures |
| CO5 | Compare recurrent neural networks, their types for sequence data processing and explain gradient issues |
| CO6 | Design a deep neural network architecture to solve real-world problems |

**Unit I: Basics of Artificial Neural Network (09)**

Biological neuron, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron learning algorithm, Linear separability, Activation functions, Feedforward networks: Multilayer Perceptron, Gradient Descent, Backpropagation

**Unit II: Deep Neural Networks (09)**

Deep feedforward networks, Architecture design, Gradient based learning, Vanishing and exploding gradients, Regularization, Optimization methods (AdaGrad, AdaDelta, RMSProp, Adam, NAG) for training deep models, Hyperparameters.

**Unit III: Convolutional Neural Networks (09)**

Building blocks of Convolutional Neural Network (CNN), Convolution operation and layer, Kernels and Filters, Pooling layer, Stacking of layers, Cross-validation, Data augmentation, Transfer learning, Modern CNN architectures: AlexNet, VGGNet, GoogLeNet, ResNet, Autoencoder.

**Unit IV: Sequence Modeling (09)**

Recurrent Neural Network (RNN), Types of RNN, Bidirectional RNNs, Back propagation through time (BPTT), Vanishing Gradients with RNNs, Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM).

**Unit V: Applications of Deep Learning (06)**

Applications of CNN: Object recognition, Image classification.
Applications of RNN: Speech, language, and text processing.

**Text Books:**

1. Laurene Fausett, **"Fundamentals of Neural Networks: Architectures, Algorithms and Applications"**, *Pearson Education*, (1st Edition), (2008).
2. S. N. Sivanandan and S. N. Deepa, **"Principles of Soft Computing"**, *Wiley India*, (2nd Edition), (2011).
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, **"Deep Learning"**, *MIT Press*, (1st Edition), (2016).
4. Josh Patterson and Adam Gibson, **"Deep Learning- A Practitioner's Approach"**, *O'Reilly Media*, (1st Edition), (2017).

**Reference Books:**

1. Francois Chollet, **"Deep Learning with Python"**, *Manning Publications*, (1st Edition), (2018).
2. Phil Kim, **"MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence"**, *Apress*, (1st Edition), (2017).

**Online Resources:**

1. NPTEL Course **"Fuzzy Logic and Neural Networks"**
   https://onlinecourses.nptel.ac.in/noc21_ge07/preview
2. NPTEL Course **"Deep Learning"**
   https://onlinecourses.nptel.ac.in/noc21_cs76/preview

# 20PEEC601LA ROBOTIC LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester : 25Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To demonstrate robot working and degree of freedom using physical components
2. To demonstrate robot functioning using simulation software
3. To design microcontroller based robotic system for specific task

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Explain mechanical configuration of robot manipulation
CO2 Select sensors and actuators used in robot manipulation
CO3 Apply formulation to simulate to obtain work space, kinematics, Dynamics and trajectory path of robot manipulator
CO4 Develop robot for specified task

**List of Experiments:**

1. Velocity and Position measurement using optical encoder.
2. Interface Pneumatic system component to actuate single acting and double acting cylinders.
3. Plot of work space of 2-link planer arm using simulation software.
4. Simulation of Forward Kinematics and Inverse Kinematic of
    1. 3-Link Robot
    2. PUMA 560 Robots.
5. Simulation of Dynamics of 3 link robot
6. Simulation of Trajectory and Path planning of :
    1. 3-Link Robot
    2. PUMA 560 Robots.
7. Hardware simulation of 3 Link robotic arm.
8. Design Robot for any application.

## 20PEEC601LB BIOMEDICAL ELECTRONICS LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In Semester : 25Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To understand signal acquisition of some of the bio signals
2. To explore and select appropriate signal conditioning techniques
3. To study different AI/ML techniques for analysis and automatic classification

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Compare the performances of different sensors used in Biomedical Applications
CO2 Select and Apply appropriate signal conditioning techniques to the different biomedical signals
CO3 Implement spectral analysis techniques on Biomedical signals
CO4 Develop a microcontroller based system to acquire the real life biosignal and perform analysis of the same

**List of Experiments:**

1. Temperature measurement using AD590 / LM35/Digital sensor
2. Measure ECG and Heart rate (photoelectric transducers/ finger plethysmography) : Normal and after exercise, Raw signal and after signal conditioning
3. Measure EMG for different muscles while performing any actions
4. Measurement of unknown resistance by using a Strain Gauge/Load cell in the Wheatstone bridge and finding the sensitivity of the bridge
5. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument (Test points on a Trainer kit). Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP)
6. Use of AI/ML techniques for analyzing the spectrum of ECG/EEG/PCG signals
7. Open ended assignment

# 20PEEC601LC POWER ELECTRONICS LAB

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Practical: 2 Hours / Week | In Semester : 25Marks |
| | Practical: 25 Marks |
| | **Credit: 1** |

**Course Objectives:**

1. To demonstrate torque-speed characteristic of dc and ac motors
2. To analyze synchronization in gate drive circuits of the power converters
3. To demonstrate the applications of power converters
4. To compare the output voltage waveforms of power converters for R and R-L loads
5. To examine the power converter using simulation tool

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Test synchronization in gate drive circuits of power converters
CO2 Analyse the output of power converters for different values of firing angles and duty cycles
CO3 Apply power converters for speed control of motors
CO4 Analyse the power converter performance using simulation tool

**List of Experiments:**

1. Plot torque-speed characteristics of the DC motor and Induction motor.
2. Simulation of half controlled bridge rectifier and testing the effect of firing angle change on the output.
3. Speed control of a DC motor using a half controlled bridge rectifier circuit.
4. Analysis of the output of a single phase fully controlled bridge rectifier for R, R-L load and R-L with flywheel diode.
5. Test the gate drive circuit and analyse the effect of change of duty cycle on the output of Step-down chopper. Analyse the effect of using a filter at the output.
6. Simulation and analysis of full bridge inverter.
7. Analyse the waveforms of the triggering circuit, output of power circuit and measure the output voltage of ac voltage controller.
8. Speed control of induction motor using ac to ac converter/ inverter.

# 20PEEC601LD DEEP LEARNING LAB

**Teaching Scheme**
Practical: 2 Hours /Week

**Examination Scheme**
In Semester : 25Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To implement Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN)
2. To get familiar with deep learning frameworks and Python libraries used for Deep Learning
3. To apply ANN, CNN and RNN algorithms to solve real-world problems

**Course Outcomes:**

After completion of the course, students will be able to-

| | |
|---|---|
| CO1 | Apply neural network learning methods and transfer learning for classification/regression applications |
| CO2 | Select a suitable Convolutional Neural Network architecture and hyperparameters to solve real-world image classification, object recognition problems |
| CO3 | Develop an algorithm for text processing and time series prediction using Recurrent Neural Networks and Long Short-Term Memory |
| CO4 | Analyze performance of Deep Learning models based on different evaluation metrics |

**List of Experiments:**

1. Introduction to Python libraries (Keras, TensorFlow) for deep learning.
2. Write a program to implement a Perceptron learning algorithm.
3. Write a program to perform classification (on Kaggle dataset) using Backpropagation.
4. Develop an algorithm and write a program for image classification using Convolutional Neural Network.
5. Write a program to implement image recognition using transfer learning.
6. Develop an algorithm and write a program for object detection using Convolutional Neural Network.
7. Develop an algorithm and write a program to predict the stock prices based on historic data using Long Short-Term Memory/ Gated Recurrent Unit.
8. Develop an algorithm and write a program for text preprocessing and text summarization using Recurrent Neural Network.

# 20OE601B AUTOMOTIVE ELECTRONICS

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**
1. To explain the operation of basic automotive System components
2. To discuss sensors and actuators in automotive applications
3. To describe the system view of automotive control systems and In-vehicle Communication Protocols
4. To introduce diagnostic methodologies and safety aspects in automotive system

**Course Outcomes:**
After completion of the course, students will be able to:
CO1. Explain the functioning of automotive systems
CO2. Identify key components of automotive control systems and represent in terms of block diagram
CO3. Develop a model for simple systems using model based development.
CO4. Compare communication protocols, safety systems and diagnostic systems

**Unit I: Fundamentals of Automotive Systems** **(10)**

Overview of an Automotive System, Basics of Spark Ignition, Compression Ignition Engines, Need of Electronics in Automobiles, Ignition systems, Transmission systems, Suspension system, Braking system, Steering system, Fuel Delivery system, Alternator and battery charging circuit, Basics of Hybrid Electric Vehicles.

**Unit II: Automotive Sensors, Actuators, Control Systems** **(08)**

Systems approach to Control and Instrumentation: Concept of a system, Analog and Digital system, Basic Measurement system, Types of Control Systems, Sensor Characteristics, In-vehicle Sensors: Air flow sensing, Crankshaft Angular Position sensing, Throttle angle sensing, Temperature sensing, EGO sensor, Vibration sensing (in Air Bags), Actuators: Fuel injector, EGR actuator, Ignition system, Variable Valve Timing (VVT), BLDC motor, Electronic Engine Control, Engine Management System strategies for improving engine performance and efficiency.

**Unit III: Microcontrollers / Microprocessors in Automotive Domain, Model Based Development** **(09)**

Critical review of Microcontroller / Microprocessor (Architecture of 8-bit /16-bit Microcontrollers with emphasis on Ports, Timers/Counters, Interrupts, Watchdog Timer and PWM ), Criteria to choose the appropriate microcontroller for automotive applications, Automotive grade processors, Fuel Maps and Ignition Maps, Introduction to Model Based Development.

**Unit IV: Automotive Communication Protocols** **(07)**

Overview of Automotive Communication Protocols, CAN, LIN, FLEXRAY, MOST, Communication Interface with ECUs, Interfacing with infotainment gadgets, Application of telematics in automotive domain: GPS and GPRS, Relevance of Protocols such as TCP/IP, Bluetooth, IEEE 802.11x standard, in automotive applications.

**Unit V: Safety Systems in Automobiles, Diagnostics, Standards (08)**

Active Safety Systems: Anti-lock Braking System (ABS), Traction Control System, Electronic Stability Program, Passive Safety systems: Airbag System, Advanced Driver Assistance System (ADAS), Anti-theft systems, Fundamentals of Diagnostics, Self Diagnostic System, On-Board Diagnostics and Off-Board Diagnostics, Importance of Reliability in Automotive Electronics, Reliability Testing with example, Environmental and EMC Testing for Automotive Electronic Components, ISO, IEC and SAE Standards.

**Text Books:**


1. Williams B. Ribbens, **"Understanding Automotive Electronics"**, *Newnes,* ($7^{th}$Edition), (2003).
2. Robert Bosch, **"Automotive Electronics Handbook"**, *John Wiley and Sons,* ($1^{st}$Edition), (2004).


**Reference Books:**


1. Ronald K Jurgen, **"Automotive Electronics Handbook",** *McGraw-Hill,* ($2^{nd}$ Edition), (1999).
2. James D Halderman, **"Automotive Electricity and Electronics",** *PHI Publication* , ($1^{st}$ Edition), (2005).
3. Tom Denton, **"Automobile Electrical & Electronic Systems",** *Routledge,* ($4^{th}$Edition), (2002).
4. Tom Denton, **"Advanced Automotive Diagnosis",** *Elsevier,*($2^{rd}$ Edition), (2006).
5. V.A.W. Hillier, **"Fundamentals Automotive Electronics",** *Oxford University Press,* ($6^{th}$ Edition), (2014).
6. Mehrdad Ehsani, Ali Emadi, Yimin Gao, **"Modern Electronic, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press,* ($2^{nd}$ Edition), (2009).
7. Terence Rybak, Mark Steffka, **"Automotive Electromagnetic Compatibility (EMC)"**, *Springer,* (2004).


**Online Resources:**

1. **NPTEL Course "Fundamentals of Automotive Systems"**
   https://onlinecourses.nptel.ac.in › noc20_de06 › preview

# 20OE601E COMPUTER VISION

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**20EC501 Digital Signal Processing

**Course Objectives:**
1. To introduce major ideas, methods and techniques of Computer Vision algorithms
2. To introduce fundamentals of Image formation
3. To explain concepts of Camera Calibration and Stereo Imaging
4. To explain different Background Subtraction techniques and Motion tracking algorithms

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Explain the fundamentals of Image formation, Camera calibration parameters and Stereo Imaging

CO2 Apply camera calibration concepts to calculate intrinsic and extrinsic parameters of camera

CO3 Explain different Background Subtraction techniques and Calculate the Performance measures of it.

CO4 Select the appropriate feature extraction techniques according to the requirement of the applications

CO5 Analyze the appropriate Background Subtraction techniques and Object tracking algorithms according to the requirement of the applications

**Unit I: Digital Image Processing Fundamentals (13)**
Digital image formation and low-level processing; overview and state of art, Fundamentals of image formation, geometric primitives and transformations, camera model, introduction to stereo imaging, image enhancement, histogram processing, image segmentation.

**Unit II: Visual Features and Representations (11)**
Edge, Corner Detection, Blob detection (DoG,LoG), Gray Level Co-occurrence Matrix,Histogram of Oriented Gradient,Scale Invariant Feature Transform.

**Unit III: Visual Features and Representations (09)**
Edge, Blobs, Corner Detection, SIFT, SURF, HoG.

**Unit IV: Background Subtraction Techniques for Moving Object Detection (09)**
Frame differencing, Mean and Median filtering, Gaussian Mixture Model (GMM), Kernel density estimation, Applications.

**Unit V: Motion Tracking (09)**
Motion tracking using Optical flow, blob tracking, Colour feature based mean shift, Kalman tracking, Applications.

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, "**Digital Image Processing**", *Pearson Education*, (4th Edition).
2. D. Forsyth, J. Ponce, **"Computer Vision, A Modern Approach"**, *Prentice Hall*, (2nd Edition), (2003).
3. R. Szeliski, **"Computer vision algorithms and applications",** *Springer-Verlag*, (2nd Edition), (2010).

**Reference Books:**

1. L. G. Shapiro, George C. Stockman**, "Computer Vision"**, *Prentice Hall*, (1st Edition), (2001).
2. E. Trucco, A. Verri, **"Introductory Techniques for 3-D Computer Vision"**, *Prentice Hall*, (1st Edition), (1998)
3. D. H. Ballard, C. M. Brown, **"Computer Vision"**, Prentice Hall, (1st Edition), (1982).
4. M. Sonka, V. Hlavac, R. Boyle, **"Image Processing, Analysis, and Machine Vision",** *Thomson Press*, (3rd Edition), (2011).

**Online Resources:**

NPTEL Course **"Computer Vision"**

1. https://nptel.ac.in/courses/106/105/106105216/
2. http://www.ai.mit.edu/projects/vsam/Publications/stauffer_cvpr98_track.pdf
3. https://people.cs.rutgers.edu/~elgammal/pub/ieeeproc-paper-final.pdf
4. http://www.cs.cmu.edu/~16385/s15/lectures/Lecture24.pdf

# 20OE601K MULTIMEDIA SYSTEMS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
ISE: 50 Marks
ESE: 50 Marks
**Credits: 3**

**Prerequisite:**20EC402 Analog and Digital Communication

**Course Objectives:**

1. To introduce basic concepts and design of Colour TV and Digital TV
2. To explain advanced TV technologies like HDTV, CATV, CCTV, DTH, CAS and case study for live telecast
3. To introduce multimedia compression techniques, standards and multimedia over the internet
4. To familiarize the students with digital recording and playback systems, acoustic design, microphones and loudspeakers

**Course Outcomes:**

After completion of the course, students will be able to

- CO1 Explain the concepts of colour TV design, systems and Digital TV
- CO2 Discuss and compare advanced TV systems like CATV, CCTV, DTH, HDTV, CAS, Wi-fi TV, 3DTV and different display technologies
- CO3 Apply and analyze multimedia compression standards for text, audio, image and video and explain multimedia over the internet
- CO4 Compare optical recording techniques, microphones and loudspeakers
- CO5 Design acoustics and PA system for auditorium, public meeting, debating hall, football stadium and college classrooms

**Unit I: Colour and Digital TV (11)**

Resolution, interlaced scanning, BW, CVS, Color TV systems, frequency interleaving, colour difference signals, colour TV receiver, NTSC, PAL, SECAM encoders and decoders, Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters and receivers.

**Unit II: Advanced TV Systems (10)**

HDTV standards and systems, HDTV transmitter and receiver, CCTV, CATV, Direct to Home TV (DTH), Set top box, Conditional Access System (CAS), 3D TV systems, Case study (Cricket match, Marathon, Football match), Wi-Fi TV, Video door phone systems, Display devices: LED, LCD, Plasma.

**Unit III: Multimedia Compression and Multimedia over Internet (11)**

Introduction, Overview, Concept of Multimedia, Multimedia Applications, Text: Types, Compression, Hypertext, Image Compression techniques: JPEG, Multimedia Audio: MIDI, MP3, Video: MPEG, Animation: Introduction, types, 3D animation, Virtual reality, Multimedia over Internet**:** Introduction to Multimedia Services, Transmission of Multimedia over the Internet, IP Multicasting, Explaining VOIP.

**Unit IV: Acoustics and Digital Audio Video (10)**

Optical recording, noise, CD, DVD, dual layer DVD, rewritable DVD, Blu Ray DVD, Studio acoustics and reverberation, acoustic chambers, PA system for : auditorium, public meeting, debating hall, football stadium, college hall, Advanced PA systems, Different types of speakers and microphones.

**Text Books:**


1. R. R. Gulati, **"Modern Television Practice",** *New Age International*, (5th Edition), (2015).
2. Ralf Steinmetz, Klara Nahrstedt, **"Multimedia: Computing, Communication and Applications"**, *Pearson Publication*, (8th Edition), (2011).
3. R.G. Gupta, **"Audio and Video Systems"**, *Tata Mcgraw Hills,* (2nd Edition), (2020).
4. Robert D. Finch, **"Introduction To Acoustics",** *PHI*, (2nd Edition), (2007).
5. Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, "**Advance Computer Network"**, *Wiley*, (2nd Edition), (2014).


**Reference Books:**


1. A. M. Dhake, "**Television and Video Engineering**", *Tata Mcgraw Hills*, (2nd Edition), (2003).
2. Ranjan Parekh, **"Principles of Multimedia**", *Tata Mcgraw Hills*, (2nd Edition), (2013).
3. Alec Nisbett , "**The Sound Studio**", *Focal Press*, (5th  Edition) , (1993).


**Online Resources:**

**NPTEL Course " Multimedia Systems"**

1. https://nptel.ac.in/courses/117/105/117105083/

# 20PEEC 801A MICROWAVE AND RADAR ENGINEERING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC601 Wave Theory and Antenna

**Course Objectives:**
1. To study the basics of waveguides and various microwave components
2. To analyze microwave components using scattering parameters
3. To study various microwave measurement techniques
4. To explain different types of Radars and its applications

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Discuss the advantages and applications of microwaves
CO2 Analyze different modes of propagation in waveguides
CO3 Derive and analyze S parameters for different microwave components
CO4 Explain the operation of different microwave tubes
CO5 Calculate and analyze parameters at microwave frequencies
CO6 Discuss the principle of Radar and compare different types of Radars

**Unit I: Microwave Transmission Lines (08)**
Introduction of Microwaves and their applications, Rectangular waveguides, Solution of Wave equation in TE and TM modes, Power transmission and Power losses, Planar transmission lines.

**Unit II: Waveguide Components (08)**
Scattering matrix representation of networks, Rectangular cavity resonator, Waveguide Tees, Directional couplers, Faraday rotation principle, Circulators and isolators.

**Unit III: Microwave Tubes (08)**
Introduction to conventional vacuum tubes, High frequency limitations of conventional tubes, Klystron tubes, Magnetron, TWT and their applications.

**Unit IV: Microwave Measurements (06)**
Introduction to microwave measurements, Measurement methods of parameters such as Frequency, Power, Attenuation, Phase shift, VSWR, Impedance, Insertion loss, Q of a cavity resonator.

**Unit V: Radar Fundamentals (06)**
Radar block diagram and operation, Radar range equation, Prediction of range performance, Minimum detectable signal, Radar cross section of targets, Pulse repetition frequency and Range ambiguities, Radar Displays.

**Unit VI: Types of Radar and Applications (06)**
Types of Radars, Doppler effect, CW radar, basic principle and operation of FMCW radar, MTI and Pulse Doppler Radar.

**Text Books:**

1. S.Y. Liao**, "Microwave Devices and Circuits",** *Prentice Hall India*, (2nd Edition), (2014).
2. M. Kulkarni**, "Microwave and Radar Engineering",** *Umesh Publications***,** (4th Edition), (2013)**.**
3. M. I. Skolnik, "**Introduction to Radar Systems",** *McGraw Hill, (*3rd Edition), (2008).

**Reference Books:**

1. David M. Pozar, **"Microwave Engineering"**, *John Wiley and Sons*, (5th Edition), (2014).
2. NadowLevanon, **"Radar Principles"**, *John Wiley and Sons*, (5th Edition), (1989).

**Online Resources:**

1. NPTEL Course on **"Microwave Theory and Techniques"**
   https://onlinecourses.nptel.ac.in/noc19_ee57/preview
2. NPTEL Course on **"Basic Blocks of Microwave Engineering"**
   https://nptel.ac.in/courses/117105130/

# 20PEEC801B  REMOTE SENSING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite**: PEEC 501 Digital Image Processing, 20EC403 Machine learning with Python

**Course Objectives:**

1. To understand basic concepts, principles and applications of remote sensing
2. To provide knowledge related to remote sensing data collection, reading and analysis
3. To perform image pre-processing, classification and clustering on remote sensing data
4. To learn multidisciplinary applications of remote sensing

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Explain geometric and radiometric principles, Digital Image Processing techniques for pre-processing of Remote Sensing image data
CO2 Illustrate atmospheric and energy interaction, scanning mechanism on earth surface
CO3 Interpret data products from different satellites and calculate image statistics
CO4 Apply machine learning algorithms for dimensionality reduction, clustering and classification on satellite images
CO5 Analyze performance of different machine learning algorithms on multispectral and hyperspectral images
CO6 Demonstrate multidisciplinary applications of remote sensing

**Unit I: Introduction to Remote Sensing (08)**
Energy sources and radiation principles, Energy interactions in the atmosphere, Characteristics and Physics of Remote Sensing systems, Electromagnetic spectrum, Effects of Atmosphere, Scattering and Absorption, Atmospheric window, Energy interaction with surface features: Spectral reflectance of Vegetation, Soil and Water, Atmospheric influence on spectral response patterns.

**Unit II: Multispectral, Thermal, and Hyperspectral Sensing (08)**
Platforms used for Remote Sensing data acquisition and characteristics, Different types of aircrafts, Manned and Unmanned spacecrafts, Sun-synchronous and geo-synchronous satellites, Types and characteristics of different platforms, Opto-mechanical and electro-optical sensors: across-track and along-track scanners, Multispectral scanners and Thermal scanners, Imaging spectroscopy.

**Unit III: Data Representation and Preprocessing (09)**
Resolution: spatial, spectral, radiometric and temporal resolution, Data products and their characteristics, Visual and digital interpretation, Image statistics, Basic principles of data processing: Radiometric correction, Geometric correction, Atmospheric errors and corrections, Image enhancement.

**Unit IV: Data Analysis (09)**
Dimensionality reduction techniques, Image classification: Supervised classification, Unsupervised classification, Classification accuracy assessment, Image segmentation.

**Unit V: Applications of Remote Sensing** **(08)**

Hyperspectral image analysis, Multispectral image analysis, Time Series Analysis using machine learning techniques in different application areas as urban planning, agricultural, forestry and disaster management.

**Text Books:**

1. Lillesand T.M., and Kiefer, R.W.,"**Remote Sensing and Image interpretation**", *John Wiley & Sons*, ($6^{th}$ Edition), (2000).
2. John R. Jensen, **"Introductory Digital Image Processing: A Remote Sensing Perspective"**, *Pearson*, ($4^{th}$ Edition), (2016).
3. George Joseph, **"Fundamentals of Remote Sensing",** *Universities Press*, ($2^{nd}$ Edition), (2005).

**Reference Books:**

1. John A. Richards, **"Remote Sensing Digital Image Analysis"**, *Springer–Verlag*, ($5^{th}$ Edition), (2013).
2. Charles Elachi and Jakob J. Van Zyl, **"Introduction to The Physics and Techniques of Remote Sensing"**, *Wiley Series in Remote Sensing and Image Processing*, ($2^{nd}$ Edition), (2006).
3. JianGuo Liu, Philippa J. Mason,**"Image Processing and GIS for Remote Sensing: Techniques and Applications"**, *John Wiley & Sons, Ltd.*, ($2^{nd}$ Edition), (2016).

**Online Resources:**

1. NPTEL Course**"Remote Sensing and Digital Image Processing of Satellite Data"**
   https://nptel.ac.in/courses/105/107/105107160/
2. NPTEL Course**"Remote Sensing Essentials"**
   https://nptel.ac.in/courses/105/107/105107201/
3. https://www.iirs.gov.in

# 20PEEC801C INDUSTRIAL AUTOMATION

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:**

**Course Objectives:**
1. To introduce the basics of process control and automation systems
2. To explain the essential elementsas required  for a process control system
3. To introduce the basics of P.L.C. programming and P.L.C. programming standard
4. To familiarize with SCADA and DCS

**Course Outcomes:**
After completion of the course, students will be able to :

| | |
|---|---|
| CO1 | Explain the basics of  a Process Control System and Automation System |
| CO2 | Design subsystems of a Process Control application |
| CO3 | Develop P.L.C. ladder diagram for process control application |
| CO4 | Explain communication in P.L.C. (Programmable Logic Control), SCADA(Supervisory Control and Data acquisition) and DCS (Distributed Control System) |

**Unit I: Process Control and Automation (08)**
Process control principles, Servomechanisms, Control System Evaluation, Analog control, Digital control, Types of Automation, Architecture of Industrial Automation Systems, Advantages and Limitations of Automation.

**Unit II: Transmitters and Signal Conditioning (08)**
Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire and 3-Wire transmitters, Analog and Digital signal conditioning for R.T.D., Thermocouple, Differential Pressure Transmitter ( D.P.T.) , Smart and Intelligent transmitters.

**Unit III: Controllers and Actuators (09)**
PID Controller, Cascade PID control, Microprocessor Based control, PAC(Programmable Automation Controller), Mechanical switches, Solid state switches, Electrical Actuators: Solenoids, Relays and Contactors, A.C. Motor, V.F.D., D.C. Motor, B.L.D.C. Motor, Stepper Motor, Servo Motor, Pneumatic and Hydraulic actuators.

**Unit IV: Programmable Logic Controller (09)**
Functions of P.L.C., Types of PLCs, Advantages, Architecture, Working of P.L.C., Selection of P.L.C., Networking of P.L.C.s, Ladder Programming basics, Ladder Programming examples, Interfacing Input and Output devices with P.L.C., P.LC. Programming standard IEC61131.

**Unit V: Industrial Automation Technologies : Supervisory Control And Data Acquisition (S.C.A.D.A.) and Distributed Control System (D.C.S.), Industrial Communication (08)**
Introduction to S.C.A.D.A. (Features, MTU-functions of MTU, RTU-Functions of RTU, Applications of S.C.A.D.A., Communication in S.C.A.D.A.: types, methods and Media used), Introduction to DCS (Architecture, Input and Output modules, Communication module,

Specifications), Industrial Communication: Devicenet, Interbus , Device network : Foundation Fieldbus -H 1, HART, CAN, PROFIBUS-PA, Control network: ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP.

**Text Books:**


1. Curtis Johnson, **"Process Control Instrumentation Technology"**, Pearson Education, (8th Edition), (2013).
2. S. Sen, S. Mukhopadhyay, A. K. Deb, **"Industrial Instrumentation Control and Automation"**, Jaico Publishing House, (1st Edition), (2013).
3. Madhuchhanda Mitra, Samarjit Sengupta, **"Programmable Logic Controllers and Industrial Automation"**, Penram International Publishing India Pvt. Ltd., (2nd Edition), (2012).
4. Stuart A. Boyer, **"SCADA (Supervisory Control and Data Acquisition)"**, ISA Publication, (4th Edition), (2010).


**Reference Books:**


1. John W. Webb, Ronald A. Reis, **"Programmable Logic Controllers, Principles and Applications"**, Prentice Hall of India Pvt. Ltd., (5th Edition), (2016).
2. Kilian, **"Modern Control Technology: Components & Systems"**, Cengage India, (3rd Edition), (2021).
3. BelaG. Liptak, **"Process Software and Digital Networks"**, CRC Press, (3rd Edition), (2011).


**Online Resources:**

1. **NPTEL Course on Industrial Automation and Control**
   https://onlinecourses.nptel.ac.in/noc21_me67/preview

## 20PEEC801D EMBEDDED AND RTOS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester:50 Marks
**Credits: 3**

**Prerequisite:** 20EC503 Advanced Processors, 20ES02 Fundamentals of Programming Language I

**Course Objectives:**
1. To discuss embedded system design challenges
2. To explain Operating System (OS) requirement for embedded systems
3. To describe real time operating system concepts
4. To discuss features of Linux OS
5. To interface real world input and output devices

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Identify and analyze design metrics for development of embedded systems
CO2 Compare and contrast different types of software development model for a given application
CO3 Explore the structures, task services, states and other basic operations of the real time operating systems
CO4 Apply real time system concepts for developing embedded systems
CO5 Explain Linux kernel configuration and bootloader

**Unit I : Introduction to Embedded Systems (07)**
Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Process, Design Metrics and optimization of various parameters of embedded system. Embedded processor technology: IC technology, Design technology, Software development life cycle (SDLC) models like Waterfall, Spiral, V, Rapid Prototyping models and comparison.

**Unit II: Structure of µCOS II (07)**
Kernel Structure: Foreground and background systems, Pre-emptive and Non-Preemptive, Starting the OS, Tasks, Task States, Task Control Blocks (TCB), Ready list, Task Scheduling, Task Level, Multitasking , Context Switching, Idle Task, Statistics Task, Task Management: Creating/Deleting and Suspending/Resuming Task, Task Stacks and checking, Changing Task's Priority.

**Unit III : Synchronization in µCOS II (07)**
Critical Session, Shared resources, Inter task communication, Mutual exclusion, Semaphore Management: Creation/Deletion, Pending/Posting/Acceptance/Query, Mutual Exclusion Semaphores: Creation/Deletion, Pending/Posting/Acceptance/Query, Event Flag Management: Internals, Creation/ Deletion of Event Flag groups, Waiting/Setting/Clearing/Looking for/Querying an Event Flag Group.

**Unit IV: Structure of µCOS II (07)**
Static and Dynamic Priorities, Priority inversion, Synchronization mechanism, Interrupts: Latency, Response and Recovery, Clock Tick, Memory requirements. Schedulers, Locking and unlocking of scheduler, Interrupts, Clock Tick, Initialization, Time Management: Delaying/Resuming task, System

Time.

**Unit V: Communication in µCOS II** **(07)**

Message Mailbox Management: Creating/Deleting a Mailbox, Waiting/ Sending /Getting without waiting a Message from Mailbox, Status of Mailbox, and Alternate uses of Mailbox, Message Queue Management: Creating/Deleting/Flushing a Message Queue, Waiting/Sending/Getting without waiting a Message from Queue, Status and Alternate use of Message Queue, Memory Management: Memory Control Block(MCB), Creating a partition, Obtaining /Returning/Waiting for a memory Block, Partition Status, Porting of µCOS-II: Development tools, Directories and Files, Configuration and testing of Port.

**Unit VI: Linux Kernel Construction** **(07)**

Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS Versus Boot loader Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration, Role of a Bootloader, Bootloader Challenges, A Universal Bootloader: Das U-Boot, Porting U-Boot.

**Text Books:**

1. Jean J. Labrosse, **"MicroC OS II, The Real-Time Kernel",** *CMP Books*, (2nd Edition), (2011).
2. Christopher Hallinan, **"Embedded Linux Primer - A Practical, Real-World Approach",** *Prentice Hall Pvt.*, (2nd Edition), (2010).
3. Raj Kamal, **"Embedded Systems –Architecture, Programming and Design",** *McGraw Hill*, (2nd Edition), (2008).

**Reference Books:**

1. Dr. K. V. K. K. Prasad **"Embedded / real time System: Concepts, Design, & Programming - Black Book"**, *Dreamtech Press Publication*, (2nd Edition), (2003).
2. Frank Vahid and Tony Givargis, **"Embedded System Design – A Unified hardware/ Software introduction"**, *Wiley Publication*, (3rd Edition), (2006).

**Online Resources:**

1. NPTEL Course on "**Real Time Operating System"**
   https://onlinecourses.nptel.ac.in/noc20_cs16/
2. NPTEL Course on "**Real-Time Systems"**
   https://onlinecourses.nptel.ac.in/noc21_cs98/

# 20PEEC802A ADVANCED VLSI DESIGN

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC502 VLSI Design

**Course Objectives:**

1. To discuss the coverage of timing analysis
2. To study the fundamentals of static timing analysis
3. To understand logic fault models and learn test generation for sequential and combinational logic circuits
4. To learn power distribution and power optimization techniques

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Apply the timing constraints, including clocks and external delays for performance improvement |
| CO2 | Apply Static Timing Analysis(STA) checks for timing closure |
| CO3 | Analyze the faults in digital circuits |
| CO4 | Analyze the design for testability methods for combinational and sequential circuits |
| CO5 | Describe power distribution and power optimization techniques |

**Unit I: Introduction to Timing Analysis** **(08)**

Performance axes, Design flow, Static versus dynamic methods, Intrinsic and extrinsic delays, Delay factors, Path delays, Combinational paths, Synchronous paths, Pipelining and analysis, Clock definitions: Skew, Frequency and phase, Clock distribution.

**Unit II: Static Timing Analysis** **(08)**

True paths, Transitions, Multi-cycle operations, Clock specification, Interface specification, Timing checks, Timing constraints, Design rule constraints, Wire-load model, Gate delay, Net delay, Timing reports, Back annotation, Delay Formats: Standard Delay Format (SDF).

**Unit III: Basics of Testing** **(08)**

Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits, Current sensing based testing, Classification of sequential ATPG methods, Fault collapsing and simulation.

**Unit IV: Design for Testability (DFT)** **(08)**

Scan design, Partial scan, Use of scan chains, Boundary scan, DFT for other test objectives, Memory Testing. Built-in self-test (BIST): Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

**Unit V: Power Analysis and Clock Synthesis (10)**

Introduction, Power Basic, Key Factors in Accurate Power Estimation, Power Estimation Early in the Design Cycle, Simulation Based Power Estimation, Best Practices for Power Estimation, Supply and ground bounce, Power distribution techniques, Power optimization, Clock Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Interconnect routing techniques.

**Text Books:**


1. J. Bhasker, Rakesh Chadha, **"Static Timing Analysis For Nano-meter Designs: A Practical Approach"**, *Springer*, (1st Edition), (2009).
2. Jan M. Rabaey, **"Digital Integrated Circuits Design Perspective"**, *Prentice Hall of India Pvt. Ltd.*, (2nd Edition), (2002).


**Reference Books:**


1. Srivastava Ashish, Sylvester Dennis, Blaau David, **"Statistical Analysis and Optimization for VLSI: Timing and Power"**, *Springer*, (1st Edition), (2005).
2. Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, **"VLSI Test Principles and Architectures: Design for Testability"**, *Elsevier*, (1st Edition), (2006).
3 M. L. Bushnell and V. D. Agrawal, **"Essential of Electronic Testing for Digital, Memory, and Mixed Signal VLSI Circuits"**, *Springer*, (1st Edition), (2005).


**Online Resources:**

1. NPTEL Course **"Advanced VLSI Design"**
   https://nptel.ac.in/courses/117/101/117101004/
2. NPTEL Course **"VLSI Physical Design"**
   https://nptel.ac.in/courses/106/105/106105161/

# 20PEEC802B ARTIFICIAL INTELLIGENCE

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester:50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC403 Machine Learning with Python

**Course Objectives:**
1. To explain the basics of Artificial Intelligence
2. To introduce various types of algorithms useful in Artificial Intelligence
3. To explain the types of reasoning
4. To explain the code of ethics for Artificial Intelligence

**Course Outcomes:**
After completion of the course, students will be able to
1. Explain the components of intelligent agents and expert systems
2. Apply knowledge representation techniques and problem solving strategies to Artificial Intelligence applications
3. Explain and analyze the search and learning algorithm along with the reasoning
4. Describe the code of ethics for the Artificial Intelligence systems

**Unit I: Basics of Artificial Intelligence (05)**
Categories of Artificial Intelligence (AI), Applications of AI, Intelligent agents, Agents and environments, Good behavior, The nature of environments, Structure of agents. Applications of Artificial Intelligence, Game Playing, Expert Systems, Natural Language Processing, Image Understanding, Robotics, Pattern Recognition, Virtual Reality, Computer Vision, Intelligent Control

**Unit II: Problem Solving (07)**
Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic function, Local search algorithms and optimistic problems, Optimal decisions in games, MINIMAX algorithm, Alpha Beta Pruning, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP.

**Unit III: Knowledge Representation (07)**
Logic, Propositional logic, First order logic, Knowledge engineering in first order logic, inference in first order logic, Prepositional versus first order logic, Forward chaining, backward chaining, Resolution , Knowledge representation, Uncertainty and methods, Bayesian probability and Belief network.

**Unit IV: Reasoning (06)**
Types of Reasoning, Non-monotonic Inference Methods Non-monotonic Reasoning, Truth Maintenance Systems, Reasoning with Fuzzy Logic, Fuzzy Sets, Fuzzy Reasoning, Rule-based Reasoning, Diagnosis Reasoning, Case-based Reasoning Systems, Model-based Reasoning Systems

**Unit V: Learning (07)**

Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Statistical learning, Hidden Markov Models, Association Learning: Apriori Algorithm, Eclat Algorithm, Fuzzy Network, Fuzzy Systems, Info Fuzzy Networks, Fuzzy Neural Systems

**Unit VI: Expert systems and Ethics for Artificial Intelligence (10)**

Introduction to Expert System, Architecture and functionality, Examples of Expert system, Basic steps of pattern recognition system, Object Recognition- Template Matching theory, Prototype Matching Theory, Pattern Mining.

Ethics of AI : Privacy and Surveillance, Manipulation of Behavior, Opacity of AI Systems, Bias in Decision Systems, Human-Robot Interaction, Automation and Employment, Autonomous Systems, Machine Ethics, Artificial Moral Agents Privacy

**Text Books:**

1. Vinod Chandra S. S., Anand Hareendran S., "**Artificial Intelligence and Machine learning**", *PHI*, (1st Edition) (2014).
2. Stuart Russell, Peter Norvig, **"Artificial Intelligence", A Modern Approach '**, *Pearson Education/Prentice Hall of India*, (3rd Edition), (2010).
3. Elaine Rich, Kevin Knight and Shivshankar Nair, **"Artificial Intelligence"**, *Tata McGraw Hill*, (3rd Edition), (2009).
4. Paula Boddington**, "Towards a Code of Ethics for Artificial Intelligence", ***Springer international Publishing***,** (1st Edition), (2017).

**Reference Books:**

1. Nils J. Nilsson, **"Artificial Intelligence: A new Synthesis"**, *Morgan Kaufmann Publishers*, (1st Edition), (1998).
2. George F. Luger, **"Artificial Intelligence: Structures and Strategies for Complex Problem Solving",** *Pearson Education***,** (6th Edition), (2008).

**Online Resources:**

1. NPTEL Course **"Artificial Intelligence"** http://nptel.ac.in/courses/106105077/
2. https://plato.stanford.edu/entries/ethics-ai/
3. https://intelligence.org/files/EthicsofAI.pdf
4. https://www.europarl.europa.eu/RegData/etudes/STUD/2020/634452/EPRS_STU(2020)634452_EN.pdf

# 20PEEC 802C STATISTICAL SIGNAL PROCESSING

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC501 Digital Signal Processing

**Course Objectives:**
1. To explain concepts of statistical signal processing that have been used in many applications fields such as communications, speech signal processing, image processing
2. To describe Signal Modeling methods and its importance in signal processing
3. To explain Parametric and non-parametric spectral estimation methods
4. To introduce Linear prediction and optimum filters and its necessity for noise filtering
5. To explore necessity of adaptive filters and algorithms for real time noise filtering

**Course Outcomes:**
After completion of the course, students will be able to

CO1 Apply statistical models for analysis of signals using Stochastic processes
CO2 Design Optimum filters for prediction and filtering of real world signals
CO3 Analyze real world signals by estimating its power spectral densities using parametric and non-parametric spectral estimation methods
CO4 Apply Adaptive filtering algorithms for real world signals

**Unit I: Signal Modeling (08)**
Random processes, Introduction to signal modeling, Signal modeling using Least Square methods, Pade’ method, Prony’s method, Signal modeling using MA(q), AR(p) , ARMA(p,q) models.

**Unit II: Linear Prediction of Signals (08)**
Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters, Linear Minimum Mean-Square Error (LMMSE) Filtering.

**Unit III: Wiener Filter (08)**
Wiener Hoff Equation, Causal and Non Causal FIR filter, Linear Prediction using FIR Filter, Lattice representation of FIR filter, Causal IIR Wiener filter, Application of Wiener Filter as Noise Canceller.

**Unit IV: Adaptive Filtering (10)**
Principle and Applications, Steepest Descent Algorithm Convergence characteristics, LMS algorithm, Convergence, Excess mean square error, Leaky LMS algorithm, Application of Adaptive filters, Kalman filtering**:** State-space model and the optimal state estimation problem, Discrete Kalman filter, Extended Kalman filter.

**Unit V: Spectral Analysis (08)**
Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing, Periodogram: Parametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

**Text Books:**

1. Charles W. Therrien, **"Discrete Random Signals and Statistical Signal Processing",** *Prentice Hall Signal Processing Series*, (1st Edition), (2004).
2. Monson H. Hayes, **"Statistical Digital Signal Processing and Modeling"**, *John Wiley and Sons, Inc, Singapore*, (1st Edition), (2002).

**Reference Books:**

1. Simon Haykin, **"Adaptive Filter Theory",** *Prentice Hall*, (5th Edition), (2013).
2. J. G. Proakis, **"Algorithms for Statistical Signal Processing",** *Pearson Education*, (1st Edition), (2002).

**Online Resources:**

1. NPTEL Course **"Statistical Signal Processing"**
   https://nptel.ac.in/courses/108/103/108103158/

# 20PEEC 802D MOBILE COMMUNICATION

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20EC 402 Analog and Digital Communication

**Course Objectives:**

1. To explain the fundamentals of cellular system design and the techniques used to maximize the capacity of cellular network
2. To describe the basics of multi-path fading and various parameters used to characterize small scale fading
3. To explain various multiple access techniques
4. To explore the architecture and call processing of GSM and CDMA system

**Course Outcomes:**

After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Explain the basics and design challenges of cellular networks |
| CO2 | Analyze signal propagation issues and their impact on the communication system performance |
| CO3 | Compare and determine capacity of different multiple access techniques |
| CO4 | Describe the architecture, operation and call processing of GSM system |
| CO5 | Describe CDMA system and analyze it's design parameters |

**Unit I: Cellular Fundamentals (10)**

Introduction to wireless Communication Systems, Evolution in cellular standards, Cellular concepts, Frequency reuse, Channel assignment, Handoff, Interference and System capacity, Trunking and Grade of service, Improving coverage and capacity.

**Unit II: Mobile Radio Propagation (10)**

Propagation mechanism, Free space path loss, Fading and Multipath, Small scale multipath propagation, Impulse response model of multipath channel, Parameters of mobile multipath channels, Types of small scale fading, Equalization techniques.

**Unit III: Coding and Multiple Access Techniques for Wireless Communications (06)**

Selection of Speech Coders for Mobile Communication, Linear Predictive Coders, Vocoders, GSM Codec, Multiple Access Techniques, Orthogonal Frequency Division Multiplexing(OFDM), OFDM applications.

**Unit IV: Global System for Mobile Communications (08)**

Evolution of Mobile standards, System Overview, The air interface, Logical and Physical channels, Synchronization, GMSK modulation, Call establishment, Handover.

**Unit V: Code Division Multiple Access (08)**

Basics of spread spectrum, Orthogonal codes, Physical and logical channels of IS-95, Handover mechanism, Factors affecting the performance of CDMA system, Comparison of WCDMA and CDMA 2000, Overview of LTE Standard, Architecture and Frame structure of LTE, Introduction to 5G standard, Comparison between 4G and 5G.

**Text Books:**

1. Theodore S Rappaport**, "Wireless Communications Principles and Practice",** *Pearson Education*, (2nd Edition), (2010).
2. Andrea Goldsmith**, "Wireless Communications",** *Cambridge University Press***,** (1st Edition), (2005)**.**
3. William C.Y. Lee, **"Mobile Communications Engineering: Theory and applications"**, *McGraw-Hill Education*, (2nd Edition), (2017).

**Reference Books:**

1. Vijay K. Garg, Joseph E. Wilkes, **"Principles and Applications of GSM"**, *Pearson Education*, (6th Edition), (2009).
2. *Vijay K. Garg*, **"IS-95 CDMA and CDMA 2000 Cellular/PCS Systems Implementation"**, *Pearson Education*, (1st Edition), (2000).
3. R. Blake, "**Wireless Communication Technology",** *Thomson Delmar*, (1st Edition), (2015).

**Online Resources:**

1. NPTEL Course on **"Introduction to wireless and cellular communication"** https://onlinecourses.nptel.ac.in/noc20_ee61/

## 20OE801B CYBER PHYSICAL SYSTEM

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20EC404 Embedded System, 20EC603 Control Systems

**Course Objectives:**
1. To introduce modeling of the Cyber Physical System (CPS).
2. To analyze the CPS.
3. To explain the software modules.

**Course Outcomes:**
After completion of the course, students will be able to
1. Categorize the essential modeling formalism of CPS
2. Analyze the functional behavior of CPS based on standard modeling formalisms
3. Apply specific software for the CPS using existing synthesis tools
4. Design CPS requirements based on operating system and hardware architecture constraints

**Unit I: Cyber Physical Systems (CPS) applications and Characteristics (07 )**
CPS in the real world, Basic principles of design and validation of CPS, CPS: From features to software components, Mapping software components to Electronic Control Unit (ECU), CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal methods for Safety Assurance of CPS.

**Unit II: CPS physical systems modeling (07)**
Stability Analysis: CLF (Common Lyapunov function), MLF (Multiple Lyapunov function), stability under slow switching, Performance under Packet drop and Noise.

**Unit III: CPS computer systems modeling (07)**
CPS SW Verification: Frama-C, C Bounded Model Checker (CBMC), Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Hybrid Automata Modelling: Flow pipe construction using Flowstar (Flow*), Polyhedral Hybrid Automaton Verifier (Phaver) tools (Reliability testing).

**Unit IV: Operating systems and hardware architecture support for CPS (07)**
CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques, CPS HW platforms: Processors, Sensors, Actuators, CPS Network.

**Unit V: Analysis and verification of CPS (07)**
Advanced Automata based modeling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, Reachability analysis, Analysis of CPS Software, Weakest Preconditions, Bounded Model checking.

**Unit VI: CPS case studies (07)**

Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid.

**Text Books:**


1. Lee, Edward Ashford, and SanjitArunkumarSeshia,**"Introduction to embedded systems: A cyber physical systems approach**", MIT Press, (2nd Edition), (2017).
2. Rajeev Alur, "**Principles of Cyber-Physical Systems**". *MIT Press*, (1st Edition), (2015).
3. Wolf, Marilyn, **"High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing".** *Elsevier*, (1st Edition), (2014).


**Reference Books:**


1. P. Tabuada, **"Verification and control of hybrid systems: a symbolic approach",** Springer-Verlag, (1st Edition), **(**2009).
2. Raj Rajkumar, Dionisio De Niz , and Mark Klein, **"Cyber-Physical Systems***"*, *SEI Series in Software Engineering*, (1st Edition), (2018).
3. André Platzer, **"Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics",** *Springer*, (1st Edition), (2010).
4. Jean J. Labrosse, **"Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C",** *CRC Press*, (2nd edition), (2011).


**Online Resources:**

1. Coursera course**, Cyber Physical system modelling**
   https://www.coursera.org/learn/cyber-physical-systems

# 20OE801H QUANTUM COMPUTING

| **Teaching Scheme** | **Examination Scheme** |
| --- | --- |
| Lectures: 3 Hours / Week | In Semester: 50 Marks |
| | End Semester: 50 Marks |
| | **Credits: 3** |

**Prerequisite:** 20BS04 Physics, 20BS01 Linear Algebra & Univariate Calculus,20BS03 Multivariate Calculus

**Course Objectives:**
1. To give an introduction to quantum computation
2. To explain the basics of quantum mechanics
3. To analyze quantum circuits using qubit gates
4. To elaborate difference between classical and quantum information theory
5. To explain quantum algorithms
6. To explain noise and error correction

**Course Outcomes:**
After completion of the course, students will be able to
- CO1. Describe the basics of quantum computation
- CO2. Apply the concepts of quantum mechanics
- CO3. Design of quantum circuits using qubit gates
- CO4. Comparison between classical and quantum information theory
- CO5. Utilize quantum algorithms
- CO6. Apply noise and quantum error correction

**Unit I: Introduction to Quantum Computation (03)**
Quantum bits, Bloch sphere representation of a qubit, multiple qubits.

**Unit II: Background Mathematics and Physics (08)**
Hilbert space, Probabilities and measurements, Entanglement, Density operators and correlation, Basics of quantum mechanics, Measurements in bases other than computational basis.

**Unit III: Quantum Circuits (08)**
Single qubit gates, Multiple qubit gates, Design of quantum circuits.

**Unit IV: Quantum Information and Cryptography (08)**
Comparison between classical and quantum information theory, Bell states, Quantum teleportation, Quantum Cryptography, No cloning theorem.

**Unit V: Quantum Algorithms (07)**
Classical computation on quantum computers, Relationship between quantum and classical complexity classes, Deutsch’s algorithm, Deutsch’s-Jozsa algorithm, Shor factorization, Grover search.

**Unit VI: Noise and error correction (08)**
Graph states and codes, Quantum error correction, fault-tolerant computation.

**Text Books:**

1. Michael Nielsen and Isaac Chuang, **“Quantum Computation and Quantum Information”**, *CambridgeUniversity Press, UK*, (10th Edition), (2012).
2. Phillip Kaye, Raymond Laflamme and Michele Mosca,**“An Introduction to Quantum Computing”**, *Oxford University Press*, *UK*, (1st Edition), (2007).

**Reference Books:**


1. N. David Mermin, **“Quantum Computer Science An Introduction”**,*Cambridge University Press*, UK, (1st Edition), (2007).
2. NosonYanofsky and MircoMannucci, **“Quantum Computing for Computer Scientists”**, *Cambridge University Press*, (1st edition), (2008).


**Online Resources:**

**1.** NPTEL Course **“Quantum Computing”**
https://onlinecourses.nptel.ac.in/noc19_cy31/

# 20OE802C AUTONOMOUS ROBOTS

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** 20BS01Linear Algebra and Univariate Calculus, 20ES01: Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To explain fundamentals of robotic system
2. To introduce kinematics, dynamics and control for robotics systems
3. To introduce trajectory planning for motion
4. To describe application of robots in automation

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Explain and classify different components used in developing autonomous robot
CO2 Select sensors, actuators and grippers for autonomous robot
CO3 Apply formulations to obtain kinematics, dynamics and trajectory planning of autonomous robot
CO4 Develop path planning and navigation algorithm for autonomous robot
CO5 Design robot for automation

**Unit I: Introduction to Robotics (10 )**

Definition of robotics, Types of robots, Components of Robot system, Classification of robots , Robot architecture, Robot locomotion, Specification of robot, Robot sensors for position, Acceleration sensors, Proximity, Velocity sensors, Force sensors, Tactile sensor, Camera and robot vision, Actuators and end effectors.

**Unit II: Introduction to Mechanics of Robotic Arm (10)**

Position and orientation description, Coordinate transforms, Homogeneous transform, Denavit and Hartenberg (DH) parameters, Forward and inverse kinematic analysis, Dynamics and inverse Dynamics of robots, Newton–Eller formulation, Trajectory and Path planning, Application of robotic arm.

**Unit III: Mobile robot Kinematics and Dynamics (08)**

Forward and inverse kinematics, holonomic and nonholonomic constraints, Kinematic models of simple car and legged robots, Dynamic simulation of mobile robots.

**Unit IV: Localization (06)**

Odometric position estimation, Belief representation, Probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, Positioning beacon systems.

**Unit V: Introduction to Planning and Navigation (08)**

Path planning algorithms based on Simultaneous Localization and Mapping (SLAM) algorithm, A-star, D-star, Voronoi diagrams, Probabilistic Road Maps (PRM), Rapidly exploring Random Trees (RRT), Markov Decision Processes (MDP), Stochastic Dynamic Programming (SDP).

**Text Books:**

1. R. Siegwart, I. R. Nourbakhsh, **"Introduction to Autonomous Mobile Robots"**, *The MIT Press*, (2nd Edition), (2011).
2. Francis X. Govers, **"Artificial Intelligence for Robotics",** *Packt Publishing Ltd., United Kingdom*, (1st Edition), (2018).
3. Robin R. Murphy, **"Introduction to Artificial Intelligence for Robotics"**, *The MIT Press*,(2nd Edition), (2000).
4. S. K. Saha, **"Introduction to Robotics"**, *Tata McGraw Hill*, (2nd Edition), (2014).

**Reference Books:**

1. K. S.Fu, R. C. Gonzalez, C. S. G. Lee, "**Robotics Control, Sensing, Vision and Intelligence" ,** *Tata McGraw Hill* **,** (2nd Edition), (2008).
2. Robert J. Schilling, **"Fundamentals of Robotics- Analysis and Control",***Prentices Hall India*, (1st Edition), (2008).

**Online Resources:**

1. NPTEL Course **"Wheeled Mobile Robot"**
   https://nptel.ac.in/courses/112/106/112106298/

# 20OE802I Wireless Networks

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks

**Prerequisite:** Nil

**Course Objectives:**

1. To explain the importance of wireless communication and multiple access techniques
2. To elaborate the behavior of communication system for indoor and outdoor wireless networks
3. To introduce 3G, 4G cellular network components and 5G future wireless network
4. To explain MIMO technology
5. To introduce visible light communications

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Explain fundamentals of wireless communication and multiple access techniques
CO2 Analyze the behavior of communication system for indoor and outdoor wireless networks
CO3 Apply 3G, 4G cellular network standards and describe 5G future wireless network
CO4 Interpret MIMO technology its advantages and limitations
CO5 Explain LiFi networking and technology for indoor network access

**Unit I: Introduction to wireless communication (08)**

Fundamentals of Wireless Communication: Advantages, Limitations and Applications, Frequency Spectrum, Radio and Infrared Frequency Spectrum, Wireless Media, Spread spectrum, Multiple access technique: TDMA, CDMA, FDMA, CSMA, OFDMA.

**Unit II: Wireless indoor and outdoor networks (08)**

WLAN, WiFi, Bluetooth, Zigbee, Ultra Wideband communication, Infrared, UHF narrowband, WiMax, Limitation of indoor networks.

**Unit III: Cellular Network (08)**

Spectrum reuse and re-framing, Cell cluster concept, Co-channel and adjacent channel interference, Cell site, call blocking and delay, Channel allocation strategies, 3G and 4G standard.

**Unit IV: Future Wireless networks (10)**

Introduction to 5G, Modulation techniques for 5G, Architecture, MIMO, Massive MIMO, Limitations and applications.

**Unit V: Visible Light Communications (08)**

LiFi Technology, LiFi Networking, LiFi technology for indoor network access, Applications.

**Text Books:**


1. T. Rappaport, "**Wireless Communications - Principles and Practice**", *Prentice Hall* , ($2^{nd}$Edition) , (2011).

2. Vijay Garg, "**Wireless Communications and networking**", *Elsevier*, (1st Edition), (2007).
3. Jonathan Rodriguez, **"Fundamentals of 5G Mobile Networks"**, *Wiley*, (1st Edition),(2015).
4. Mohamed Gado, Doaa Abd El-Moghith, "**Li-Fi Technology for Indoor Access**", *LAMBERT Academic Publishing*, (1st Edition), (2015).

**Reference Books:**

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "**3G Evolution HSPA and LTE for Mobile Broadband"**, *Academic Press*, (2ndEdition) , (2008).
2. Anurag Kumar, D.Manjunath, Joy kuri, "**Wireless Networking**", *Elsevier*, (1st Edition), (2011).
3. Simon Haykin, Michael Moher, David Koilpillai, "**Modern Wireless Communications**", *Pearson Education* , (1st Edition), (2013)
4. Aditya K. Jagannatham, "**Principles of Modern Wireless Communications Systems**", *McGraw Hill Education (India) Private Limited*, (1st Edition), (2016).

**Online Resources:**

1. NPTEL Course on **"Introduction to Wireless and Cellular Communications",** https://nptel.ac.in/courses/108/106/106106167/#
2. NPTEL Course on **"Advanced 3G and 4G Wireless Mobile Communications**", https://nptel.ac.in/courses/117/104/117104099/

# 20PEEC 801LA MICROWAVE AND RADAR ENGINEERING LAB

**Teaching Scheme**
Lectures: 2 Hours / Week

**Examination Scheme**
In Semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives:**

1. To learn reciprocal and non reciprocal passive microwave components.
2. To learn the characteristics of active devices like reflex klystron and Gunn diode.
4. To learn the nature of standing waves formed due to impedance mismatch.
5. To learn the working principle of Radar.

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Measure and Analyze the characteristics of reciprocal and non-reciprocal passive microwave components.

CO2 Analyze the characteristics of various microwave sources like Reflex Klystron and Gunn Diode.

CO3 Analyze Standing waves for various terminations.

CO4 Simulation of Radar to measure range and speed of the target.

**List of Experiments:**

1. Measure and plot mode characteristics of the Reflex klystron.
2. Measurement of the free space wavelength of the microwave (for TE 10 mode) with the help of the X-band microwave test bench and verify with its theoretical calculation.
3. Measure VI characteristics of Gunn Diode and study of PIN modulator.
4. Measure and verify port characteristics of microwave tees (E, H, E-H or magic tee).
5. Measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
6. Measure and verify port characteristics of Isolator and Circulator. Calculate insertion loss and isolation in dB.
7. Measure wavelength of the microwave using a microwave test bench and verify with its theoretical calculations.
8. Plot a standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using a slotted section with probe carriage.
9. To simulate the operation of Radar.

# 20PEEC801LB REMOTE SENSING LAB

| | |
|---|---|
| **Teaching Scheme** | **Examination Scheme** |
| Practical: 2 Hours / Week | In Semester: 25 Marks |
| | Practical: 25 Marks |
| | **Credits: 1** |

**Course Objectives:**

1. To introduce Geographic information system (GIS) software and operations on geo data using Quantum GIS (QGIS)
2. To provide knowledge about collecting and reading remote sensing data
3. To develop programming skills for satellite image analysis
4. To apply digital image processing and machine learning techniques on multispectral and hyperspectral images

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Apply QGIS software for geospatial data analysis

CO2 Choose and apply image pre-processing and enhancement techniques on satellite images

CO3 Collect data from different satellites and apply data analysis steps using Python

CO4 Develop algorithms for clustering and classification of multispectral and hyperspectral images

**List of Experiments:**

1. (a) Introduction to Quantum GIS (QGIS) software, (b) Read and display satellite images, Process raster data and create composites.
2. Implement image enhancement techniques for satellite images.
3. Implement pan-sharpening algorithm on satellite data.
4. Develop an algorithm to perform data analysis on satellite images (Sentinel/Landsat)- Read data, Visualize bands, Plot histogram, Calculate vegetation and soil indices.
5. Develop an algorithm to perform dimensionality reduction and clustering in hyperspectral images.
6. Develop an algorithm for supervised classification in multispectral/hyperspectral images.

# 20PEEC801LC INDUSTRIAL AUTOMATION LAB

**Teaching Scheme**
Practical: 2 Hours / Week

**Examination Scheme**
In semester: 25 Marks
Practical: 25 Marks
**Credits: 1**

**Course Objectives :**
1. To demonstrate the measurement& control of a physical variable using an appropriate measurement and control circuit
2. To plot the response of Proportional (P), Proportional and Integral (PI) and PID Controllers
3. To introduce interfacing of I/O devices with PLC
4. To develop Ladder Program for Process Control Applications
5. To interface PLC with SCADA

**Course Outcomes :**
After completion of the course, students will be able to
CO1 Detect & control a physical variable using an appropriate measurement & control circuit
CO2 Plot the response of a Proportional, Proportional & Integral and PID Controllers
CO3 Interface I/O devices for a process control application with PLC
CO4 Develop PLC Ladder Programs for Process Control Applications
CO5 Interface PLC with RTU (Remote Terminal Unit) and SCADA

**List of Experiments:**
1. Temperature detection & control using RTD.
2. Temperature detection & control using Thermocouple.
3. Plotting step response of Proportional, Proportional & Integral and PID Controllers ( Matlab based )
4. Interfacing of I/O devices ( eg. Mechanical Switches, Relays ) with PLC
5. Controlling the speed of Servo Motor using an analog voltage of 0-10V
6. Interfacing of PLC to Pneumatic Circuit
7. Developing PLC Ladder Programs for basic logical operations
8. Developing PLC program for a given Process Control Application
9. Interfacing PLC with RTU & SCADA at remote location.

**Level 4.5 | First Year**

**Curriculum for UG Degree Course in BTech.** Computer Engg and Information Technology Programmes

(Academic Year: 2023-24 Onwards)

**Semester-I**

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| BSC102 | Chemistry | 3 | 0 | 0 | **3** | 50 | 50 | 0 | 100 |
| BSC103 | Linear Algebra and Univariate Calculus | 3 | 1 | 0 | **4** | 50 | 50 | 0 | 100 |
| ESC102 | Basics of Electrical & Electronics Engineering | 3 | 0 | 0 | **3** | 50 | 50 | 0 | 100 |
| IKS101 | Indian Knowledge System | 2 | 0 | 0 | **2** | 50 | 0 | 0 | 50 |
| CC101 | Liberal Learning Course-1 | 1 | 0 | 2 | **2** | 50 | 0 | 0 | 50 |
| AEC101 | Professional Communication | 1 | 0 | 2 | **2** | 50 | 0 | 0 | 50 |
| BSC102L | Chemistry Lab | 0 | 0 | 2 | **1** | 25 | 0 | 0 | 25 |
| ESC102L | Basics of Electrical & Electronics Engineering Lab | 0 | 0 | 2 | **1** | 25 | 0 | 0 | 25 |
| VSEC101L | Programming Skills in C Language Lab | 0 | 0 | 4 | **2** | 25 | 0 | 25 | 50 |
| | Total = | **13** | **01** | **12** | **20** | **375** | **150** | **25** | **550** |

*L=Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation, ESE =End Semester Examination, Pr/Or = Practical/Oral.*

APPROVED BY
Secretary Academic Council
MKSSS's Cummins College of Engineering
For Women, Pune-411052

APPROVED BY
Chairman Academic Council
MKSSS's Cummins College of Engineering
For Women, Pune-411052

## BSC102 Chemistry

| Teaching Scheme | Examination Scheme |
|---|---|
| Lectures: 3Hrs/week | In-Semester: 50Marks |
| Credits: 3 | End-Semester: 50Marks |

**Course Objectives**

The Chemistry course is designed such that the learners imbibe chemical principles relevant in the engineering context. The course facilitates undergraduates to understand chemical processes, methods of analysis, structure-property relationship and evaluate role of chemical substances for engineering applications. Further the course inculcates basic problem-solving skills involving chemistry principles.

**Course Outcomes:**

After completion of this course a student should be able to

1. Interpret properties and applications of molecules based on their atomic structure.
2. Analyze quality parameters for water, coal, petrol using analytical methods.
3. Apply chemical principles for problems related to water, batteries, fuel or polymers.
4. Outline the process of synthesis for inorganic substances and nanomaterials.
5. Elucidate the construction and functioning of a device/chemical reagent.

**Module 1: Physical Chemistry (13)**

**Unit 1.** Chemical Bonding: Types of bonds, intermolecular forces, bonding in molecules: valence bond theory, molecular orbital theory for diatomic molecules.

**Unit 2.** Electrochemistry: Electrochemical cell, Nernst equation, EMF of cell, reference and indicator electrodes, battery characteristics, Lead-acid, Lithium-ion battery, Fuel cell technology.

**Module 2: Inorganic and Materials Chemistry (13)**

**Unit 3.** General overview of the Periodic table and properties; chemistry of some elements like H, Si and their compounds, Si for chipmaking, $H_2$ gas as fuel.

**Unit 4.** (A) Engineering materials: Structural features, properties and applications of OLEDs - PPV (- solar cell), liquid crystal polymers, conducting polymers – as a chemical sensor, polymer composites.

(B) Nanomaterials:

Introduction to nanomaterials, synthesis by top down and bottom-up methods. Structure, synthesis and some typical applications of nanomaterials.

**Module 3: Analytical Chemistry** **(16)**

**Unit 5.** Analysis of -

(A) Water: Hardness determination in water, TDS, effect of hard water in boilers, Internal and external treatment of hardness, water softening techniques -zeolite and ion exchange method. Desalination methods-Reverse osmosis. Electrodialysis. Waste water recycling.

(B) Carbon based fuels: Analysis of coal/petrol.

**Unit 6.** Analytical techniques such as spectroscopy, pH-metry, conductometry and their applications.

**Text Books:**

1. S.S. Dara 'Engineering Chemistry' S. Chand Publications (2010)
2. B.S. Chauhan 'Engineering Chemistry': Univ Sc Press. (Third edition)2009
3. Shashi Chawla 'A Text Book of Engineering Chemistry': Dhanpat Rai & Co. (2015)
4. Jain and Jain 'A Text Book of Engineering Chemistry' Dhanpat Rai & Co.
5. G. Chatwal 'Instrumental methods of Chemical Analysis' Himalaya publication house

**Reference Books:**

1. Steven S. Zumdahl, 'Chemistry concepts and applications', Cengage learning publication (2009)
2. Ram D. Gupta, 'Hydrogen fuel 'C.R.C. Publications (2009)
3. Puri, Sharma, Pathania 'Principles of Physical Chemistry': Vishal Publ. Co.
4. Robert Braun' Instrumental methods of analysis' Pharma med press (2010)
5. J.D. Lee, 'Concise Inorganic Chemistry', 4th edition, Wiley Publication (2019)

## BSC103 Linear Algebra and Univariate Calculus

| **Teaching scheme** | **Examination scheme** |
|---|---|
| Lectures: 3hrs/week | In-Sem Exam: **50** Marks |
| Tutorial: 1hr/week | End-Sem Exam: **50** Marks |
| Number of Credits: 4 | |

**Course Objectives:**

1. To familiarize the prospective engineers with techniques in linear algebra and calculus of one variable.
2. To equip the students with standard concepts and tools in linear algebra and calculus of one variable which they will find useful in their disciplines.

**Course Outcomes:**
After completion of this course a student should be able to

**CO1:** Use matrix method to solve linear system of equations, Linear Transformations.

**CO2:** Calculate eigenvalues, eigenvectors and apply it to diagonalize a matrix.

**CO3:** Apply knowledge of linear algebra to solve simple real life problems.

**CO4**: Compute differentiation, series expansion, integration of function of one variable.

**Unit-I: Matrices (08)**

Rank of a matrix, Echelon form, System of linear equations, Euclidean vector spaces and Linear Transformations

**Unit-II: Diagonalization of a Matrix (08)**

Eigenvalues, Eigenvectors, Properties of Eigenvalues, Diagonalization of a matrix

**Unit-III: Applications of Linear Algebra (09)**

Introduction to Modular Arithmetic, Euclid's algorithm, Encrypt and decrypt the statement using matrix, Applications to simple real life problems

**Unit-IV: Differential Calculus (08)**

Successive differentiation, nth order derivatives of some standard functions, Taylor's and Maclaurin's theorem, Standard series expansions

**Unit-V: Integral Calculus** **(09)**
Reduction formulae, Beta Function, Gamma function, Differentiation under integral sign, Error function

**Text-Books:**


1. David Poole,' Linear Algebra: A Modern Introduction', 2nd Edition, Brooks/Cole (2005).
2. B. V. Ramana ,'Higher Engineering Mathematics', *Tata McGraw-Hill Publications*, (2007).
3. B.S. Grewal, 'Higher Engineering Mathematics', *Khanna publishers*, Delhi (40th edition), (2008).


**Reference Books:**


1. C.R. Wylie, L. C. Barrette, 'Advanced Engineering Mathematics', *McGraw-Hill Publications, New Delhi* ( 6 th edition),(2006)
2. Maurice Weir, Joel Hass, Thomas 'Calculus' , 12th edition, *Pearson India*(2016)
3. George Thomas, Jr., Ross Finney, Late, Calculus, 9th edition, *Pearsons India*
4. Sudhir Ghorpade, Balmohan Limaye,'A Course in Calculus and Real Analysis', (Undergraduate Text in Mathematics), *Springer*(2006).
5. Erwin Kreyszig, 'Advanced Engineering Mathematics', *Wiley Eastern Ltd*(10th Edition), (2017)

## ESC102 Basic Electrical and Electronics Engineering

| **Teaching Scheme:** | **Examination Scheme** |
|---|---|
| Lectures: 3 Hrs./Week | In-Semester: **50** Marks |
| Credits: 3 | End-Semester: **50** Marks |

**Course Objectives:**

1. To educate the students about the realization of basic theoretical concepts & laws in electrical engineering in real physical world.
2. To make students familiar with three phase supply.
3. To make students familiar with single phase transformers.
4. To understand the construction and applications of diode and BJT
5. To understand basics of combinational logic, Boolean algebra and flip -flops.

**Course Outcomes:**
After completion of course, students will be able to
**CO1:** Analyze and calculate parameters of DC circuits
**CO2:** Analyze and calculate parameters of AC circuits
**CO3:** Calculate performance parameters of single-phase transformer.
**CO4:** Analyze I-V characteristics of semiconductor diodes and transistors and design simple analog circuits using these devices
**CO5:** Build simple combinational and sequential logic circuits.

**Unit – I: DC Networks (08)**

Kirchhoff's laws, Mesh and Nodal Analysis, Thevenin and Superposition Theorems, maximum power transfer theorem, Network Simplifications using star-delta / delta-star transformations.

**Unit – II: AC Circuits (07)**

Series and parallel RL, RC and RLC circuits , concept of Impedance and admittance, power triangle and power factor. Resonance in series and parallel RLC circuit, Three phase voltage generation and waveform, star and delta balanced systems. Relationship between phase and line quantities, phasor diagram, power in a three phase circuit.

**Unit – III: Electromagnetism and Single Phase Transformers (06)**

Magnetic materials and B-H curve, self and mutual inductance,1 Φ transformer: concept, types, working, ideal transformer, practical transformer, equivalent circuit, phasor diagram, efficiency and regulation calculations.

**Unit – IV: Diodes and rectifiers (07)**

Construction and characteristic of p-n junction diode, LED, photodiode, Half wave, full wave and bridge rectifiers, need of capacitor filter, rectifier operation with capacitor filter, Zener diode as a voltage regulator, block diagram of Regulated power supply

**Unit – V: Junction Transistor Amplifiers (07)**

Bipolar junction transistor, Construction of BJT, Types of biasing:-fixed bias and self bias circuit, BJT characteristics for-CE,CB,CC configurations, relationship between $\alpha$ and $\beta$, load line for a transistor, application of transistor as a switch and amplifier.

**Unit – VI: Digital Electronics (07)**

Basic gates, implementation of basic gates using universal gates, Boolean algebra, standard representation of logic functions (SOP and POS forms), Introduction of Combinational logic circuits like multiplexer ,demultiplexer, half adder and full adder, Introduction of Sequential logic circuits like flip- flops (SR, D), counters and shift registers.

**Text Books:**

1. Hughes, 'Electrical and Electronic Technology', Pearson education, (10th edition), (2008)

**Reference Books:**

1. D.P. Kothari and I.J. Nagrath, 'Basic Electrical Engineering', McGraw-Hill, (3rd edition), (2010)
2. A.E.Fitzgerald, A.Grabiel,'Basic Electrical engineering',McGraw-Hill, (5th edition), (2009)
3. Floyd, 'Electronic Devices and Circuits', pearson education, (7th edition),(2008)
4. AP Malvino & Donald Leach,'Digital Principles and Applications', McGraw Hill Education,( 6 th edition), (2009)

## IKS101 Indian Knowledge System

**Teaching Scheme:**
Lecture: 2 Hrs. /week
Credits: 2

**Examination Scheme:**
In semester: 50 marks

**Course Objectives:**

1. Creating awareness amongst the student about the true history and rich culture of the country
2. Understanding the scientific value of the traditional knowledge of Bhārata
3. Converting the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm
4. After completion of this course the students will get a holistic insight into the understanding the working of nature and life

**Course Outcome:**

After completion of this course a student should be able to

**CO1**. Reproduce ancient Indian philosophy and knowledge

**CO2**. Describe ancient Indian Science & Arts

**CO3**. State ancient Indian Medicine practices

**CO4.** Describe ancient Indian Architecture and Technology

**Unit – I: Ancient Indian philosophy and knowledge system (07)**
Vedic Period: Vedas and their Significance, Upanishads: Philosophy and Knowledge, The Six Schools of Indian Philosophy: Overview, Indian Linguistics: Panini and Sanskrit, Evolution of Other Indian languages - Tamil, Marathi, Hindi etc , Ancient Indian Education System: Gurukul System, Ancient Indic Religions: Hinduism, Buddhism, Jainism and Sikhism: Teaching & Philosophy

**Unit- II: Ancient Indian Science (08)**
Ancient Indian Mathematics: Overview and Contributions, Ancient Indian Astronomy and Astrology: Overview and Contributions, Charak & Sushrut Samhita, Ayurveda: Principles and Practices, Trade and Commerce in Ancient India, Arthashastra, Ancient Indian Farming Practices

**Unit- III: Ancient Indian Art and crafts (06)**
Ancient Indian Art and Culture, Ancient Indian Music and Dance, Ancient Indian craftsmanship

**Unit- IV: Ancient Indian Architecture (07)**

Ancient Indian Architecture: Vastu Shastra and Temple Architecture, Ancient Indian Warfare and Weaponry, Ancient Indian Engineering and Technology, Ancient Indian Knowledge Systems: Global Influence

**Text Books:**

Introduction to Indian knowledge system: Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat, Nagendra Panana R.N. PHI Publication

**Reference Books:**

1. Knowledge System in India by Amit Jha, Atlantic Publishers & Distributers (P) LTD
2. Textbook on the Knowledge System of Bhārata by Bhag Chand Chauhan.

## CC101 Liberal Learning course - 1

**Teaching Scheme:**
Lecture: 1 Hrs. /week
Practical: 2 Hr/week
Credits: 2

**Examination Scheme:**
In semester: 50 marks

**Course Objectives:**

1. To encourage the holistic development of students through art forms.
2. To develop life skills of the students through individual and group activities.

**Course Outcome:**

After completion of this course the students will be able to

**CO1:** Present the creative work through art forms.

**CO2:** Demonstrate the ability to lead and participate in teams.

**NOTE:**

1. Hands on session of 2 hrs/ week for 12 weeks will be conducted.
2. Student will opt for any **one** of the following five modules.

**Module 1: Culinary Arts** **(12)**

Planning a meal, Pre-cooking preparation, ingredients measurements, cleaning of vegetables, chopping and actual cooking.
Preparation and cooking Chinese dishes sandwiches, donuts, mocktails, cookies, salads, noodles, pasta, wheat brownie etc.

**Module 2: Dance** **(12)**

Warm up sessions, basic dance steps on Bollywood music, Zumba, folk dance, choreography.

**Module 3: Gardening** **(12)**

Fundamentals of gardening, projects like terrarium, kokedama, etc. knowledge of soil, fertilizers and seeds. Fundamentals of landscape designing.

**Module 4: Painting** **(12)**

Indian art forms, viz. Warli, Madhubani, Mandala, and Dot Painting. Familiarity with variety of materials, viz. acrylic, pencil, and water colour paints.

**Module 5: Theatre** **(12)**

Variety of exercises and activities such as improvisation, character development, scene work, vocal and physical warm-ups, script analysis, and feedback sessions. Technical aspects of theatre production such as lighting, sound, and set design.

**Textbooks:**

**Culinary arts: "**Theory of Cookery" by Krishna Arora, Macmillan Publishers

**Dance: "**Text book of Dance" by Gyanendra Dutt Bajpai, Kanishka Publisher

**Gardening: "**Gardening in India" 2nd Edition, by T K Bose, D Mukharjee, Oxford and IBH Publishers

**Painting: "**Panoramic Indian Painting" by R C Luthera, C K Luthera, Nidhi Sekhon Vishal Publishing Co.

**Theatre: "**Indian Theatre: Drama, Music and Dance" by Shovana Narayan, Shubhi Publishers.

**References: Online resources:**

**Culinary arts:**

Kai Sean Lee, "Culinary aesthetics: World-traveling with culinary arts", Annals of tourism research, 97 (1) Nov 2022

**Dance:**

Malathi B, "Development of Dance In India", International Educational Applied Scientific Research Journal, Volume: 5 ¦ Issue: 1 ¦ Jan 2020

**Gardening:**

Selma Lunde Fjaestad , Jessica L Mackelprang , Takemi Sugiyama "Mental health outcomes associated with gardening" July 2023, Book: Cultivated Therapeutic Landscapes (pp.104-130)

**Painting:**

Maarit Anna Maleka, Tero Heinkkinen, Nithikul Nimkulrat "Drawing as a research tool: Making and understanding in art and design practice" article, February 2014, ResearchGate

**Theatre:**

Heli Aaltonen , Ellen Foyn Bruun "Practice as research in drama and theatre: Introducing narrative supervision methodology:, July 2014, Nordic Journal of Art and Research 3(1)

Dr.C.M.Vinay Kumar , Romesh Chaturvedi "Art of the Theatre on New Media Platform & Audience viewing Experience.", Global Media Journal-Indian Edition, Winter Issue/December 2013/Vol. 4/No. 2

## AEC 101 Professional Communication

| **Teaching Scheme** | **Examination Scheme:** |
|---|---|
| Lecture: 1 Hr/week | In semester: 50 marks |
| Practical: 2Hrs/week | |
| Credits: 2 | |

**Course Objectives:**

1. Enable engineering students to communicate effectively and work smoothly with classmates, clients and people involved in projects.
2. Nurture students' professional skills encompassing written, verbal and electronic communication realms, with a primary focus on refining their soft skills.

**Course Outcome:**

After completion of this course a student should be able to

**CO1**. Illustrate their Communication Skills through impactful presentations.

**CO2**. Develop proficient written communication skills for tasks such as drafting resumes, cover letters, and summary of articles on recent trends in technology

**CO3**. Compose well organized professional emails and create social media profiles.

**Module I: Verbal Communication** **(06)**
Key concepts and barriers in effective communication, Elevator pitch for self: Delivery and practice, Presenting a news item: Analysis and delivery, Presentation on a topic related to technology / science / social science, Group Discussion.

**Module II: Written Communication** **(06)**
Resume Writing and Cover letter, Writing summary of an article on recent trends in technology, Book/ Movie review.

**Module III: Email Communication** **(02)**
Professional e-mails and creating an effective social media presence (e.g., LinkedIn Profile)

**Text Books:**

1. M. Ashraf Rizvi, "Effective Technical Communication", Tata McGraw-Hill Publishing Company Limited, New Delhi (2008)
2. Jeff Butterfield, "Soft Skills for Everyone" Cengage Learning India Private Limited, New Delhi (2019)

**Reference Books:**

1. William Strunk and E. B. White, "Elements of style", CreateSpace Independent Publishing Platform, (2018).
2. William K Zinsser, "On Writing well", HarperCollins, (2012).
3. Stephen King, "On Writing: A Memoir of the Craft", Pocket Books, (2002)

**Website URL:**
TED talks - https://www.ted.com/talks

**Lab Sessions: (2hrs each)**

1. Exercise on Listening Skills to understand barriers in Communication.
2. Elevator Pitch.
3. Presenting a News item
4. Group Discussion on topics related to technology/ science / social science.
5. Preparing a Cover Letter and Resume.
6. Writing a summary of an article on recent trends in Technology.
7. Creating a LinkedIn Profile.
8. Writing a Book/Movie review.
9. Drafting a professional email.

## BSC102L Chemistry Lab

**Teaching Scheme:**
2 hours / week
Number of Credits: 1

**Examiation scheme:**
Term Work: 25Marks

**Course outcomes**

After completion of this course a student should be able to

**CO1 :** Apply chemistry principles for quantitative analysis.
**CO2 :** Make use of an instrument for chemical analysis.
**CO3 :** Calculate chemical parameter based on recorded observations.
**CO4 :** Evaluate quality of coal and polymer based on their chemical properties.
**CO5 :** Prepare a chemical substance such as soap, zeolite, biopolymer etc. based on experimental procedure.

**LIST OF EXPERIMENTS:**

1. Determination of total hardness of sample water by EDTA Method (complexometric titration)
2. Determination of total alkalinity of sample water.
3. Measuring EMF of electrochemical cell to predict spontaneity as well as to calculate Gibb's free energy and equilibrium constant.
4. Viscometric method to determine Molecular weight of a Polymer.
5. Estimation of sodium from given solution using flame photometry.
6. Colorimetric estimation of $KMnO_4$ from solution.
7. Proximate analysis of coal samples and Comment on it's quality.
8. Laboratory preparation of soap.

## ESC102L Basic Electrical and Electronics Engineering Lab

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Practical: 2 Hrs./Week | In semester : 25 marks |
| Credits: 1 | |

**Course Outcomes:**

After completion of course, students will be able to

**CO1:** Perform basic domestic wiring

**CO2:** Apply circuit laws to find the parameters of given electrical network

**CO3:** Build a basic regulated DC power supply

**CO4:** Obtain frequency response of CE amplifier

**CO5:** Build basic digital circuits

**List of experiments:**

- Introduction of different electrical and electronics components and instruments.
- To perform electrical wiring to control lamps using one way and two-way switches.
- To verify Thevenin's theorem & superposition theorem.
- To determine phase angle of L-C-R series circuit.
- To perform load test on single phase transformer to determine regulation and efficiency.
- To determine output voltage and ripple voltage of half wave, full wave rectifier with center tap transformer and bridge rectifier with and without filter.
- Assemble and build simple DC regulated power supply.
- To determine frequency response of CE amplifier.
- Assemble and build half adder & full adder circuits.

## VSEC101L Programming Skills in C Language Lab

**Teaching Scheme:**
Practical: 4 Hr/week

**Credits: 2**

**Examination Scheme:**
In-Sem: 25 Marks
Practical/oral: 25 Marks

**Course Objectives:**

To facilitate the learners:

1. To learn the fundamentals of C programming for logic building.
2. To implement a solution of given problem using appropriate data type, operators of C language.
3. To understand the decision and iteration interpretation in a programming language.
4. To implement the logic using arrays, strings, functions, pointers and structures of C programming language.

**Course Outcomes:**

After completion of course, students will be able to

**CO1**: Develop the logic for a given problem using flowchart/ algorithm/ pseudo code.
**CO2**: Apply appropriate basic language constructs, decision and iterative constructs for solving the given problem.
**CO3:** Implement the solution for a given problem using Arrays, String, Structures and functions.
**CO4**: Apply C programming skills to simulate real life problems/scenarios/applications.

Intent of this laboratory is to build the logic development and problem solving skills of students and build proficiency and competency in C language. For this purpose a sample list of assignments are grouped into Group A, Group B and Group C with increasing levels of difficulty and understanding.

Group A assignments are based on real life problems using language constructs such as constant, variable, data type, operator, array, string, expressions, decision, iteration etc.

Group B assignments are based on the applications of language constructs and combination of language constructs, control structures, String, Arrays, Pointers, Structures, Functions.

Group C assignments are a little more challenging. Assignments will be open ended which can either be a mini project or simulation of real life problems/scenarios/applications. It can also include Debugging and Feature enhancement / Alternative solution/ testing / Code-refactoring of given problem statements or Analyze the given code and comment on the output.

Instructors can conduct a total of 10 assignments, six from Group A, three from Group B, one from Group C. Other assignments can be considered as extra assignments.

Instructors must enhance assignment by coming up with new application domains, by combining multiple constructs in one assignment or more complex logic.

**Suggestive List of Assignments**

**Assignment 0:** Get acquainted with Windows/Linux Platform, C environment, IDE installation, structure of basic C program, compilation, debugging and execution of C program.

**Group A - Language constructs**

For Group A problem statements, students should draw flowchart/ algorithm/ pseudo code and convert it into a C program. Problems are based on constructs such as concepts of constant, variable, data type, operator and expressions, arrays, strings, iteration, decision making and others.

1) Convert measurement units such as feet to inches, inches to centimeters, and centimeters to meters, Kilograms to grams, grams to milligrams, Dollar to Rupees, Euro to Rupees, temperature conversion Degree to Fahrenheit, days into years, weeks and days and vice versa.
2) Basic problems of Engineering Mathematics and Physics like area calculation, sine wave calculation, speed calculation, determining type of triangle, verify pythagoras theorem etc.
3) Obtain the first 25 numbers of a Fibonacci sequence/prime numbers with and without recursion etc.
4) Search the data from an array of numbers/ characters/ string.
5) Calculate the total number of characters in the string and the total number of vowels in the string with the number of occurrences in the string.
6) Operations on matrices.
7) Find the maximum/minimum of given numbers.
8) Order the numbers in sequence.
9) Swap two data elements using pass by value, pass by reference and without using a third variable.
10) Number conversion (decimal to binary, binary to decimal, binary to octal, octal to binary)
11) Reverse a string without using a third variable.

**Group B - Applications of Language Constructs**

Group B problem statements address the applications of language constructs such as Loops for iteration, Arrays, Strings, Structures, Functions for modularity wherever required. They should implement the application using a function (call by reference/ call by value) wherever appropriate. Problems are based on real life applications/ scenarios.

1) Perform employee operations such as accept, display, search by name, search by number, update a record. Explore the possibility of modularity for implementation.
2) For a class an examination is conducted and the results for the students of all the 5 subjects are recorded. Write a C program to display the record of students. On the basis of the record compute:
   i. The average score of class
   ii. Highest score and lowest score of class
   iii. Marks scored by most of the students
   iv. List of students who were absent for the test
3) Write a menu-based modular program in C to perform following operations for complex numbers:
   i. reading a complex number
   ii. writing a complex number
   iii. addition of two complex numbers
   iv. subtraction of two complex numbers
   v. multiplication of two complex numbers
4) Two friends issued 5 books each from the library, Write a program in C to compute operations
   i List of all books with them
   ii. List common titles with them
   iii. List of books with friend 1 but not with friend 2
5) A list of names of users of a product of a company is provided. Write a modular C program to calculate the total number of characters in the name and the total number of vowels in the name with the number of occurrences in the name, search set of characters in name, and sort names.

6) Create a structure to specify data of customers in a bank. The data to be stored is: Account number, Name, Balance in account. Assume a maximum of 200 customers in the bank. (a) Write a function to print the Account number and name of each customer with balance below Rs. 100. (b) If a customer requests for withdrawal or deposit, it is given in the form: Acct. no, amount, code (1 for deposit, 0 for withdrawal) Write a program to give a message, "The balance is insufficient for the specified withdrawal"

7) Find Permutations in which n people can occupy r seats in a theatre.

8) In a secret language DOG is written as HSK, CAT is written as GEX. Write a program to accept a string from a user and convert it into the secret language and accept a string in the secret language and convert it back to English.

**Group C**

Group C problem statements address big real life problem solving. Students are expected to apply the learnt concepts to solve these problems. Students should choose any one of the following:-

1) Mini Project - Small games like - tic-tac-toe, Create Crossword, Solving sudoku, Information system projects

   Students should implement a mini project/ game which simulates real life problems/scenarios/applications. They are expected to make use of the appropriate constructs of C language.

2) Debugging and Feature enhancement / Alternative solution / testing / Code-refactoring of given problem statement.

   Students will be given a large and ready code. Students are expected to read and understand the code, be able to debug the code, be able to enhance the feature in given code, to be able to find alternative solutions, or refactor the given code.

**Text Books:-**

1) Kernighan and Ritchie, " The C programming language" (2nd edition)., Prentice Hall of India, 1988.

2)G.Dromey,"How to Solve it by Computer",Prentice-HallInc.,Upper Saddle River,NJ, 1982.

3) Yashwant Kanetkar, "Let's C", Allied Publishers,1998.

**Reference books:-**

1) Reema Thareja, "Introduction to C programming", Oxford University press(2nd edition),2015.

2) Alan R. Feuer, "The C Puzzle book", Pearson,1999

3) E Balagurusamy, "Computing Fundamentals and C Programming", (2nd edition), TMH,

**Level 4.5 | First Year**

**Curriculum for UG Degree Course in BTech. Computer Engineering and Information Technology Programmes**

(Academic Year: 2023-24 Onwards)

## Semester-II

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| BSC101 | Physics | 3 | 0 | 0 | **3** | 50 | 50 | 0 | 100 |
| BSC201 | Multivariate Calculus | 3 | 1 | 0 | **4** | 50 | 50 | 0 | 100 |
| ESC101 | Engineering Graphics | 2 | 1 | 0 | **3** | 50 | 50 | 0 | 100 |
| ESC203 | Sustainable Engineering | 3 | 1 | 0 | **4** | 50 | 50 | 0 | 100 |
| CC202 | Liberal Learning Course-2 | 1 | 0 | 2 | **2** | 50 | 0 | 0 | 50 |
| *PCCxx201 | Programme core Course | 2 | 0 | 0 | **2** | 25 | 25 | 0 | 50 |
| BSC101L | Physics Lab | 0 | 0 | 2 | **1** | 25 | 0 | 0 | 25 |
| ESC101L | Engineering Graphics Lab | 0 | 0 | 2 | **1** | 25 | 0 | 0 | 25 |
| VSEC201L | Programming Skills in Python Language | 0 | 0 | 4 | **2** | 25 | 0 | 25 | 50 |
| | Total = | **14** | **03** | **10** | **22** | **350** | **225** | **25** | **600** |

*L=Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation,*
*ESE =End Semester Examination, Pr/Or = Practical/Oral.*

**PCCCE201: Object Oriented Paradigms in Java*
**PCCIT201: Networking Essentials*

## BSC101 Physics

| **Teaching Scheme** | **Examination Scheme:** |
|---|---|
| Lecture 3 Hrs per week | In semester Exam: 50 Marks |
| Number of Credits: 3 | End semester Exam: 50 Marks |

**Course Objectives:**

To introduce undergraduate students of technology to the principles, notions, basic physical ideas, mathematical relations and applications of physical optics, thermodynamics, quantum physics, solid state physics and the properties of nano as well asbulk materials.

**Course Outcomes:**

After completion of this course a student should be able to

**CO1**: Apply the generalized Coulomb law and the law of Electromagnetic Radiation to determine the electric fields due to the stationary and the accelerated charges.

**CO2:** Apply the laws of Physical Optics to determine intensity distributions of interference – diffraction patterns, and to identify polarization-types.

**CO3:** Apply the principles of Statistical Physics to determine the thermal distribution of matter in different energy states and the thermal response of engineering materials.

**CO 4:** Justify the selection of — quantum probability rules and single qubit logic gates.

**CO 5:** Differentiate between the physical properties of 'nano' materials and of their 'bulk'counterparts.

**Module 1: Electromagnetic Radiation and Interference:**

Expression for the electric field beyond Coulomb's law; Two dipole radiators and Physics of interference; Mathematical treatment (propagating waves, rotating vectors, complex functions)

**Module 2: Diffraction and Polarization:**

The resultant amplitude due to *n* equal oscillators; Diffraction Grating; The electric vector of light; Types of Polarized Light; Birefringence; Polarizers

**Module 3: Statistical Mechanics and Thermodynamics:**

Principles of Statistical Mechanics (Distribution of particles in thermal equilibrium); Laws of Thermodynamics (Carnot Cycle, Entropy, Clausius-Clapeyron Equation); InformationEntropy

**Module 4: Quantum Physics:**

Laws of combining probability amplitudes; The Hamiltonian matrix & Schrödinger equation; Two-state systems: Pauli spin matrices & Photon polarization states; Single Qubit Logic Gates

**Module 5: Properties of Solids:**

Band Theory; Electrical (conductivity, resistivity), Magnetic (dia-para-ferro), Optical (absorbance, reflectance, transmittance), Mechanical (hardness, elasticity) properties (of 'bulk' & 'nano' solids)

**Text Book:**

R. P. Feynman, R. B. Leighton and M. Sands, 'The Feynman Lectures on Physics', *Pearson Education* (2006)

**Reference Books:**

1. J. Walker, D. Halliday, R, Resnick, 'Principles of Physics', Wiley *Student Edition* ($10^{th}$ Edition)

2. H. Young and Roger Freedman, 'University Physics', Pearson Addison Wesley($12^{th}$ Edition)

## BSC201 Multivariate Calculus

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures: 3 Hrs/Week | In-Semester: **50** Marks |
| Tutorial: 1 Hr/Week | End-Semester: **50** Marks |
| Credits: 4 | |

**Course Objectives:**

1. To familiarize the students with techniques of differentiation and integration of multivariable function.
2. To equip the students to deal with advanced level of Mathematics, and applications that would be essential for their disciplines.

**Course Outcomes:**

After completion of this course, students will be able to

**CO1:** Calculate partial derivatives and solve problems using partial derivatives.

**CO2:** Analyze stationary points and calculate extrema of function of several variables.

**CO3:** Solve double integral, triple integral over the region.

**CO4:** Determine physical parameters using double and triple integral.

**Course Content:**

**Unit – I: Partial differentiation**

Function of several variables, partial derivatives, Geometrical interpretation of partial derivatives, chain rule, higher order partial derivatives, Euler's theorem.

**Unit – II: Applications of partial differentiation.**

Maxima, minima and saddle points, second derivative test, constrained extrema and Lagrange's multipliers, applications in optimization of functions of several variables. Applications of first order partial derivatives in data fitting using the method of least squares.

**Unit – III: Double integration**

Tracing of curves in Cartesian and Polar coordinate system, double integrals over a rectangle, double integrals over regions, change of order of integration, Introduction of Jacobian determinant for two variables, double integral in polar coordinates, The Gaussian integral.

**Unit – IV: Triple integration**

Triple integral over a box, triple integrals by iterated integration, change of variables, Cylindrical and Spherical coordinates, The Jacobian determinant for three variables, evaluation of triple integral.

**Unit – V: Applications of Double and Triple integration**

Applications of double integral and triple integral: Area of plane Lamina, mass of plane lamina, surface area, volume, mass of solid.

**Text Books:**

1. B. V. Ramana, **'Higher Engineering Mathematics ',** *Tata McGraw Hill Publications,* (2007).

2. B.S. Grewal, **'Higher engineering Mathematics'**, *Khanna publishers, (*$40^{th}$ edition), (2008).

3. Hughes-Hallett et al., '**Calculus - Single and Multivariable',** *John-Wiley and Sons,* ($3^{rd}$ Edition), (2003).

4. Maurice Weir, Joel Hass, '**Thomas' Calculus'**, *Pearson India*, ($13^{th}$ edition), (2016).

**Reference Books:**

1. J. E. Marsden, A. J. Tromba and A. Weinstein, '**Basic Multivariable Calculus'**, *Springer,* ($3^{rd}$ edition), (1993).

2. G. B. Thomas and R. L. Finney, '**Calculus and Analytic geometry'**, *Pearson, Reprint* ($9^{th}$ Edition), (2002).

3. Sudhir Ghorpade, Balmohan Limaye, '**A Course in Multivariable Calculus and Analysis'**, (Undergraduate Text in Mathematics), *Springer* (2009).

4. Dennis G. Zill, Warren S. Wright**, 'Multivariable Calculus**, **Early Transcendental'**, *Jones & Bartlett Publisher*( $4^{th}$ edition), (2009).

## ESC101 Engineering Graphics

**Teaching Scheme:**
Theory: 2 Hrs/week
Tutorial: 1 Hr/week
Credits: 3

**Examination Scheme:**
In semester: 50 Marks
End semester: 50 Marks

**Course Objectives:**

1. To develop the visualization and interpretation skills for the physical objects.
2. To provide the basic knowledge and develop the skills for creating 2 D drawings.
3. To provide the basic knowledge and develop the skills for creating Isometric views.
4. To familiarize about the development of solids.
5. To familiarize the construction and applications of Engineering Curves.

**Course Outcomes**:

After completing the course students will be able to draw

**CO1**: Orthographic and sectional orthographic projections of an object
**CO2**: Isometric views of the given object
**CO3**: Development of surfaces of the given object
**CO4**: Engineering curves by applying the given method.

**Unit 1**

Introduction: Layout and sizes of drawing sheets, drawing instruments, types of lines used in drawing practice, dimensioning systems, representation of tolerances, standard codes by B.I.S (SP- 46). (Not for Examination**)**

**Unit 2**

Orthographic Projection: Theory of projections, methods of obtaining orthographic views, sectional orthographic projections, Missing views**.**

**Unit 3**

Isometric Views: Isometric axes, Isometric scale, isometric projections and views, construction of isometric view from given orthographic views

**Unit 4**

Development of Solids: Parallel line development, radial line development, methods to transfer points for development of prisms, pyramids, cylinder andcone.

**Unit 5**

Engineering Curves: Construction of ellipse, parabola, hyperbola, involute, cycloid, Archimedeanspiral, helix on cone and cylinder.

**Text Books:**

1. N. D. Bhatt and V. M. Panchal,'Engineering drawing, plane and solid geometry', Charotor Publication House.
2. R. K. Dhawan,'A text book of Engineering Drawing', Pearson Education Inc.
3. P.S. Gill, 'Engineering Graphics', Kataria and sons Publications.
4. M. L. Dabhade, 'Engineering Graphics', Vision Publications.

**Reference Books:**

1. Warren J. Luzzader, 'Fundamentals of Engineering Drawing', Prentice Hall of India, New Delhi.
2. Fredderock E. Giesecke, Alva Mitchell, 'Principles of Engineering Graphics',Maxwell
3. Dhananjay A. Jolhe, 'Engineering Drawing', Tata McGrawHill Publishing Co. Ltd.

## ESC203 SUSTAINABLE ENGINEERING

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lecture: 3 Hrs/week | In semester: 50 marks |
| Tutorial: 1Hr/week | End Semester: 50 Marks |
| Credits: 4 | |

**Course Objectives:**

1. To understand interdisciplinary approach towards sustainable development.
2. To acquire knowledge, skills, values & attitudes that empowers to contribute to sustainable development.
3. Understand the relevance and importance of natural resources & protection of environment for sustainability.
4. To understand the role of engineering & technology within sustainable development.

**Course Outcome:**

After completion of this course a student should be able to

**CO1: Identify** the need of sustainable development.

**CO2: Explain** the challenges in achieving environmental sustainability.

**CO3: Compare** & suggest suitable method of water harvesting.

**CO4: Calculate** energy efficiency of building.

**CO5: Distinguish** between smart cities with other cities.

**Unit I: Introduction to Sustainable Engineering**

Need & concept of sustainability, Three circle model- Social, environmental & economic, Role of sustainable engineering, Goals and Challenges of sustainable development

**Unit II: Environmental Sustainability**

Environmental issues- resource degradation, climate change, global warming, ozone layer depletion, Sources, effect, collection & disposal of solid waste, Concept of LCA & Circular economy (3 R concept), zero waste concept, carbon credits & carbon foot print, Assessment tools for sustainability, Disaster Management.

**Unit III: Sustainable Use of Water Resources**

Need of water conservation, Traditional & modern methods of Rainwater harvesting, sustainable use of water, source, effect & treatment of waste water, Household/ Domestic Solutions, Agricultural Solutions.

**Unit IV: Sustainable Use of Energy Resources**

Energy resources -Basic concepts- Conventional & non-conventional, Solar energy, wind energy, biofuels, energy derived from oceans, geothermal energy, Sustainable Approach to Energy Management, low-carbon energy systems, hydrogen fuels, carbon-neutral fuels, Energy storage, Waste to energy technology, Methods for increasing energy efficiency of building.

**Unit V: Sustainable Urbanization**

Basic concepts of sustainable habitats, Integrated build environment, Concept of Urban forestry, Concept of New urbanism, Concept features & strategies of Smart city, Green building, Concept of smart village, case studies.

**Text Books:**

R.L.Rag, Lekshmi Dinachandran Ramesh - Introduction to Sustainable engineering

**Reference Books:**

1. Bhavik R. Bakshi - Sustainable engineering (principles and practise) -*Ohio state university*
2. Allen D.T and shonnard D. R- Sustainability engineering concept design and case studies.
3. Mokia schoiz- Sustainable Water treatment engineering solution for variable climate
4. *Handbook of Sustainable Engineering* W. Wimmer, and Joanne Kauffman (Eds.), Springer (Available in June 2011).

## CC202 Liberal Learning Course-2

**Teaching Scheme**
Lecture: 1 Hr/week
Lab: 2 Hrs/week
Credits: 2

**Examination Scheme**
In-Semester: 50 marks

- Student will opt for any **one** of the following 3 options.
- Brief description/syllabus of the modules proposed under this course are as follows:

**A:** Foreign Language (German/French/Japanese)
Basics of language: Reading, Writing and Listening, Vocabulary, Greetings words
Grammatical rules, Verb categorization, Dialogue oriented vocabulary with little grammar

B: Personality Development and Leadership
Personality, Self-Assessment, Individual personality attributes and characteristics, Factors determining work performance.
Leadership traits, Leadership Development

**C:** Yogasana& Meditation
Preparatory Movements/ Loosening Exercise, Surya namaskar, Science of Yoga and Breathing Techniques
Pranayama and Meditation

# CC202 Liberal Learning Course-2

## A: Foreign Language (German/French/Japanese)

**Teaching Scheme**
Lectures: 1 Hour / Week
Lab: 2 Hours/ Week
Credits: 2

**Examination Scheme**
In-Semester: 50 Marks

**Course Objectives:**

1. Enable engineering students for primary communication in foreign language and to understand intonation of language while indulging in day to-day dialogues
2. Acquaintance with skills of reading, writing, and listening thereby helping for better communication.

**Course Outcomes:**
After completion of the course, students will be able to

**CO1** Read and Write Basics of Foreign Language

**CO2** Demonstrate listening skills and memorising vocabulary and to apply the same when communicating with proper grammar.

**CO3** Express their thoughts and confidently speak about day to-day dialogues.

**Unit I: Basics of language writing and reading**
Alphabets, Numbers, Vocabulary, Months, Seasons, Weekdays, Fruits, Colors, Vegetables, Greetings words, Me- Myself, Family Introduction, Time Expression, Food and Beverages etc

.

**Unit II: Reading, Writing and Listening**
Grammatical rules and their application in communication skills. Nouns, Pronouns, Articles, Cases, Verbs and their declination, Verb categorization, Usages of verbs in present tense, W questions etc. Focus on the Listening skills with the help of audio tracks in foreign languages, Introducing dialogue-oriented vocabulary with little grammar. Describe your House, Food and Clothing, Shopping, Professions, Festivals, Hobbies etc.

**Reference Books:**

1. Sprachlotsen 1 German course book for Maharashtra State Board
2. Deutsch Kreative International- German Composite Course for $10^{th}$ standard.
3. Easy Japanese - NHK
4. Apprenons le francais – Mahita Ranjit – French

# CC202 Liberal Learning Course-2

## B: Personality Development and Leadership

**Teaching Scheme**
Lectures: 1 Hour / Week
Lab: 2 Hours/ Week
Credits: 2

**Examination Scheme**
In-Semester: 50 Marks

**Course Objectives:**

1. Understand various aspects of personality and its traits
2. Study different techniques for personality development and leadership
3. Understand leadership skills, styles, and its traits

**Course Outcomes:**

After completion of the course, students will be able to

**CO1:** Demonstrate the Self-awareness in aspects of goals, values, emotions and self-image

**CO2:** Apply techniques for Self-management and Personality Development

**CO3:** Illustrate the leadership skills, traits for Leadership Development

**Unit I:** **Self-management & Integrated Personality Development**

**Personality:** Definition, Personality Traits, **Self-knowledge**: Exploring habits, Preferences and experience, Knowing ambitions, goals and Core values, **Self-Assessment**: SWOT analysis, Personality quotients (Intelligence Quotient- IQ, Emotional Quotient- EQ, Social Quotient- SQ) Interpersonal Relationship, Time management, Ethics, Integrity, Values, Attitude, Responsibility, ways to develop positive attitude.

**Integrated Personality Development:** Gradual growth in different dimensions of personality: Physical, Intellectual, Emotional, Moral, Social and Spiritual, enhancing self-image and self-confidence, **Factors determining work performance:** Self-esteem, Goal setting

## CC202 Liberal Learning Course-2

## B: Personality Development and Leadership

**Unit II:** **Leadership:** Communication Skills, interpersonal Skills, Team Building, Mental Strength, Self-confidence, Self-assurance, Empathy and listening skills, Stress Management & Time Management

**Leadership Development:** Decision-making skills, Conflict: Process & Resolution, Developing effective Habits, Effective Speech, Good manners & Etiquettes Emotional Intelligence

**Leadership styles:** Autocratic Leadership, Pace-setting Leadership, Transformational Leadership, Coaching Leadership, Democratic Leadership, Affiliative Leadership, Delegative Leadership

**Textbooks:**

1. Mark J., "Personality Development", Zen Consultants 2002
2. Joshi V. "Leadership and Personality Development", Symbiosis Centre of Distance Learning 2011

**Reference Books:**

1 Mitra B.K., "Personality Development and Soft Skills", Oxford 2013
2 Dale Carnegie, "The Leader in You", Prabhat Prakashan, Delhi, 2018

**Online Resources:**

1. [www.ted.com](www.ted.com)

## CC202 Liberal Learning Course-2

## C: Yogasana & Meditation

**Teaching Scheme**
Lectures: 1 Hour / Week
Lab: 2 Hours/ Week
Credits: 2

**Examination Scheme**
In-Semester: 50 Marks

**Course Objectives:**

1. To enable the student to have good health.
2. To practice mental hygiene.
3. To possess emotional stability

**Course Outcomes:**

After completion of the course, students will be able to

## CC202 Liberal Learning Course-2

## C: Yogasana & Meditation

**CO1:** Demonstrate Flexibility and Mobility & Lung capacity through Practice of Asanas.
**CO2:** Practice Stress Management through Meditation & Mental wellbeing.
**CO3:** Explain common Health Problems and their Remedies.

**Unit I: Introduction – Yoga**

Introduction - Preparatory Movements/ Loosening Exercise, Suryanamaskar Science of Yoga and Breathing Techniques, Dwipad Uttanasana, Setubandhasana, Markatasana, Pawanmuktasana Kriya, Markatasana Variation, Sarvangasana (Shoulder Stand), Bhujangasan, Salabhasana, Adho Mukha Svanasana, Naukasana, Padmasana Yog Mudra, Vajrasana Yog Mudra, Naukasana, Paschimottanasana, Akarna Dhanurasana, Vakrasana, Ardha Matsyendrasana, Tadasana , Vrikshasana , Virasana, Ugrasana , Trikonasana, Garudasana, Nataraj Asana

**Unit II Pranayam and Meditation**

Preparation For Pranayam, Experience of Relaxation, Shuddhi Kriya- Kapalbhati, Deep Breathing, Fast Breathing (6 Types), Pranayam and Meditation, Anulom Vilom, Brahmari, Ujjayi, Meditation / Omkar, Dhyan

**Reference Books:**

1. Yoga Pravesh – Yogacharya Dr. Vishwas Mandlik
2. Yoga Parichay – Yogacharya Dr. Vishwas Mandlik

## PCCCE201 Object Oriented Paradigm in Java

**Teaching Scheme:**
Lecture: 2 Hr/week
Credits: 2

**Examination Scheme:**
In-Sem: 25 Marks
End-Sem: 25 Marks

**Course Objectives:**

To facilitate the learners:

1. To Apply object-oriented concepts for given problems.
2. Construct readable and reusable code using inheritance, abstract class, interface and polymorphism.
3. Understand the significance of Exception handling in Java.
4. To design and implement an application using Java Programming.

**Course Outcome:**

By taking this course, the learner will be able to:

**CO1:** Make use of object oriented programming concepts using Java such as Class, Object constructor and control structures for program development.

**CO2:** Apply polymorphism and Inheritance for readability and reusability of code.

**CO3:** Apply concepts of abstract class, interface and packages for program development.

**CO4:** Demonstrate Exception handling concepts using in-built classes and user defined exceptions.

**Course Content:**

**Unit-I : Introduction to Object Oriented Paradigm in Java**

Need of object-oriented paradigm, basic concepts of object oriented programming (OOP), benefits of OOP. General characteristics for OOP, History of Java, Features of Java, Java and Internet, Java virtual machine, First java Program, Command line arguments, Java Programming elements: Data types, Control Structures, Encapsulation, Abstraction and Polymorphism, Class, object, constructor

Illustration through real life examples and use cases.

**Unit-II: Polymorphism and Inheritance**

Function overloading, argument passing, constructor overloading, this, static, final keywords.

Types of inheritance, base class and derived class, access specifiers, method overriding.
runtime polymorphism.
Illustration through real life examples and use cases.

**Unit-III: Abstract Class and Interfaces**

Abstract class, interfaces, dynamic method dispatch, package, Java Collection Framework overview - ArrayList, Stack
Illustration through real life examples and use cases.

**Unit-VI: Exception Handling in Java**

Errors and Exceptions, Types of exceptions, try, catch, throw, throws and finally keywords, Build-in exceptions, creating and using custom exceptions.
Illustration through real life examples and use cases.
Advance Java Concepts - Java Frameworks, Java for Application development, Java Full Stack Technologies, JAVA APIs.

**Text Books:**

1. Herbert Schilt, "J**AVA Complete Reference**", *Tata McGraw Hill, (9$^{th}$Edition),* (2014)
2. Eckel B., "**Thinking in Java**", *Pearson Education,* (3$^{rd}$ Edition)

**Reference Books:**

1. Kathy Sierra & Bert Bates, "**Head First Java**", *Oreilly publication,* (2$^{nd}$ Edition) (2009)
2. Barry Burd "**Beginning Programming with Java for Dummies**", *Oreilly publication,* (5$^{th}$ Edition) (2017)
3. Paul Deital and Harvey Deital, "**Java How to program**", *Prentice Hall Publication,*(9$^{th}$ Edition) (2011)

## PCCIT201 Networking Essentials

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures: 2 Hrs/Week | In-Semester: **25** Marks |
| Tutorial: - | End-Semester: **25** Marks |
| Credits: 2 | |

**Course Objectives:**

Familiarize students with the

1. Networking topologies.
2. Functionality of OSI data link layer and the key protocols associated with it.
3. Different media access control schemes.
4. Error detection mechanisms.

**Course Outcomes:**

After completion of this course, students will be able to

**CO1:** Select appropriate network topologies for various network scenarios.

**CO2:** Analyze various functions of OSI data link layer in data transmission.

**CO3:** Apply appropriate media access control methods.

**CO4:** Apply suitable error detection and correction mechanisms.

**Course Content:**

**Unit – I: Introduction to Networking**
The Architecture of the Internet, Principles of Layering and Encapsulation, Types of Networks: LAN, WAN, and MAN, Overview of Networking Devices, Introduction to Network Topologies, Point-to-Point and Point-to-Multipoint Topologies, LAN and WAN Design Demonstrations, Group Discussion: Analysing Network Designs

**Unit – II: Network Models and Protocols**
Communication Platforms and Networking Protocols, Introduction to the OSI Model, Understanding the TCP/IP Model, Protocol Data Units (PDUs) and Encapsulation, Comparing the OSI and TCP/IP Models, Network Addressing Schemes, Case Study: Protocol Analysis and Comparison, Demonstrations: OSI and TCP/IP Models

**Unit – III: Data Link and Ethernet**
Introduction to Ethernet, Ethernet Basics: Collision and Broadcast Domains, CSMA/CD and Half / Full-Duplex Ethernet, Data Link Layer Functions and Design Issues, Ethernet addressing and Frame Structure, Channel Bonding and Aggregation, Error Detection and Correction in Data Link Layer, Demonstrations: Ethernet Setup and Frame Analysis

**Unit – IV: Linear Block Codes and Physical Layer**
Introduction to Linear Block Codes, Basics of Error-Correcting Codes, Linear Block Code Properties and Encoding, Decoding Linear Block Codes: Syndrome Decoding, Error Detection and Correction in Linear Block Codes, Transmission Media: Guided and Unguided
Demonstrations: Linear Block Code Encoding and Decoding, Carrier Sense Multiple Access Protocol

**Text books:**

1. Behrouz A. Forouzan, "**Data Communications and Networking**," McGraw Hill Education (5E), ISBN: 978-0072967753
2. Jeffrey S. Beasley and Piyasat Nilkaew, "**Networking Essentials**," Pearson, ISBN-13: 978-0134872023
3. Cisco Press, "**Network Fundamentals**"

**Reference Books:**

1. Olivier Bonaventure, "**Computer Networking: Principles, Protocols and Practice**"
2. Harjinder Singh, "**Computer Networking: Principles and Protocols**"
3. William Stallings, "**High-Speed Networks and Internets: Performance and Quality of Service**"
4. Andrew S. Tanenbaum, "**Computer Networks**," Pearson (6th edition, 2021)

## BSC101L Physics Lab

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| Practical: 2 Hrs. / Week | In semester: 25Marks |
| Number of Credits: 1 | |

**Course Objectives:**

The objective of the Physics Lab course is two-fold:
To inculcate experimental skills, and
To demonstrate the interplay between theoretical & experimental physics.

**Course outcomes:**

After completion of this course a student should be able to

**CO 1:** Record the observations as per the least counts of measuring instruments and perform necessary calculations.
**CO 2:** Compare the experimental findings with the corresponding theoretical physics models.
**CO 3:** Determine errors in experimental findings and Analyze their sources and causes.
**CO 4:** Reach the conclusions pertaining to the observed behavior of physical systems.

**List of Experiments:**

Physical Optics Experiments:

I. Polarization of light, II. Diffraction Grating: Emission Spectra, III. Michelson Interferometer, and IV. Newton's Rings.

Electromagnetism & Heat Experiments:

I. Dia-Para-Ferromagnetism: Magnetic Permeability, II. Faraday's Law, and III. Hysteresis (B-H) Curve of Iron core, IV: Specific Heat of solid materials.

Modern Physics Experiments:

I. Planck's Constant, II. I - V Characteristic of LED, III. Hall Effect, and IV. Zeeman Effect.

## ESC101L Engineering Graphics Lab

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Practical: 2 Hrs./week | In Semester: 25 marks |
| Credits: 1 | |

### Course Objectives:

**To familiarize student about**

1.Advantages of using software for Engineering drawing
2.2-D drafting using a software
3. 3-D modeling using a software
4. 3-D printing technology

### Course Outcomes:

After completing the course using a software package students will be able to

**CO1:** Draw orthographic projections of a given component.
**CO2:** Draw Isometric projections of a given component.
**CO3:** Draw development of solids
**CO4:** Draw free hand sketches of the machine elements.

### Part I

**Introduction to 2-D Drafting using a drafting software**

- Orthographic Projections
- Isometric Projections
- Development of surfaces of solids
- Free hand sketching of standard machine elements

### Part II

**Demonstration of 3-D Modeling and 3-D Printing**

Creating a 3-D model of a simple component using a solid modeling software and manufacture using a rapid prototyping technique.

### Text Books:

N. D. Bhatt and V. M. Panchal,'*Engineering drawing, plane and solid geometry'*,Charotor Publication House.

M.L.Dabhade, 'Engineering Graphics', *Vision Publications.*

Bethune, J.D., "*Engineering Graphics with AutoCAD 2013*", PHI Learning Private Limited, Delhi, 2013

The objective of the Physics Lab course is two-fold:
To inculcate experimental skills, and
To demonstrate the interplay between theoretical & experimental physics.

**Course outcomes:**
After completion of this course a student should be able to

**CO 1:** Record the observations as per the least counts of measuring instruments and perform necessary calculations.
**CO 2:** Compare the experimental findings with the corresponding theoretical physics models.
**CO 3:** Determine errors in experimental findings and Analyze their sources and causes.
**CO 4:** Reach the conclusions pertaining to the observed behaviour of physical systems.

**List of Experiments:**
Physical Optics Experiments:

II. Polarization of light, II. Diffraction Grating: Emission Spectra, III. Michelson Interferometer, and IV. Newton's Rings.

Electromagnetism & Heat Experiments:

I. Dia-Para-Ferromagnetism: Magnetic Permeability, II. Faraday's Law, and III. Hysteresis (B-H) Curve of Iron core, IV: Specific Heat of solid materials.

Modern Physics Experiments:

II. Planck's Constant, II. I - V Characteristic of LED, III. Hall Effect, and IV. Zeeman Effect.

## VSEC201L Programming Skills in Java Language

**Teaching Scheme:**
Practical: 4 Hr/week
Credits: 2

**Examination Scheme:**
In-Sem: 25 Marks
End-Sem : 25 Marks

**Course Objectives:**

To facilitate the learners:

1. To explore the principles of object oriented programming
2. To apply object oriented programming concept for developing applications using Java
3. To make use of class, object and constructor for coding basic object oriented program
4. To handle built-in and user defined exceptions

**Course Outcome:**

By taking this course, the learner will be able to:

CO1: Apply basic object oriented constructs of Java such as class, object, data types, control flow, constructor for program development.

CO2: Develop readable and reusable code using inheritance and polymorphism

CO3: Make use of exceptions using inbuilt classes and user defined exceptions

CO4: Develop application using object oriented programming language Java to solve real life problem

**Suggestive List of Assignments**

**Assignment 0:** Get acquainted with Windows/Linux Platform, Java environment, IDE installation, structure of basic Java program, compilation, debugging and execution of Java program.

**Group A: Java Language Constructs**

1. Write a MyDate class which has attributes as day, month and year. Create five objects of MyDate and display them.

2. Write a Java program to simulate the traffic signal by creating a class called "TrafficLight" with attributes for color and duration, and methods to change the color of the signal.
3. Write a Java program that displays the number of characters, lines and words in a text.
4. A circle has a radius. Its area can be calculated. The area is a double number. Its perimeter can be calculated as $2\pi r$ . The perimeter is a double number. Given two circles one can find out which is large and which is small. Create two circles c1 and c2 with radius as 10 and 7 respectively. Calculate the area and perimeter of each. Compare two circles with each other and display which is large and which is small.
5. Design, code, test, and debug a user defined abstract data type 'Complex' in Java. Write a program using polymorphism to perform arithmetic operations of two complex numbers.
6. Write a Java program using inheritance to create a base class Sports with a method called play(). Create three subclasses: Football, Basketball, and Rugby. Override the play() method in each subclass to play a specific statement for each sport.
7. Write a Java program to create a class called Employee with methods called work() and getSalary(). Create a subclass called HRManager that overrides the work() method and adds a new method called addEmployee().
8. Write a Java program to create an interface Shape with the getArea() method. Create three classes Rectangle, Circle, and Triangle that implement the Shape interface. Implement the getArea() method for each of the three classes.
9. Write a Java program that works as a simple calculator to perform +, -,*, % operations. Handle any possible exceptions like divide by zero.
10. Write a Java program to implement Java Collection Frameworks like Stack and List.
11. Write a Java program to create a method that takes an integer as a parameter and throws an exception if the number is odd.
12. Write a Java program to create a method that takes a string as input and throws an exception if the string does not contain vowels.

**Group B: Applications of Language Constructs**

1. Create a student result database in Java. Calculate the grades of students. Decide criteria for best student and short-list students who satisfy the criteria.

a) A student has a roll No, name, marks in five courses and a grade. A student list has many students. If a student has grade equal or beyond 8, he is considered as a top band student.
b) Create at least ten students. From these, find all such students which satisfy the criteria of top band student. Create a list of such students and display the students in the list.

2. Create an application like a bookshop and maintain the inventory of books that are being sold at the shop. Reading material has a title and price. A book is a reading material. It has an ISBN number. A magazine is a reading material, it has a month of issue. A CD is a reading material, it has duration in minutes. Represent the above description as a generalization, specialization tree. Identify the parent class, its attributes, child class and their attributes. Implement and Test all of them.
3. Find appropriate class hierarchy, polymorphic behavior in applications like banking and implement it.
4. Model the HRD application using the concepts of inheritance, interface, polymorphism
5. Write a program to simulate the operations of a restaurant by creating appropriate classes and attributes and methods.
6. A company has many employees of different designations with different perks and deductions. When an employee is appointed, he is assigned with an employee Id, designation and perks. One can ask for the total salary of the employee and take-home salary of the employee. Identify a class/classes and relationships (is-a / has-a) from the above statement, identify the attributes, the data types, the behavior. Test your program for ten employees.
7. A vehicle has engine no and chassis number. It can be locked, unlocked. Every vehicle is movable (interface). It can be started, stopped, turned, accelerated, turned, and decelerated. A car is a vehicle. It has steering. An airplane is a vehicle. It has wings. A boat is a vehicle. It has a propeller. Identify a class/classes/interfaces from the above statement, identify the attributes, the data types, the behavior. Test your program for different types of vehicles.
8. Write a Java program to create a class called "Library" with a collection of books and methods to add, display and remove books, issue and return of books.

**Group C problem statements address big real life problem solving. Students are expected to apply the learnt concepts to solve these problems. Students should choose any one of the following:-**

1. Students should simulate real life problems/scenarios/applications. They are expected to make use of the appropriate constructs of Java language (Advanced Java concepts can be used)
2. Debugging and Feature enhancement / Alternative solution / testing / Code-refactoring of given problem statement. Students will be given a large and ready code. Students are expected to read and understand the code , be able to debug the code, be able to enhance the feature in given code, to be able to find alternative solutions, or refactor the given code.

# VSEC201 Programming Skills in Python Language

**Teaching Scheme:** | **Examination Scheme:**
**Practical: 4** Hours/week | **In Semester: 25** Marks
**Credits: 2** | **End Semester: 25** Marks

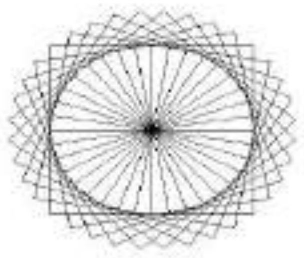
**Prerequisites:** Basic Mathematics.
**Course Objectives:**
Familiarize students with
1. The fundamentals of Python programming for logic building.
2. Appropriate data types, operators of Python language.
3. Conditional statements and loops in Python programming language.
4. List, strings, functions, and structures of Python programming language.

**Course Outcomes:**
Students will be able to:
1. Implement programs to solve real-life problems.
2. Implement Python programs using appropriate control structures, data type, operators and functions.
3. Execute Python programs.
4. Test Python programs for various inputs.

**Suggested list of assignments:**
1. Demonstration of installation and configuration of Anaconda and Spyder.
2. Accept and display class names and roll numbers of all the students from your class.
3. Create an empty dictionary for the film database, add films to the dictionary, update the key value and display all details of films.
4. Create an empty list of districts. Insert districts of Maharashtra, append districts of Gujarat, extend districts of Kerala, search for specific districts, access the first 5 districts, remove any one district and display all districts.
5. A) Create an empty tuple of cricket player names. Add a few player names to the tuple and display all the players in the tuple.
   B) Swap positions of two players using tuples and display the initial and swapped contents of the tuples.
6. Perform string manipulation functions (concatenation, substring, comparison, palindrome)
   a. Display your first name
   b. Concatenate your last name to first name
   c. Find substring "as" in your concatenated string
   d. Compare your first name with your friends first name and specify if it's same
   e. Check if following strings are palindrome or not
      i. Your first name
      ii. nitin
      iii. madam
      iv. noon
      v. Your friend's name.

7. Create a text file and add course outcomes of this course. Implement file operations on it.
8. Calculate area of the circular cricket ground for a given radius using:
    a. formula
    b. Inbuilt function from numpy library.
9. Plot sin(x) and cos(x) functions for values of x between 0 and pi. Use inbuilt libraries numpy and matplotlib.
10. Create a class named Person and assign values for name and age.
11. Implement a mini project based on String, function, directory, tuple and list.

**Extra assignments:**
1. Find out maximum and minimum salary of employee.
2. Calculate factorial using functions.
3. Generate fibonacci series using recursion.
4. Print multiplication table from 1 to 10
5. Design a two-player Rock-Paper-Scissors game
6. Python program to draw a circle of squares using Turtle



7. Generate a random number between 1 and 9 (including 1 and 9). Ask your friend to guess the number, then tell them whether they guessed too low, too high, or exactly right.
8. The company gives a dearness allowance 45% of basic salary and house rent allowance is 25% of basic salary. Write a python program to calculate gross salary.

**Text books:**
1. Reema Thareja, "Python Programming using problem solving Approach", Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Interdisciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
3. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and Updated for Python 3.2", Network Theory Ltd., 2011.

**Reference Books:**
1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)
2. Michael B. Feldman and Elliot B. Koffman. "Ada95: Problem Solving and Program Design", Addison-Wesley, Reading, Massachusetts, 1996.
3. Fredrik Johansson et al., "Mpmath: A Python library for Arbitrary-Precision Floating Point Arithmetic", December 2013. http://mpmath.org/.

# Rules & Scheme of evaluation for Internship / Project during 7th Sem

❖ **Preamble** : The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. In line with guidelines for AICTE and on the strong recommendations received through stake holder's feedback, CCEW have launched 6 months Internship program. Adopting an impactful internship based strategy at CCEW, Pune is with intent for creating a future talent pool for the industry. We expect, it will not only helps fresh passing-outs in gaining professional know-how but also benefits, corporate on fresh perspectives on business issues and even discovering future business leaders.

The main aim of this initiative is towards enhancement of the employability skills of the passing out students. At CCEW, we prepared a curriculum with the help of prominent academicians of the country so that our all programme could produce competent employable graduates as per the needs of the industries. The revised curriculum includes the internship for students of six months' duration in the 7th Semester of all programmes.

Keeping this in view, this developed this policy document is giving guidelines for organizing Internship. These guidelines comprise of Steps for Establishing, Maintaining & Fostering Internships. We hope, this internship experience will augment outcome based learning process and inculcate various attributes in a student in line with the graduate attributes defined by the NBA.

## I. Rules for internship / project during 7th semester:

1) Students can select and work on any option either project or internship (of any duration) as explained in Table 1. Credit and marks distribution and examination scheme for internship and project is discussed in Table 1.

**Table 1 Credits and marks distribution for internship and project work**

| Internship Industry (Months) | Project (In-house / Ind.) (Months) | Credits for Internship | Credits for Project | Marks for Internship | Marks for Project |
|---|---|---|---|---|---|
| 6 | -- | 15 | -- | 300 | -- |
| 5 | 1 | 13 | 02 | 250 | 50 |
| 4 | 2 | 11 | 04 | 200 | 100 |
| 3 | 3 | 08 | 07 | 150 | 150 |
| 2 | 4 | 05 | 10 | 100 | 200 |
| -- | 6 | -- | 15 | -- | 300 |

2) Students can opt for research internship but they need to follow college academic calendar.
3) Students need to report her decision about opting either project or internship (of any duration viz. 2, 3, 4, 5, 6 months) as an option to earn credits in 7th Semester to their respective department coordinator before 15th June of academic year.
4) In case, students opt for or need to work for Internship for plus project option then, they need to complete internship first and then only can work on selected project [change in this sequence is not permitted].
5) In case students (because of any reason) want to increase their project or internship duration, they need to take prior approval, 15 days before completion of their current(earlier) project or internship duration.
6) Students applying with excuse because of any reason(s) such as medical reason, personal tour etc. during internship duration will not be entertained.
7) Individual students can work on approved projects or a maximum of four students in a group can work on approved project work.
8) Interdepartmental /multidisciplinary projects are allowed. Further, students from different departments can form their project groups [in such case Guides from both the departments will guide the project & evaluate students' performances].
9) Students involved in co-curricular activities viz. BAJA / ROBOCON etc. can take up related and relevant technical tasks as their project. In such cases, to define project work content, prior approval and recommendations from authorities is required.

## II. Scheme of evaluation: Internship Option

- Credit distribution and examination scheme for internship option is discussed in Table 2.
- Further, Table 3 discusses Rubric parameters *[of equal weightage]* for evaluating student's performance evaluation during Internship duration.

### Table 2 Student performance evaluation during Internship duration and phase wise-marks distribution

| Internship Duration (Months) | Total Marks for Internship | ISE - I (Industry In-house / Mentor/ Guide ) | ISE - II (Industry In-house / Mentor/ Guide ) | ISE - III (Industry In-house / Mentor/ Guide ) | ISE (I+II+III) Total | ESE |
|---|---|---|---|---|---|---|
| **6** | 300 | 75 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **200** | **100** |
| **5** | 250 | 50 [Before ESE] | 50 [After 2 months] | 75 [After 4 months] | **175** | **75** |
| **4** | 200 | 50 [Before ESE] | 40 [After 2 months] | 60 [After 3 months] | **150** | **50** |
| **3** | 150 | 30 [Before ESE] | 70 [After 2 months] | --- | **100** | **50** |
| **2** | 100 | 15 [Before ESE] | 35 [After 2 months] | --- | **50** | **50** |

**ISE= In-Sem. Exam., ESE= End-Sem. Exam.*

### Table 3 Rubric parameters for evaluating Student performance evaluation during Internship duration

| Criteria [Phase – I] | Criteria [Phase – II & III] |
|---|---|
| 1. Regularity | 1. Log Book (Weekly) (Identification Scheduling w.r.t. time Completion) |
| 2. Eagerness to learn | 2. Tools and Techniques |
| 3. Professional work ethics | 3. Problem Scope identification, Procedure / algorithm/methodologyfollowed |
| 4. Ability to work in a team | 4. Design/ Implement /Validate System (Components, Processes etc.) |
| 5. communication skills | 5. Presentation |

*Oral all points same except in place of Log Book add report

- Further, faculty mentor can decide Rubric parameters for evaluating student's performance evaluation of Internship duration during End Sem. Evaluation (ESE).

## III. Scheme of evaluation: Project Option

- Credit distribution and examination scheme for project option is discussed in Table 4.

**Table 4 Student performance evaluation, Project duration andphase wise-marks distribution**

| Project Duration (Months) | Total Marks for Project | *ISE | | *ISE (I+II) Total | **ESE (Industry& In-house Mentors ) |
|---|---|---|---|---|---|
| | | ISE - I (Industry & College Guide ) | ISE - II (Industry & College Guide ) | | |
| **6** | 300 | 50 [After 2 months] | 150 [After 4 months] | **200** | **100** [After 6 months] |
| **4** | 200 | 30 [After 1.5 months] | 120 [After 3 months] | **150** | **50** [After 4 months] |
| **3** | 150 | 20 [After 1 month] | 80 [After 2 months] | **100** | **50** [After 3 months] |
| **2** | 100 | 15 [After 1 month] | 35 [After 2 months] | **50** | **50** [After 2 months] |
| **1** | 50 | 10 [After 1 month] | 15 [After 1 month] | **25** | **25** [After 1 month] |

**ISE= In-Sem. Exam, **ESE= End-Sem. Exam.*

- Rubric parameters for evaluating student's performance evaluation during Project duration for ISE I, II and ESE will be defined by respective programmes.
- It is strongly recommended to add research publication criteria for projects of duration more than 4 months.
- Individual or maximum four students per group can work on one project work.
- Inter-department project group formation is allowed [Guides from both departments will guide the project and evaluate students' performance]
- Students involved in BAJA / ROBOCON / ADIRA / with pre-approval from their HoD.

## Reference

1. AICTE INTERNSHIP POLICY: GUIDELINES & PROCEDURES
https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf
2. EXAMINATION REFORM POLICY
https://www.aicte-india.org/sites/default/files/ExaminationReforms.pdf
3. MANUAL FOR ACCREDITATION OF UNDERGRADUATE ENGINEERING PROGRAMS (Tier I Institutions)
https://www.nbaind.org/files/NBA_UGEngg_Tier_I_Manual.pdf

# 20HS701- Economics and Personal Finance

**Teaching Scheme**
Lectures: 2 Hrs/Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 2**

**Prerequisite:** Nil

**Course Objectives:**

1. To enable students to acquire knowledge and develop an understanding of basic concepts and principles of Economics & Finance
2. To make students acquaint with standard concepts and tools that they are likely to find useful in their profession when employed in the firm/industry/corporation in public or private sector
3. To sensitize students to the current economic issues of the nation
4. To develop an understanding of the role of institutions in the functioning of an economy
5. To understand Markets and behaviour of the firm
6. To enhance financial literacy of engineering students.

**Course Outcomes:**
After completion of the course, students will be able to

| | |
|---|---|
| CO1 | Demonstrate the importance of National and International economy in ones economic life |
| CO2 | Analyse the behaviors of consumer, firms and market and its impact on corporate finance |
| CO3 | Apply financial techniques to evaluate companies and investments |
| CO4 | Develop Personal Financial strategies using various investment options and taxation |

**Unit I: Macro Economics : Understanding Indian Economy- Domestic and International (03)**

Economics for Engineers, Definition and classification of Economics, Basic Economic Problems and Economic Systems, India Economy: Mixed economy, Sector-wise contributors Gross Domestic Product (GDP) of India, GDPs of other nations, Macroeconomics, Per Capita Income, Employment, Inflation calculation : Consumer Price Index (CPI), Wholesale Price Index (WPI), Fiscal Policy, Fiscal Deficit, Government expenditure and Taxation, Concept of Goods and Service Tax (GST), Monetary policy, Central Bank- Reserve Bank of India (RBI), Statutory Liquidity Ratio (SLR), Prime Lending Ratio (PLR), Cash Reserve Ratio (CRR).

**Unit II: Microeconomics : Understanding behaviors of Consumers, Firms and Markets (05)**

Consumer Behaviour, Concept of Demand and Supply, Determinants of Demand and Supply, Price Elasticity of Demand and Supply, Market Equilibrium and it's applications, Market and Market Structures- Perfect Competition, Monopolistic Competition, Oligopoly and Monopoly Cost Concepts, Product Costing and Pricing strategy.

**Unit III: Personal Finance and Taxation I : Personal Financial strategies Background Concepts (06)**

Financial analysis of a business firm: Statement of Profit and Loss, Balance Sheet, Analyzing various business firms though Ratio Analysis, Time value of money, Annuities. Calculations in Excel, International Trade and Comparative Advantage, International Financing : Foreign Exchange (FOREX) market and Exchange rates, Balance of Payment.

**Unit IV:** **Personal Finance and Taxation II :** Personal Financial strategies **(07)**
**Goal Setting and Tax, Credit and Risk Management**

Understanding Personal Finance : Financial Goal, Importance, Opportunity Costs in Decision Making, The Time Value of Money, Basics of Financial Planning, Personal financial statements, Cash flow and debt management, Tax Management : Taxes, Direct and Indirect, Income Tax slabs and sections, Other taxes, Credit Management : Consumer Loans, Credit cards, Credit Rating, Credit Information Bureau (India) Limited (CIBIL), Interest Rates, Understanding Monetary Policy, Risk Management : Insurance- Life and General, Types of life Insurance, Unit Linked Insurance Plan (ULIPS), Health Insurance, Vehicle Insurance and other major types, Understanding Insurance riders and decision making while buying insurance.

**Unit V:** **Personal Finance and Taxation III : Personal Financial strategies** **(07)**
**Investments in Bonds, Stocks and Mutual Funds, Retirement Planning**

Investment in Government Securities : Bank Accounts, Government Securities, Bonds, Fixed Deposits, Gold Bonds, Investment in Stock Market : Introduction to Stock Market, Stock Exchange Sensitive Index (SENSEX), National Stock Exchange (NSE), Dematerialised account (Demat) Account, How to select stocks- Price per Earning (P/E) ratio, Fundamentals analysis, Investment in Mutual Funds : What is Mutual Fund, Types, Exchange Traded Funds, Net Asset Value (NAV), Factors for selection of Mutual Funds, Retirement Planning : Public Provident Fund (PPF), Employee Provident Fund (EPF) , National Pension Scheme (NPS) and other Pension Funds, Annuity calculations.

**Text Books:**

1. Paul A Samuelson, "**Economics"**, Indian Adaptation, Sudip Chaudhari,Anindya Sen, *Mc Graw Hill* (2010), 19th edition
2. Lawrence J Gitman, "**Principles of Managerial Finance"**, *Pearson*.(2016) 11th edition
3. Prasanna Chandra , "**Finance Sense: Finance for Non-finance Executives**", 5th edition, CFMTMH professional series in Finance
4. Monika Halan , "**Let's Talk Money**" Harper Business 2018
5. P V Subramanya, **"Retire Rich"** TV18 Broadcast Ltd., 2019
6. Abhishek Kumar, "**The Richest Engineer"**, Manjul Publishing House, 2016

**Reference Books:**

1. Lipsey, R.G. & Chrystal, K.A., "**Economics"**, 11th Edition, Oxford University Press, 2007
2. K.K.Dewett, "**Modern Economic Theory"**, S.Chand, 2005

**Online Resources:**

1. www.economicshelp.org
2. www.rbi.org
3. www.khanacademy.org

# 20IT 801 Distributed Systems

**Teaching Scheme:**
**Lectures :** 3 hours/week
**Tutorial : --**

**Examination Scheme:**
**In-Semester : ** 50 Marks
**End-Semester :** 50 Marks
**Credit :** 3

**Prerequisites:** Web Technology, Computer Networks, Operating Systems, Database Management Systems

**Course Objectives:**
Familiarize students with
1. Fundamental knowledge of distributed systems architectures and models.
2. Process Communication and synchronization in a distributed environment.
3. Methods of fault tolerance and replication for distributed systems
4. Distributed File Systems and naming services

**Course Outcomes:**
Students should be able to
1. Apply basic concepts of Distributed systems for communication
2. Apply various synchronization and mutual exclusion algorithms
3. Recommend appropriate techniques for fault tolerance, resource and process management
4. Explain concepts of Distributed File System and naming services for distributed environment

**Unit – I Introduction to Distributed Systems 7 Hours**

Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software concepts, Middleware: Models of Middleware, Services offered by middleware, Client Server model.

Case Study: The World Wide Web

**Unit – II Communication 7 Hours**

Layered Protocols, Inter process communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI), Message Oriented Communication, Stream Oriented Communication, Group Communication.

**Unit – III Synchronization 7 Hours**

Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion - Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, and Performance measure.

Election Algorithms- Non token based algorithm, Token based algorithm.

Case Study: IBM's Websphere Message-Queuing System

**Unit – IV Resource and Process Management 7 Hours**

Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration.

**Unit – V Replication and Fault Tolerance 7 Hours**

Introduction to replication and consistency, Data-Centric and Client- Centric Consistency Models, Replica Management, Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery, Distributed Commit, checkpoints

Case Study: Catching and Replication in Web

**Unit – VI Distributed File Systems and Name Services 7 Hours**

Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Distributed File Systems (DSF), Network File System (NFS), Introduction to Name services and Domain Name System, Directory Services, Case Study: The Global Name Service, The X.500 Directory Service

Designing Distributed Systems: Google Case Study

**Text Books**

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", 2nd edition, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

**Reference Books**

1. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
2. M. L. Liu, "Distributed Computing Principles and Applications", Pearson Addison Wesley, 2004.

3. Sunita Mahajan, Seema Shah, "Distributed Computing", Oxford University Press, 2nd Edition, ISBN-13: 978-0198093480.
4. Abhijit Belapurkar, Anirban Chakrabarti, Harigopal Ponnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, Srikanth Sunder rajan, "Distributed System Security: Issues, Processes and solutions", Willey online Library, ISBN: 978-0-470-51988-2.
5. "Linux System Programming", 2nd Edition, Robert Love, O'reilly

# 20PEIT 801A Advanced Machine Learning

**Teaching Scheme:**
**Lectures :** 3 hours/week
**Tutorial : --**

**Examination Scheme:**
**In-Semester :** 50 Marks
**End-Semester :** 50 Marks
**Credit :** 3

**Prerequisites:** Machine Learning

**Course Objectives:**

Familiarize students with

1. Selection of appropriate features of the dataset for processing
2. Various algorithms in Ensemble Learning
3. Fundamentals of Reinforcement Learning
4. Basic concepts of Neural Network and Deep Learning

**Course Outcomes:**

Students should be able to

1. Perform preprocessing tasks such as dimensionality reduction, vectorization of an image and so on
2. Explain wide variety of advanced Machine Learning algorithms and techniques
3. Apply advanced Machine Learning techniques to solve real-world problems
4. Compare various advanced Machine Learning algorithms

**Unit – I Dimensionality Reduction 7 Hours**

Introduction to Dimensionality Reduction, Feature Selection, Subset Selection, Principal Component Analysis, Linear Discriminant Analysis

**Unit – II Ensemble and Reinforcement Learning 9 Hours**

Ensemble Learning: Wisdom of crowd, Bagging – Bootstrap, Random Forest, Boosting – AdaBoost
Reinforcement Learning: Concept, elements of RL, K-armed Bandit problem, Q-learning
Incremental Learning: Concept, an adaptive incremental learning framework

**Unit – III Neural Network and Artificial Neural Network 9 Hours**

Biological motivation, neurons, McCulloch Pitts neurons, logic gates, Limitations of McCulloch Pitts neurons, Perceptron, Limitations of perceptron, Single Layer Perceptron, Activation layers, Artificial Neural Network and XOR and Multi-layer Perceptron, Error in output, Backpropagation, Gradient Descent

**Unit – IV Convolutional Neural Network 9 Hours**

Vectorization of an image, concept of Convolutional Neural Network, Properties of Convolutional Neural Network, Convolutions, Filters, Strides, layers, padding, Channels, Pooling, Flattening, fully connected network, Convolutional Neural Network and image datasets.

**Unit – V Sequence Modeling: Recurrent Neural Network 8 Hours**

Unfolding Computational Graphs, Recurrent Neural Network, Bi-directional Recurrent Neural Network, Encoder-Decoder Sequence to Sequence Architecture, The challenge of Long-Term Dependencies, Long Short-Term Memory.

**Text Books**

1. Etham Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition – 2013.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press – 2016.

**Reference Books**

1. Nikhil Buduma, "Fundamentals of Deep Learning – Designing Next Generation Machine Intelligence Algorithms", O'Reily – 1st Edition – 2017.
2. Parag Kulkarni, "Reinforcement Learning and Systemic Machine Learning for Decision Making", IEEE Press – 2015.
3. Haibo He, "Self-Adaptive Systems for Machine Intelligence", Wiley – 2011.

**Other Resources**

1. MNIST datasets: https://www.kaggle.com/datasets?search=mnist
2. CIFAR datasets: https://www.kaggle.com/datasets?search=cifar

# 20PEIT 801B Introduction to DevOps

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| **Lectures :** 3 hours/week | **In-Semester : ** 50 Marks |
| **Tutorial : --** | **End-Semester :** 50 Marks |
| | **Credit :** 3 |

**Prerequisites:** Operating Systems and Cloud Computing

**Course Objectives:**

Familiarize students with

1. DevOps Continuous Development and Continuous Integration.
2. DevOps Operation Services.
3. DevOps Architecture.
4. DevOps Technologies.

**Course Outcomes:**

Students should be able to

1. Explain DevOps framework and security aspects in DevOps
2. Apply advanced strategies for software deployment
3. Employ appropriate type of testing in DevOps environment
4. Analyze data to detect anomalies

**Unit – I Introduction to DevOps 7 Hours**

Introduction, Why DevOps?, DevOps Perspective, DevOps and Agile, Team Structure, Co- ordination and barriers. The cloud as a platform, Operations, Operations Services, Service Operation Functions, Continual Service Improvement, Operation and DevOps.

**Unit – II Deployment Pipeline 6 Hours**

Overall Architecture, Does DevOps require architectural change? Overall architecture structure, Microservice architecture, Amazon's rules for teams, Microservice adoption for existing systems.

**Unit – III Building and Testing 7 Hours**

Moving a system through the deployment pipeline, Crosscutting aspects, Development and pre-Commit testing, UAT/Staging/Performance Testing, Production, Incidents, Deployment – Strategies for managing a deployment, logical consistency, packaging, deploying to multiple Environments, partial deployment, rollback, tools

**Unit – IV Deployment 7 Hours**

Introduction, Strategies for Managing a Deployment, Logical Consistency, Packaging, Deploying to multiple environments**,** partial deployments, Rollback, Tools.

**Unit – V Monitoring 7 Hours**

Introduction, what to monitor, How to monitor, When to change the monitoring configuration, Interpreting monitoring data, challenges, tools, diagnosing an anomaly from monitoring data.

**Unit – VI Trends in DevOps 8 Hours**

GitOps, MLOps, AIOps, DataOps, DevSecOps

**Text Books**

1. Len Bass, Ingo Weber, Liming Zhu, DevOps A software Architect's Perspective, Pearson, First edition.
2. Sanjeev Sharma, The DevOps Adoption Playbook, A guide to adopting DevOps in a Multi Speed IT Enterprise. Wiley, IBM Press.

**Reference Books**

1. Jennifer Davis and Katherine Daniels, "Effective DevOps", O'Reilly, First Edition
2. Deepak Gaikwad, Viral Thakkar, "DevOps Tools from practitioner's Viewpoint", Wiley, First Edition
3. Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, Lynn Heidmann, "Introducing MLOps", O'Reilly Nov 2020
4. Billy Yuen, Jesse Suen, Alex Matyushentsev, Todd Ekenstam, "GitOps and Kubernetes", O'Reilly, April 2021
5. John Schnidt and Kirit Basu, "DataOps: The Authoritative Edition", Sept 2019
6. Geradus Blokdyk, "DevSecOps: A Complete Guide", 2019 Edition

# 20PEIT 802A Advanced Databases

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| **Lectures :** 3 hours/week | **In-Semester : ** 50 Marks |
| **Tutorial : --** | **End-Semester :** 50 Marks |
| | **Credit :** 3 |

**Prerequisites:** Data structures, database management systems.

**Course Objectives:**

Familiarize students with

1. Concepts and applications of advanced database architectures.
2. Different ways to process queries in advanced databases.
3. Storage and indexing structures.
4. Security management in database management systems.

**Course Outcomes:**

Students should be able to

1. Examine different database architecture of advanced databases.
2. Analyze the techniques of transactions and query processing in advanced databases.
3. Devise appropriate ways to store and index data.
4. Apply appropriate database security techniques.

**Unit – I Parallel Databases 7 Hours**

Database system architecture, client server architecture, parallel database architecture, shared memory, shared disk, shared nothing, hierarchical, I/O parallelism, inter query parallelism, intra query parallelism, interoperation parallelism, intra operation parallelism, design of parallel systems.

**Unit – II Distributed Databases 7 Hours**

Distributed system architecture, homogenous and heterogeneous databases, distributed data storage, distributed transaction, commit protocol, concurrency control in distrusted databases, availability, distributed query processing, cloud databases.

**Unit – III Transaction processing in advance databases 7 Hours**

Distributed transactions, commit protocols, concurrency control in distributed databases, replication, extended concurrency control protocols, coordinator selection, Consensus in Distributed Systems

**Unit – IV Big Databases 7 Hours**

Introduction to Big Data, NoSQL database system – Column based and key value based

Column based Database ( Cassandra ) : Architecture, Managing data, Data Caching, Tuning, Data backup, Cassandra Query Language, CQL Data Model, Indexing Key Value based Database (DynamoDB) : Data Model, Operations, Data Access, Indexing.

**Unit – V Database Indexing and hashing 7 Hours**

Basics of query processing, Introduction to indexing, ordered indices, B+ tree index files, B+ tree extensions, Hash indices, Multiple key access, creation of indices, write optimized index structure, bitmap indices, indexing of spatial and temporal data, static and dynamic hashing.

**Unit – VI No SQL and semi structured Data Management 7 Hours**

Introduction to Big Data, No SQL Databases, MongoDB, Map reduce. XML Databases, DTD, XML Schemas, XQuery, XPath. JSON

**Text Books**

1. Silberschatz A., Korth H., Sudarshan S, Database System Concepts, McGraw Hill Publication, ISBN- 0-07-120413-X, Sixth Edition.
2. Ramez Elmasri, Shamkant B. Navathe**,** Fundamentals of Database Systems, Pearson Publication, ISBN-13: 978-0-136-08620-8

**Reference Books**

1. S. K. Singh, "Database Systems: Concepts, Design and Application", Pearson Publication, ISBN-978-81- 317-6092-5.
2. C J Date, "An introduction to Database Systems", Addition-Wesley.
3. Raghurama Krishnan, Johannes Gehrke, "Database Management Systems", TATA McGrawHill, 3rd Edition, 2003.
4. Reema Thareja, "Data warehousing", Oxford University Press. ISBN 0195699610.

# 20PEIT 802B Unified Communications

**Teaching Scheme:** | **Examination Scheme:**

**Lectures :** 3 hours/week | **In-Semester :** 50 Marks

**Tutorial : --** | **End-Semester :** 50 Marks

**Credit :** 3

**Prerequisites:** Network Fundamentals, Computer Networks

**Course Objectives:**

Familiarize students with

1. Compare Circuit switching and packet switching related to performance parameters.
2. Choose VOIP protocols for unified communications.
3. Analyze contact center as application of unified communications.
4. Interpret emerging technologies/protocols in VOIP communications.

**Course Outcomes:**

Students should be able to

1. Understand and apply VOIP unified communications and analytics concepts to Contact Center Working.
2. Design and Implement VOIP protocols for telecommunication systems/applications.
3. Interpret and apply current or emerging knowledge in telecommunication engineering.
4. Use relevant mathematics and computer science concepts as tools.

**Unit – I Introduction to digital and lP Telephony 7 Hours**

Digital Telephony: circuit switched networks, ss7, ISDN, Exchanges, E.164 Numbering Plans IP Telephony: Packet switched Networks, signaling & Media separation' Media Encapsulation ' RTP and RTCP, Audio and Video Codecs.

**Unit – II VolP Protocols 7 Hours**

H.323 Network Elements: Terminals, Gateway, Gatekeeper, Multi point Control Unit

H.323 protocol: RAS Channel, H.225 Call signaling, H.245 Media signaling

H.323 Call flows: Basic Audio and Video Call flows

SIP Network Elements: Registrar, Proxy, UAS, UAC, B2BUA

SIP Protocol: Requests and Responses, Methods, Headers and Parameters, Message structure, Transactions and Dialogs, Session Description Protocol SIP Call Flows: Basic Audio and Video Call Flows

H.248 protocol : Media Gateways, Media Gateway controllers, commands, Transactions, Contexts, Terminations, Descriptors' Packages

**Unit – III Unified Communications 7 Hours**

Local and Network features: Call Forward, Call coverage, Automatic Call Back, User Displays, Resource Optimization.
Voice & Data Integration: IM, presence, voice mail,
Collaboration: call Conferencing, Voice, Video, Data and content integration.
Mobility: Mobile Clients, Session Border Controllers.
Business Applications: Framework for custom applications, computer Telephony Interface, Application Sequencing.

**Unit – IV Inbound Contact Center 7 Hours**

Call Centers: Introduction, Evolution and classification of Contact Centers.
Inbound Contact Center :Introduction Self Service / Interactive Voice Response, Routing, Intelligent Routing, VXML
Agent : Skills, Selection Algorithms, Modes, Service Observing, Recording

**Unit – V Outbound Contact Center and Reporting 7 Hours**

Outbound contact center: Introduction, Proactive contact: voice, SMS, E-mail & chat. Contact Center Reporting: Types of Reports, Business use cases. Analytics: Agent Performance, Occupancy

**Unit – VI Emerging technologies in Telecommunications 7 Hours**

High Availability: Load balancing, Reliability, Failover & Failback, Location Redundancy, Hardware footprint, cloud Computing : Applications in Telecommunications Analytics in Voice & Data, Diagnostics & Management
Emerging Technologies: Google Glass, WebRTC, Hosting on Cloud.

**Text Books**

1. Allan Sulkin, "PBX Systems for IP Telephony", McGraw-Hill Professional

**Reference Books**

1. ITU-T H.323 Packet-based multimedia communications systems
2. ITU-TH.225Call Signaling Protocols and media stream packetization
3. ITU-T H-245 Control protocol for multimedia communication
4. IETF RFC 326131P: Session Initiation Protocol
5. IETF RFC4566 SDP: Session Description Protocol
6. Contact Center for' Dummies, Wiley Publishing Inc.
7. Real Time Communication with WebRTC, O'reilly Publishing

# 20PEIT 802C Information Retrieval

**Teaching Scheme:**
**Lectures:** 3 hrs/week
**Tutorial:** --

**Examination Scheme:**
**In-Semester:**50 Marks
**End-Semester:** 50 marks
**Credits:**3

**Prerequisites:** Data structures

**Course Objectives:**
Familiarize students with
1. Concepts of Information Retrieval System.
2. Indexing techniques of Information Retrieval System
3. Clustering in Information Retrieval System
4. Information sharing on semantic web

**Course Outcomes:**
Students will be able to:
1. Apply various algorithms for Information Retrieval System
2. Analyze Search Strategies used in Information Retrieval System
3. Apply different web mining concepts
4. Explain modern trends in Information Retrieval System

**Unit – I Introduction 7 Hours**
Basic Concepts of Information Retrieval, IR system architecture. Automatic Text Analysis: Luhn's ideas, Conflation Algorithm, Porter Stemmer, Retrieval Evaluation: Precision, Recall, F-Score, Mean Average Precision, Mean Reciprocal Rank, User oriented measures

**Unit – II Finite Automata with application 7 Hours**
Indexing and Index Term Weighing, Probabilistic Indexing, Inverted file, Suffix trees & suffix arrays, Signature Files, Clustered files, Cluster Hypothesis, Clustering Algorithms: Single Pass Algorithm, Single Link Algorithm, Complete Link Algorithm

**Unit – III Search Strategies 7 Hours**
Retrieval strategies: Vector Space model, Probabilistic retrieval strategies, Language models, Inference networks, Extended Boolean retrieval, Latent semantic indexing, Fuzzy set retrieval

**Unit – IV Web Mining 7 Hours**
Searching the Web: Challenges, Characterizing the Web, Search Engines, Browsing, Mata-searchers, Web crawlers, Meta-crawler, Web data mining, Finding needle in the Haystack,

Searching using Hyperlinks

**Unit – V Semantic Search Systems 7 Hours**

Semantic Search systems, Semantic Web, Ontology, Searching across ontologies, semantic web search, Google knowledge graphs

**Unit – VI Trends In Information Retrieval 7 Hours**

Case Study: Google Analytics, Search Engine Optimization, Ranking Algorithms, Recommendation Systems: Collaborative Filtering

**Text Books**

1. Yates & Neto, "Modern Information Retrieval", Pearson Education, ISBN:81-297-0274-6
2. C.J. Rijsbergen, "Information Retrieval", (www.dcs.gla.ac.uk).,2ndISBN:978- 408709293

**Reference Books**

1. Grigoris Antoniou and Frank van Harmelen, "A semantic Web Primer", Massachusetts.
2. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutzen, "Introduction to Information Retrieval", Cambridge University Press, Online book, ISBN:978-0-521-86571-5.

# 20OE 801K Software Testing and Quality Assurance

**Teaching Scheme:**
**Lectures :** 3 hours/week
**Tutorial : --**

**Examination Scheme:**
**In-Semester : ** 50 Marks
**End-Semester :** 50 Marks
**Credit :** 3

**Prerequisites:**

**Course Objectives:**
Familiarize students with
1. Testing strategies in projects.
2. Levels of testing strategies
3. Various quality assurance models
4. Automated Testing Tools

**Course Outcomes:**
Students should be able to
1. Explain different terminologies in software testing.
2. Apply appropriate testing technique based on the project scenario
3. Choose quality assurance models for the project
4. Make use of modern testing tools suitable for the project

**Unit – I Fundamentals 7 Hours**
Testing as a Process, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, Testing fundamentals, the defect repository and test design, Defect examples, Developer /Tester support for developing a defect repository. Process model to represent Different phases, Lifecycle models

**Unit – II Levels of testing 7 Hours**
Need for levels of testing, Unit testing, Integration testing, System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing, Stress testing, Regression testing, Alpha, Beta and Acceptance testing.

**Unit – III Testing techniques 7 Hours**
Using White Box Approach to Test design - Static Testing, Structural Testing, Unit Functional Testing, Challenges in White box testing, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing.

**Unit – IV Fundamentals of software quality assurance 7 Hours**

SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

**Unit – V Quality assurance models 7 Hours**

Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM, Clean-room software engineering, Defect Injection and prevention, Inspections & Walkthroughs, Case Tools and their effect on Software Quality.

**Unit – VI Software test automation 7 Hours**

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug. Combining Manual and Automated Testing

**Text Books**

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson
2. Ilene Burnstein, "Practical Software Testing", Springer International edition

**Reference Books**

1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications
2. William Perry, "Effective Methods of Software Testing", Wiley Publishing, Third Edition
3. Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition
4. Watts S Humphrey, "Managing the Software Process", Pearson Education Inc.

# 20OE 802A Applied Statistics with R programming

**Teaching Scheme:**
**Lectures :** 3 hours/week
**Tutorial : --**

**Examination Scheme:**
**In-Semester : ** 50 Marks
**End-Semester :** 50 Marks
**Credit :** 3

**Prerequisites:** Mathematics

**Course Objectives:**
Familiarize students with
1. Fundamentals in Statistics
2. Evaluation and Interpretation of applied statistics
3. Hypothesis Test
4. R programming used in statistical analysis

**Course Outcomes:**
Students should be able to
1. Apply probability for statistical analysis.
2. Draw inferences from statistical analysis of data
3. Apply statistical methods and hypothesis tests on data
4. Explain Multivariate Analysis

**Unit – I Probability 7 Hours**

Introduction, conditional probability, Bayes Theorem and independence, random variable and Probability distribution, normal distribution.

**Unit – II Basic statistical measures 9 Hours**

Introduction to statistics, type of data, processing the data, classification, graphical representation.
Introduction Measures of central Tendency: Arithmetic Mean, Weighted Arithmetic Mean, Median, mode, Measurement of variation: Quartile, Average and Standard Deviations, Coefficient Variation, Measurement of skewness

Case Study with R programming

**Unit – III Analysis of Variance 8 Hours**

Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, ANOVA, Completely randomized design, Latin square Design, Duncan's Multiple Range Test

Case Study with R programming

**Unit – IV Types of hypothesis** **9 Hours**

Introduction , types of hypothesis, Tests of hypothesis concerning means, hypothesis concerning proportions, Hypothesis concerning variations (Chi-square and F-tests), Chi square test for checking independence of categorized data, goodness of Fit Test

Case Study with R programming

**Unit – V Multivariate Analysis** **9 Hours**

Correlation: Introduction , types of correlations, Correlation Analysis, correlation coefficients,
Regression: Introduction, Linear Regression, Regression analysis, regression coefficients.
MANOVA, Discrimination Analysis, Factor Analysis, Principle Component Analysis and Independent Component Analysis

Case Study with R programming

**Text Books**

1. S.P. Gupta, "Statistical Methods", Sultan Chand and sons Publication, 41st Edition.
2. B.L. Agarwal, "Basic Statistics", New Age Publication, 9th Edition
3. A. Papoulis, S.U. Pillai, "Probability Random Variables and Stochastic Processes", Tata McGraw Hill, (4th Edition)

**Reference Books**

1. S. M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier Publication, 5th Edition
2. Piegorsch W.W, "Statistical Data Analytics", Wiley Publication.
3. E. Rukmangadchari, E.K.Reddy, "Probability and Statistics", Pearson India Pvt.Ltd.,1st Edition
4. Rohatgi A.K. Md e. Saleh, "Introduction to Probability and Statistics", Wiley Publication Pvt. Ltd. 3rd Edition.

**Web References**

1. NPTEL NOC: Descriptive Statistics with R software, Prof. Shalabh, IIT Kanpur,
2. NPTEL NOC: Applied Statistics and Econometrics, Prof. Mukherjee, IIT Kanpur

# 20PEIT 801L A Advanced Machine Learning Laboratory

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| **Practical:** 2 hours/week | **In-Semester:** 25 Marks |
| | **Oral:** 25 marks |
| | **Credits:** 1 |

**Prerequisites:** Machine Learning

**Course Objectives:**
Familiarize students with

1. Dimensionality Reduction techniques
2. Programming of Machine and Deep Learning algorithms
3. Libraries for Ensemble Learning, Deep Learning etc.
4. Usage of large datasets

**Course Outcomes:**
Students will be able to:

1. Write programs for reducing dimensionality of datasets
2. Apply Machine Learning algorithms to large datasets
3. Implement Deep Learning algorithms for classifying images
4. Compare various Machine Learning algorithms

**Implement the following assignments using Python.**

1. Select a suitable dataset having a large number of dimensions from UCI/Kaggle/Weka. Statistically analyze this dataset.
    a. Classify this dataset using any classification algorithm. Note down accuracy, precision, recall, etc.
    b. Using this dataset apply Principal Component Analysis. Classify this data using the same classification algorithm and note down accuracy, precision, recall etc.
    c. Compare both the performances.
2. Select a suitable dataset from UCI/Kaggle/Weka.
    a. Classify the dataset using any classification algorithm. Note down accuracy, precision, recall etc.
    b. Classify the same dataset Ensemble Learning algorithm (any one).
        i. Boosting
        ii. Random Forest
    c. Compare both the performances.

3. Use any image dataset from MNIST (handwritten digits or clothing) and classify using Neural Network. Compare both the performances.
    a. Artificial Neural Network
    b. Convolutional Neural Network

**Text Books**

1. Andrea Muller and Sarah Guido, "Introduction to Machine Learning with Python", O"Reily – 2017.
2. Michael Bowles, "Machine Learning in Python", Wiley – 2018.

**Reference Books**

1. Ian H. Witten, Eibe Frank, Mark A Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Elsevier 3rd Edition.

**Other Resources**

1. UCI Machine Learning Repository https://archive.ics.uci.edu
2. WEKA Collection of datasets https://waikato.github.io/weka-wiki/datasets/
3. Kaggle datasets https://www.kaggle.com/datasets

# 20PEIT 801L B Introduction to DevOps Laboratory

**Teaching Scheme:**
**Practical:** 2 hours/week

**Examination Scheme:**
**In-Semester:** 25 Marks
**Oral:** 25 marks
**Credits:** 1

**Prerequisites:** Operating Systems and Cloud Computing

**Course Objectives:**

Familiarize students with

1. Insights of the DevOps environment
2. An overview of different DevOps tools
3. Continuous integration and testing
4. DevOps containerization

**Course Outcomes:**

Students will be able to:

1. Apply version control software for development
2. Apply continuous integration tool for the application developed
3. Apply containerization tool for the application deployment
4. Apply continuous monitoring tool for the application monitoring

**List of Assignment**

Build an application using DevOps. Use the following guidelines.

1. Use Version Control System for a document/program (check in/check out/update/pull/push modifications, create tags/branches)
2. Build a prototype of an application using tools (such as Maven). Prepare unit test case and execute
3. Test the prototype/application using Integration tests
4. Using Continuous Integration (CI)/Continuous Deployment (CD) automation tool (Jenkins), build pipeline. Integrate build stage. Integrate/API test stage with pipeline.
5. Set up DevOps environment for CI, CD (creation of non-root account, S3 bucket, IAM Role, attach policies, secret keys)
6. Integrate Jenkins with DevOps environment (secret keys exchange)
7. Define Jenkins pipeline incorporating, build, test and deploy (publish) stages – I
8. Define Jenkins pipeline incorporating, build, test and deploy (publish) stages - II
9. Deploy the application, run and troubleshoot

**Text Books**

1. Ethan Thorpe, "Devops: A comprehensive beginners guide to learn DevOps step by step"
2. Deepak Gaikwad, Viral Thakkar, "Devops Tools from Practioners" viewpoint, Wiley

**Reference Books**

1. David Johnson, "Devops for Beginners Handson guide", Createspace Independent.

# 20PEIT 801L C Design Patterns Laboratory

**Teaching Scheme:**
**Practical**: 2 hrs/week

**Examination Scheme:**
**In-Semester**: 25 marks
**Oral**: 25 marks
**Credits:** 1

**Prerequisites:** Object Oriented Analysis and Design Laboratory
Object Oriented Software Engineering

**Course Objectives:**
Familiarize students with
1. Achieving extendibility using Design Patterns
2. Incorporating creational design patterns in software design
3. Incorporating structural design patterns in software design
4. Incorporating behavioral design patterns in software design

**Course Outcomes:**
Students should be able to
1. Model scenarios to a creational design pattern code
2. Apply behavioral design pattern to overcome the class collaboration mismatch
3. Apply structural design pattern to reduce the structural incompatibility
4. Analyze the design document to meet extendibility and modifiability

**List of assignments to be implemented in Java**

1. Implement strategy design pattern
2. Implement decorator design pattern
3. Implement composite design pattern
4. Implement observer design pattern
5. Implement factory method design pattern
6. Implement proxy design pattern
7. Implement all applicable design patterns to the given design document

**Text Book**
1. Alan Shalloway and James Trott, "Design Patterns Explained: A new Perspective on object oriented design", Addison Wesley

**Reference Book**

1. Eric Gamma "Design Patterns: Elements of reusable object oriented software", Addison Wesley.

# 20PEIT 501A Artificial Intelligence

**Teaching Scheme:**
**Lectures:** 3 hours/week

**Examination Scheme:**
**In-Semester:** 50 marks
**End-Semester:** 50 marks
**Credits: 3**

**Prerequisites:** Discrete Mathematics, Basic Probability Theory and Statistics
Knowledge of Data Structures

**Course Objectives:**
Familiarize students with
1. The basic principles and applications of Artificial Intelligence.
2. Concepts of problem solving and knowledge representation
3. Concepts of planning and learning
4. Concepts of Uncertainty

**Course Outcomes:**
Students will be able to:
1. Assess underlying AI concepts and their usage.
2. Implement classical Artificial Intelligence techniques
3. Represent knowledge using logic and infer new facts from it.
4. Apply Artificial Intelligence techniques for problem solving.

**Unit – I: Artificial Intelligence** **7 hours**
Introduction -What is AI? The Foundations of Artificial Intelligence,
Intelligent Agents: Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

**Unit – II: Problem Solving by uninformed search** **7 hours**
Problem Solving: Solving Problems by Searching, formulation of real world problems, Breadth first search, depth first search, Iterative deepening Depth First Search, Bidirectional Search, Comparison of Uninformed search Strategies, Searching with partial information.

**Unit – III: Problem Solving by informed search** **7 hours**
Generate& test, Hill Climbing, Best First Search, A* and AO* Algorithm, Constraint satisfaction, Game playing: Minimax Search, Alpha-Beta pruning, Waiting for Quiescence

**Unit – IV: Knowledge Representation** **7 hours**
Knowledge based agents, Wumpus world. Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. First order Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining.

**Unit – V: Planning and Uncertainty** **7 hours**
Definition of Classical Planning, Algorithm for Planning as State-Space Search, Planning Graphs, Blocks world, STRIPS.
Quantifying Uncertainty: Acting under uncertainty, Basic probability notations, Bayesian probability, belief network, probabilistic reasoning.

**Unit – VI: Artificial Neural Network** **7 hours**

Introduction to Neural networks: basic, comparison of human brain and machine, biological neuron, general neuron model, activation functions, Perceptron learning rule, applications and advantages of neural networks. Brief introduction to single layer and multilayer networks.

**Text Books:**

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall.

**Reference Books:**

1. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill
2. Charniack and D. Mcdermott, Artificial Intelligence, Addison Wesley
3. George F. Luger , "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Pearson
4. N.P. Padhy, "Artificial Intelligence And Intelligent Systems", Oxford University Publishers
5. Parag Kulkarni, Prachi Joshi: Artificial Intelligence: Building Intelligent Systems, Prentice Hall of India.
6. Toby Segaran, Programming Collective Intelligence, O"Reilly

**Web References:**

1. NPTEL Series: Artificial Intelligence, Prof. Anupam Basu and Prof. S. Sarkar, IIT Kharagpur

# 20PEIT 501B Business Intelligence

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| **Lectures:** 3 hours/week | **In-Semester:** 50 Marks |
| **Tutorial:-** | **End-Semester:** 50 marks |
| | **Credits:** 3 |

**Prerequisites:** Database Systems, probability basics

**Course Objectives:**
Familiarize students with
1. The role of Business Intelligence in various business applications
2. Methods of data processing and modeling
3. Importance of visualization and reporting in business
4. Decision making process using Business Intelligence

**Course Outcomes:**
Students will be able to:
1. Solve various business problems using BI concepts
2. Choose data transformation and modeling techniques for designing data warehouse
3. Apply business analytics and visualization concepts for business reporting.
4. Explain different BI trends and their applications.

**Unit – I Introduction 6 Hours**
Concepts of Data, Information, and Knowledge, Design and implementation aspect of OLTP and OLAP/Data Warehouse, Business Intelligence (BI) Concepts and definitions, BI architectural models (Top-down and bottom-Up), Business Applications of BI, Role of Data warehouse in BI, BI system components

**Unit – II Dimensional Modeling And Data Warehouse Design 8 Hours**
Star schema, Snowflake schema, and Fact Constellation schema, Grain of dimensional model, transactions, Recurring Snapshots, Accumulating Snapshots, Dimensions (SCD types, conformed dimensions), Facts (additive, semi-additive, non-additive), Junk dimensions, conformed dimensions, Bridge tables

**Unit – III ETL 8 Hours**
Data Quality, Data profiling, Data enrichment, data duplication, Data cleaning, ETL Architecture and what is ETL, Extraction concept and Change data capture, Transformation concept, loading concept, Initial and Incremental loading, Full loading, late arriving facts, data staging, Data marts, Smart change data capture using log-based techniques

**Unit – IV Business Analytics 6 Hours**
What is business analytics (BA)? Difference between BA and BI. Types of analytics, Market-Basket Analysis, clustering, classification, regression, In-Memory Analytics and In-DB Analytics, Applications of Business Analysis

**Unit – V Reporting And Data Visualization 8 Hours**
Metadata Layer, Presentation Layer, Data Layer, Use of different layers and overall Reporting architecture, Various report elements such as Charts, Tables, Materialized views, Query rewrite,

Ad-hoc reports, Security: report level, data level (row, column), Scheduling.
**Data visualization:** Types of data, Types of data visualization, Techniques for visual data representations, data Visualization tools- Tableau, Dashboards

**Unit – VI Recent Trends 6 Hours**
Introduction to Big Data, DW appliances, Types of BI: Real time BI, Operational BI, Embedded BI, Agile BI, Mobile BI, collaborative BI, BI for real world applications such as Real estate, Share market

**Text Books**

1. Ralph Kimball, Joe Caserta, "The Data warehouse ETL Toolkit", Publisher: Wiley
2. Jiawei Han, Micheline Kamber, Jian Pei "Data Mining: concepts and techniques", 2nd Edition, Publisher: Elsevier/Morgan Kaufmann.

**Reference Books**

1. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit", 3rd edition, Publisher: Wiley
2. Reema Thareja, "Data Warehouse", Publisher: Oxford University Press.
3. William Inmon, "Building the Data Warehouse", Wiley publication 4th edition.

# 20PEIT 501C Computer Graphics and Animation

**Teaching Scheme:**
Lectures: 3 hours/week

**Examination Scheme:**
**In-Semester:** 50 marks
**End-Semester:** 50 marks
**Credits:** 3

**Prerequisites:** Geometry and trigonometry, Vectors and Matrices

**Course Objectives:**
Familiarize students with
1. Basic concepts of computer graphics
2. Basic primitives and objects in computer graphics
3. Various methods and techniques used in computer graphics
4. Applications of computer graphics in animation and gaming

**Course Outcomes:**
Students should be able to
1. Select appropriate algorithm to draw computer graphics primitives
2. Apply transformations to computer graphics objects
3. Identify appropriate techniques to achieve desired image manipulation.
4. Design algorithmic logic for real life applications

**Unit – I Basic Concepts 7 Hours**

**Introduction:** Basics of graphics systems, raster scan & random scan displays, basic display processor.
**Display Files**: display file structure, algorithms and display file interpreter. Primitive operations.
**Plotting Primitives:** Scan conversions, line segments, vectors, pixels and frame buffers, vector generation.
**Introduction to OpenGL:** Basic OpenGL syntax, display-window management using GLUT, functions.

**Unit – II Graphics Primitives for Drawing and Filling 7 Hours**

**Line and Circle drawing Algorithms:** DDA, Bresenham's, Midpoint.
**Character Generation:** Stroke Principle, Starburst Principle, Bit map method, aliasing and anti-aliasing
**Polygon:** Polygon and its types, inside test, polygon filling methods: Seed fill, Scan Line, Flood fill and Boundary fill

**Unit – III Geometric Transformations 7 Hours**

**2D Geometric Transformations:** Translation, scaling, rotation, reflection, shearing, matrix representation and homogeneous coordinate system, composite transformations
**3D Geometric Transformations:** Translation, scaling, rotation, rotation about X, Y, Z and arbitrary axis reflection about XY, YZ, XZ and arbitrary plane.

**Unit – IV** **Segments, Windowing and Clipping** **7 Hours**

**Segment:** Introduction, segment table, segment creation, closing, deleting and renaming, visibility
**Windowing:** Concept of window and viewport, viewing transformations
**Line Clipping: C**ohen sutherland method, midpoint subdivision method
**Polygon Clipping: S**utherland hodgman method for clipping convex and concave polygon

**Unit – V** **Shading and Animation** **7 Hours**

**Shading**: Halftoning, Gouraud and Phong Shading
**Computer Animation:** Design of animation sequences, general computer animation functions, computer animation languages, key-frame systems, motion specifications.

**Unit – VI** **Gaming** **7 Hours**

**Gaming platforms**: Graphics memory pipeline, block diagram of nvidia workstation and i860 introduction to opengl es
**Interactive Graphics & usage of the tools of computer graphics:** 3D studio and maya
**2D games:** Snake game

**Textbooks**

1. D. Hearn, M. Baker, "Computer Graphics with OpenGL", 4th Edition, Pearson Education, 2014, ISBN 978-93-325-1871-1
2. S. Harrington, "Computer Graphics", 2nd Edition, McGraw-Hill Publications, 1987, ISBN 0 – 07 – 100472 – 6.

**Reference Books**

1. D. Rogers, "Procedural Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill Publication, 2001, ISBN 0 – 07 – 047371 – 4.
2. J. Foley, V. Dam, S. Feiner, J. Hughes, "Computer Graphics Principles and Practice", 2nd Edition,Pearson Education, 2003, ISBN 81 – 7808 – 038 – 9.
3. D. Rogers, J. Adams, "Mathematical Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill Publication, 2002, ISBN 0 – 07 – 048677 – 8.
4. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum‟s Series outlines.
5. F.S. Hill JR, "Computer Graphics Using Open GL", Pearson Education
6. Samuel R. Buss, "3D Computer Graphics", Cambridge University Press

# 20PEIT 502A Blockchain Architecture Design and Use Cases

**Teaching Scheme:**
Lectures: 3 hours/week

**Examination Scheme:**
**In-Semester:** 50 marks
**End-Semester:** 50 marks
**Credits:** 3

**Prerequisites:** Basics of programming, software engineering

**Course Objectives:**
Familiarize students with
1. Blockchain technology landscape
2. Bitcoin blockchain
3. Ethereum and smart contract
4. Hyperledger

**Course Outcomes:**
Students should be able to
1. Explain Blockchain technology landscape
2. Apply applications and implementation strategies of Blockchain
3. Make use of Blockchain in real life applications.
4. Evaluate security, privacy, and efficiency of a given blockchain system

**Description:**

The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. The concept and applications of Blockchain have now spread from cryptocurrencies to various other domains, including business process management, smart contracts, IoT and so on. This course will cover both the conceptual as well as application aspects of Blockchain. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains. us other domains, including business process management, smart contracts, IoT and so on.

**The course will cover following topics:**

Introduction to Blockchain, Basic Crypto Primitives, Bitcoin Basics Distributed Consensus, Consensus in Bitcoin, Permissioned Blockchain (Basics, Consensus, RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance), Blockchain for Enterprise – Overview, Blockchain Components and Concepts, Hyperledger Fabric – Transaction Flow, Hyperledger Fabric Details, Fabric – Membership and Identity Management, Hyperledger Fabric Network Setup, Fabric Demo on IBM Blockchain Cloud, Hyperledger Composer – Application Development, Network Administration, Blockchain in Financial Service, Revolutionizing Global Trade, Blockchain in Supply Chain, Blockchain in Government Blockchain Security, Comparing Ecosystems – Ethereum development tools and Quorum

**Suggested Swayam Course:**
"Blockchain Architecture Design and Use Cases", by Prof. Sandip Chakraborty, IIT, Guwahati
https://onlinecourses.nptel.ac.in/noc19_cs63/course

**Reference Books:**

1. Andreas M. Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", 1st Edition
2. Melanie Swa, "Blockchain", O'Reilly
3. Bob Dill, David Smits, "Zero to Blockchain - An IBM Redbooks course"

# 20PEIT 502B Internet of Things

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| **Lectures:** 3 hours/week | **In-Semester:** 50 Marks |
| **Tutorial:-** | **End-Semester:** 50 marks |
| | **Credits:** 3 |

**Prerequisites:** Basic programming knowledge, Network Fundamentals

**Course Objectives:**

Familiarize students with

1. Core concepts of Internet of Things (IoT)
2. Communication protocols and different types of networks in IoT
3. Programming of various exemplary devices like Arduino, Raspberry Pi
4. State of art IoT technologies and application areas

**Course Outcomes:**

Students will be able to:

1. Explain core concepts of IoT
2. Compare different communication protocols and networks
3. Program exemplary devices like Arduino, Raspberry Pi
4. Design IoT applications with IoT technologies

**Description:**

Internet of Things (IoT) is presently a hot technology worldwide. Government, academia, and industry are involved in different aspects of research, implementation, and business with IoT. IoT cuts across different application domain verticals ranging from civilian to defence sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IoT. Today it is possible to envision pervasive connectivity, storage, and computation, which, in turn, gives rise to building different IoT solutions. IoT-based applications such as innovative shopping system, infrastructure management in both urban and rural areas, remote health monitoring and emergency notification systems, and transportation systems, are gradually relying on IoT based systems. Therefore, it is very important to learn the fundamentals of this emerging technology.

**The course will cover following topics:**

Introduction to IoT, Basics of Networking, Communication Protocols, Sensor Networks, Interoperability in IoT, Introduction to Arduino Programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi, SDN for IoT, Data Handling and Analytics, Cloud Computing, Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT

**Suggested Swayam Course:**

"Introduction to Internet of Things", By Prof. Sudip Misra, IIT, Kharagpur
https://onlinecourses.nptel.ac.in/noc21_cs17/preview

**Reference Books**

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.

# 20PEIT 501L B Business Intelligence Laboratory

**Teaching Scheme:**
**Practical:** 2 hours/week

**Examination Scheme:**
**In-Semester:** 25 Marks
**Oral:** 25 marks
**Credits:** 1

**Prerequisites:** Database Systems, probability basics

**Course Objectives:**
Familiarize students with
1. Implementation of different Business Intelligence (BI) techniques
2. Methods of data processing and modeling
3. Importance of visualization and reporting in business
4. Various library functions to develop BI applications

**Course Outcomes:**
Students will be able to:
1. Apply various library functions to develop BI applications
2. Implement data transformation and modeling techniques for building data warehouse
3. Apply business analytics and visualization concepts for business reporting
4. Develop BI system for different applications

**Suggested list of laboratory assignments:**
Choose a Business Problem as Case Study to design and build BI solution using BI concepts:
1. Execute ETL process for building data warehouse
2. Perform dimension modeling
3. Implement OLAP operations on given data set
4. Visualize data using various charts using data visualization tool
5. Perform business analytics for the chosen application
6. Demonstrate complete BI application

**Text Books**

1. Big Data, Black Book, DT Editorial services, 2015 edition
2. Jiawei Han, Micheline Kamber, Jian Pei "Data Mining: concepts and techniques", 2nd Edition, Publisher: Elsevier/Morgan Kaufmann.

**Reference Books**

1. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit", 3rd edition, Publisher: Wiley
2. Reema Thareja, "Data Warehouse", Publisher: Oxford University Press.
3. William Inmon, "Building the Data Warehouse", Wiley publication 4th edition.

# 20PEIT 501L C Computer Graphics Laboratory

**Teaching Scheme:**
**Practical:** 2 hours/week

**Examination Scheme:**
**In-semester:** 25 Marks
**End-semester:** 25 marks
**Credits:** 1

**Prerequisites:** Basics of Programming, Data Structures, Algorithms, Geometry, Trigonometry, Vectors and Matrices

**Course Objectives:**
Familiarize students with
1. Various methods and techniques used in computer graphics
2. Applications of computer graphics in animation and gaming
3. Functions and Libraries of OpenGL
4. Applications and implementation of computer graphics.

**Course Outcomes:**
Students should be able to
1. Develop programs using core graphical concepts.
2. Apply graphics data manipulation in an application.
3. Implement programs using different computer graphics algorithm
4. Make use of OpenGL to implement programs

| Sr. No. | List of Assignments (minimum 8 out of 10) |
|---|---|
| 1 | Get Familiar with basic OpenGL environment, display-window management using GLUT, OpenGL functions. |
| 2 | Write a function in OpenGL on Linux Platform to draw a Line using DDA/ Bresenham's Line Drawing Algorithm. Call the Function to draw any pattern consisting of at least 10 function calls. |
| 3 | Write a function in OpenGL on Linux Platform to draw a circle using Midpoint Circle Drawing Algorithm. Call this function at least 6 times to draw any pattern. Users should only give center coordinates and radius. Rest should be drawn automatically |
| 4 | Write a program in OpenGL on Linux Platform to draw chess board using any Line drawing algorithm and fill alternate blocks using flood fill algorithm |
| 5 | Write a program in OpenGL on Linux Platform to draw a flag using any Line drawing algorithm and fill it using scanline polygon filling algorithm. |
| 6 | Write a program in OpenGL on Linux Platform to draw a polygon and perform following 2DTransformations on Triangle.<br>Translation, Scaling, Rotation |
| 7 | Write a program in OpenGL on Linux Platform to clip a Line using Cohen Sutherland Outcode Method. |
| 8 | Write a program in OpenGL on Linux Platform to clip a Polygon using SutherlandHodgman Polygon Clipping. |
| 9 | Write a program in OpenGL on Linux Platform to animate a scene like "Moving Car", "kite flying" etc. |
| 10 | Write a program to design a game using computer graphics basic techniques and OpenGL |

**Textbooks**

1. D. Hearn, M. Baker, "Computer Graphics with OpenGL", 4th Edition, Pearson Education, 2014,ISBN 978-93-325-1871-1
2. S. Harrington, "Computer Graphics", 2nd Edition, McGraw-Hill Publications, 1987, ISBN 0 – 07 – 100472 – 6.

**Reference Books**

1. D. Rogers, "Procedural Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill publication, 2001, ISBN 0 – 07 – 047371 – 4.
2. J. Foley, V. Dam, S. Feiner, J. Hughes, "Computer Graphics Principles and Practice", 2nd Edition,Pearson Education, 2003, ISBN 81 – 7808 – 038 – 9.
3. D. Rogers, J. Adams, "Mathematical Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill Publication, 2002, ISBN 0 – 07 – 048677 – 8.
4. Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Series outlines
5. F.S. Hill JR, "Computer Graphics Using Open GL", Pearson Education
6. Samuel R. Buss, "3D Computer Graphics", Cambridge University Press

# 20PEIT 601A Advanced Computer Networks

**Teaching Scheme:**
**Lectures:** 3 hours/week

**Examination Scheme:**
**In-Semester : ** 50 Marks
**End-Semester : ** 50 Marks
**Credits :**3

**Prerequisites:** Network Fundamentals, Computer Networks

**Course Objectives:**
Familiarize students with
1. Basic functions and concepts of advanced computer networks.
2. Principles of performance modeling.
3. Mechanisms to handle congestion and routing.
4. Introduction to seminal research papers.

**Course Outcomes:**
Students should be able to
1. Compare resource allocation mechanisms.
2. Evaluate the performance measures in TCP/IP networks.
3. Analyze routing algorithms.
4. Comprehend a few seminal research papers.

**Unit – I Internet architecture and performance modeling 7 Hours**
Introduction. Course logistics. Goals of Internet design, Layering abstraction and encapsulation. Network architecture and protocols. Performance of networks: delay and throughput, End-to-end delay, Concept of packetization, Circuit switching vs packet switching, Bandwidth-delay product, and Simple results from queuing theory.

**Unit – II Applications: architectures and examples 7 Hours**
Application layer architectures: client-server vs. P2P, Socket interface: TCP vs. UDP semantics, Application types: elastic vs. real-time, WWW and HTTP. Persistent vs. non-persistent connections, HTTP message formats, headers, Caching, cookies, FTP, SMTP

**Unit – III Transport protocols 7 Hours**
Basic function of transport - multiplexing and demultiplexing, UDP- simple transport, TCPconnection basics: handshake, reliability, pipelining, congestion control, flow control, Ideal window size and bandwidth delay product, Buffer sizing for TCP, Simple model for TCP throughput, Understanding TCP fairness, RED gateways, Resource allocation, QoS, and fairness, QoS architectures: Intserv and Diffserv, Admission control: Token Bucket Filter

**Unit – IV Internet routing 7 Hours**
Router scheduling, common router scheduling policies / queuing disciplines Hierarchical (intradomain and interdomain) routing, IPv6, IP-in-IP tunneling, MPLS, BGP and advanced BGP concepts

**Unit – V Link layer 7 Hours**

Link layer functions: Link layer addresses, ARP, Shared broadcast, multiple access protocols, the original Ethernet, spanning tree protocol, VLANs, NAT traversal.

**Unit – VI Advanced topics 7 Hours**

Networking with virtual machines, software switches, Network Function Virtualization, Network Virtualization, Key ideas of traditional networks vs. SDN, history, Ethane: the motivation, OpenFlow: the interface, Onix: SDN controllers, Applications - B4 by Google, Datacenter networking.

**Text Books**

1. "Computer Networking, A Top-Down Approach", 6 th edition, James Kurose and Keith Ross, Pearson Publishers.
2. "Computer Networks, A Systems Approach", 5 th edition, Larry Peterson and Bruce Davie, The Morgan Kaufmann series in Networking
3. "Data Networks" 2 nd edition Bertsekas and Gallager, Prentice hall publisher (mainly Chapter 3.3 on basic queuing theory

**Reference papers**

1. The design philosophy of the DARPA internet protocols, David Clark.
2. Chord: A Scalable Peer-to-peer Lookup Service for Internet Applications, Stoica et al
3. Congestion Avoidance and Control, Jacobson and Karels.
4. Sizing Router Buffers, Appenzeller et al
5. Bufferbloat: Dark Buffers in the Internet, Gettys and Nichols
6. The Macroscopic Behavior of the TCP Congestion Avoidance Algorithm, Mathis et al.
7. Analysis of the Increase and Decrease Algorithms for Congestion Avoidance in Computer Networks, Chiu and Jain.
8. Random Early Detection Gateways for Congestion Avoidance, Floyd and Jacobson

# 20PEIT 601B Natural Language Processing

| | |
|---|---|
| **Teaching Scheme:** | **Examination Scheme:** |
| **Lectures:** 3 hours/week | **In-Semester:** 50 Marks |
| **Tutorial:-** | **End-Semester:** 50 marks |
| | **Credits:** 3 |

**Prerequisites:** Probability Basics, Automata theory

**Course Objectives:**
Familiarize students with
1. Core concepts of Natural language processing (NLP)
2. Levels of language analysis
3. Language modeling and Parsing techniques used in natural language processing
4. State of art NLP areas

**Course Outcomes:**
Students will be able to:
1. Identify challenges involved in developing natural language processing system
2. Apply natural language processing techniques
3. Recommend Natural Language Processing techniques for language modeling, syntax and semantic parsing
4. Analyze Natural Language Processing systems for different applications

**Unit – I Introduction to Natural Language Processing 7 Hours**
Introduction: Natural Language Processing (NLP) and Natural Language Understanding (NLU) NLP applications, Brief history of field, Challenges in developing NLP system, Evaluating Natural Language Understanding Systems, The Different Levels of Language Analysis, representation and understanding, NLP tasks in syntax, semantics and pragmatics

**Unit – II Syntactic Parsing 7 Hours**
Grammar and sentence structure, A Top-Down Parser, A Bottom-Up Chart Parser, Top-Down Chart Parsing, Human Preferences in Parsing, Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, finite state transducers (FST), Finite state models and Morphological processing

**Unit – III Features and Augmented Grammars 7 Hours**
Feature Systems and Augmented Grammars : Some Basic Feature Systems for English, Morphological Analysis and the Lexicon , A Simple Grammar Using Features, Parsing with Features, Augmented Transition Networks: Definite Clause Grammars, Generalized Feature Systems and Unification Grammars

**Unit – IV Language Modeling 7 Hours**
Computational Linguistics - Probability Theory , Estimating Probabilities, Ambiguity and Uncertainty in language, Part-of-Speech Tagging, Obtaining Lexical Probabilities, Probabilistic Context-Free Grammars, Probabilistic language modeling and its applications, Markov models. N-grams. Estimating the probability of a word, and smoothing

**Unit – V Semantic Analysis 7 Hours**
Semantics and Logical Form :Word Senses and Ambiguity, The Basic Logical Form Language, Encoding Ambiguity in Logical Form ,Verbs and States in Logical Form, Case Relations Lexical Resources: WordNet, Semantic web Ontologies

**Unit – VI Future of NLP 7 Hours**
Role of Machine learning in NLP applications, Opinion mining, Sentiment Analysis. Machine Translation(MT), MT evaluation tools such as Bleu, WER (Word Error Rate), Information Extraction, Question answering, Automatic speech recognition, Deep Learning for Natural Language Processing

**Text Books**

1. James Allen, "Natural Language Understanding", Pearson Publication, ISBN: 978-81-317-0895-8 2nd Edition
2. D. Jurafsky, J. H. Martin, "Speech and Language Processing", Pearson Education, 2002

**Reference Books**

1. Christopher D. Manning, Hinrich Schutze, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts, 1999.
2. Tanveer Siddiqui, US Tiwary, Natural Language Processing and Information Retrieval
3. Daniel M.Bikel, ImedZitouni, Multilingual Natural Language Processing Applications
4. Abhijit Mishra and Pushpak Bhattacharyya, "Cognitively Inspired Natural Language Processing- An Investigation Based on Eye Tracking", Cognitive Intelligence and Robotics Series, Springer Nature Singapore, ISBN:978-981-13-1515-2, 2018.
5. Niladri Dash, Pushpak Bhattacharyya, Jyoti Pawar (eds.), "WordNets of Indian Languages", Springer, ISBN:978-981-10-1909-8, 2016.

# 20PEIT 601C Multimedia Techniques

**Teaching Scheme:**
**Lectures:** 3 hours/week

**Examination Scheme:**
**In-Semester:**50 Marks
**End-Semester:** 50 marks
**Credits:** 3

**Prerequisites:** Algebra and Geometry

**Course Objectives:**
Familiarize students with
1. Variety of multimedia data modification algorithms
2. Capturing and using multimedia components for presenting a concept
3. Multimedia data processing for its size reduction
4. Usage of multimedia in variety of domain applications

**Course Outcomes:**
Students will be able to:
1. Apply multimedia components in multimedia production.
2. Apply data processing techniques on multimedia data
3. Apply compression techniques on multimedia data
4. Choose different multimedia components for multimedia system design

**Unit – I Multimedia Overview and basics of still Image 7 Hours**
**Multimedia Overview:** Introduction, multimedia presentation and production, characteristics of multimedia presentation, hardware and software requirements, uses of multimedia, analog and digital representation, digitization, Nyquist theorem, quantization error, visual display systems, enterprise data and multimedia component.
**Digital Image:** Image as data, Image acquisition, types of images.

**Unit – II Image Processing 7 Hours**
Binary image processing, grey scale image processing, colored image processing. Image output on monitors, image output on printers, image file formats both lossless and lossy.

**Unit – III Audio data as multimedia component 7 Hours**
Introduction, acoustics, sound waves, types and properties of sound, psycho acoustics, components of an audio system, digital audio, synthesizers, MIDI, audio processing.

**Unit – IV Audio transmission and broadcasting 7 Hours**
Speech, sound card, audio transmission, digital audio broadcasting, surround sound system, audio file formats both lossless and lossy.

**Unit – V Video data as multimedia component 7 Hours**
Motion video, digital video, digital video processing, video recording and storage formats both lossless and lossy, and video editing concepts.

**Unit – VI Data compression 7 Hours**

Image compression technique, audio compression technique, video compression technique.

**Text Books**

1. Ranjan Parekh: Principles of multimedia, TMH 2nd Edition-2013.
2. Nigel Chapman, Jenny Chapman Peter: Digital Multimedia, John Wiley and sons, Edition 2012.

**Reference Books**

1. Kimberly N Rosenfield: Digital Multimedia: Concepts, Methodologies, tools and applications, Information Resources Management association 1st Edition-September 2017

# 20OE 601F Open Elective II: Design Thinking

**Teaching Scheme:**
**Lectures:** 3 hours/week
Tutorial: -

**Examination Scheme:**
**In-Semester:** 50 marks
**End-Semester:** 50 marks
**Credits:** 3

**Prerequisites:** -
**Course Objectives:**
Familiarize students with
1. Design thinking process
2. User centric approach for designing a solution
3. Problem analysis with various methods
4. Applications of Design Thinking

**Course Outcomes:**
Students should be able to
1. Analyze problems with various methods
2. Recommend a solution based on empathy, ideation, prototyping, and playful testing
3. Apply design thinking methods to generate innovative and user centric solutions
4. Test designed prototypes to reduce risks and accelerate organizational learning

**Unit – I: Design and Design Problems** **8 Hours**

What is Design? The components of design problems; measurement, criteria and judgement in design

A model of design problems – Defining problems: Selecting goals and diverse teams, creating a unified vision and scope, mapping stakeholders and personas; Analysing design problems, generators of design problems, roles of generators, design constraints

**Unit II: Design Solutions** **8 Hours**

Solutions to Design Problems: Designer's response: procrastination, non-committal design and throw away design, design problems and solutions

Design Process: define, search, ideate, prototype, select, implement, learn, Refresher and restate the challenge, getting inspiration, understanding innovation ambition, Solution ideation, Narrowing solution choice, Solution evaluation, Road map

**Unit III: Design Thinking** **9 Hours**

Types and Styles of Thinking – theories of design, types of thinking; creative thinking - what is creativity? creativity in design, Principles of design thinking

**Unit IV: Design Philosophies and Strategies** **9 Hours**

Theory and practice, three early phases of working on the same problem

Prototype Creation: Choosing a prototype approach, user interface prototypes, applications vs custom build, reference architectures, prototype and solution evaluation

**Unit V: Design Tactics and Traps** **8 Hours**

Methods and Tactics, understanding the problem, the model of problems, One or many solutions? Common traps and ways of avoiding them

**Text Books:**

1. Bryan Lawson, "How designers think: The design process demystified", 2nd Edition, Butterworth Architecture
2. Nigel Cross, "Design Thinking", Berg Publishers - 2011

**Reference Books:**

1. Ben Crothers, "Design Thinking Fundamentals", O'Reily
2. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations", HarperCollins – 2009

1. Susan Weins Chenk, "Hundred things every designer needs to know about people", New Riders Publication
2. Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley Publication
3. Roger L. Martin, "Design of Business: Why Design Thinking is the Next Competitive Advantage" Harvard Business Press
4. Karl Ulrich, "Design: Creation of Artifacts in Society" - 2011
5. Bala Ramadurai, "Karmic Design Thinking"
6. T. Amabile, "How to kill creativity", SAGE Publication - 2006
7. William Lidwell, Kritina Holden, Jill Butler, "Universal principles of Design ", Rockport Publishers
8. Bella Martin, Bruce Hanignton, Bruce M Hanington "Universal methods of design", Rockport Publishers - 2012
9. Roman Kizanie, "Empathy: Why it matters, how to get it", TarcherPerigee Publishers
10. Karla McLaren, "The Art of Empathy: A complete Guide to life's most essential skill", Sounds True Publishers

# 20PEIT 601L A Advanced Computer Network Laboratory

**Teaching Scheme:**
**Practical:** 2 hours/week

**Examination Scheme:**
**In-Semester:** 25 Marks
**Oral:** 25 marks
**Credits:** 1

**Prerequisites:** Foundations of Computer Networks, Computer Networks

**Course Objectives:**
Familiarize students with
1. Basic functions and concepts of advanced computer networks.
2. Principles of performance modeling.
3. Mechanisms to handle congestion and routing.
4. Introduction to seminal research papers.

**Course Outcomes:**
Students should be able to
1. Compare resource allocation mechanisms.
2. Evaluate the performance measures in TCP/IP networks.
3. Analyze routing algorithms.
4. Implement basic functions of SDN

**Implementation of a mini-project on any of the following topics (Use NS2/NS3, packet Tracers etc. simulators).**

1. BGP implementation
2. VLAN implementation
3. Wireless adhoc networks
4. Evaluate QoS in a network

**Text Books**

1. "Computer Networking, A Top-Down Approach", 6 th edition, James Kurose and Keith Ross, Pearson Publishers.
2. "Computer Networks, A Systems Approach", 5 th edition, Larry Peterson and Bruce Davie, The Morgan Kaufmann series in Networking
3. "Data Networks" 2 nd edition Bertsekas and Gallager, Prentice hall publisher