Basic Sciences and Humanities

Autonomous Programme Structure (Revision-1) F. Y. B. Tech. Sem-I
E&TC / Instru / Mech Programmes
A. Y.: 2020-21 Onwards

F. Y. B. Tech. First Semester									
Course Code	**Course Title**	**Teaching Scheme Hours / Week**			**Examination Scheme**			**Marks**	**Credit**
20BS01	Linear Algebra and Univariate Calculus	3	1	0	50	50	0	100	4
20BS04	Physics	3	0	0	50	50	0	100	3
20ES02	Fundamentals of Programming Language- I	1	0	0	0	25	0	25	1
20ES03	Sustainable Engineering	3	1	0	50	50	0	100	4
20ES04	Engineering Graphics	2	1	0	50	50	0	100	3
20BS04L	Physics Lab	0	0	2	25	0	0	25	1
20ES02L	Fundamentals of Programming Language- I Lab	0	0	2	25	0	0	25	1
20ES04L	Engineering Graphics Lab	0	0	2	25	0	0	25	1
20ES07L	Technical Skill Development Lab	0	0	2	25	0	0	25	1
Total		**13**	**3**	**8**	**300**	**225**	**0**	**525**	**19**
Grand Total		**24**			**525**			**525**	**19**

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

Cummins College of Engineering For Women ★ MKSSS's
Karve Nagar, Pune 411052.

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

20BS01 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 will find them useful in their disciplines.

Course Outcomes:

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 (40thedition), (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)

20BS04 Physics

Teaching Scheme	**Examination Scheme**
Lecture 3 Hrs per week	In – SEM Exam: 50 Marks
Number of Credits: 3	End – SEM 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 as bulk materials.

Course Outcomes:

By taking this course, the learner will be able to –

CO – 1: **Apply** the generalized Coulomb law and the law of Electromagnetic Radiation to determine the electric fields due to the stationary and the accelerated charges.

CO – 2: Apply the laws of Physical Optics to determine intensity distributions of interference – diffraction patterns, and to identify polarization-types.

CO – 3: 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.

Title of Module, Brief Description of Course Contents and No. of Lectures

Module – 1: Electromagnetic Radiation and Interference: 8 Lectures

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: 8 Lectures

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: 8 Lectures

Principles of Statistical Mechanics (Distribution of particles in thermal equilibrium); Laws of Thermodynamics (Carnot Cycle, Entropy, Clausius-Clapeyron Equation); Information Entropy

Module – 4: Quantum Physics: 9 Lectures

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: 9 Lectures

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* (10th Edition)**
2. **H. Young and Roger Freedman, 'University Physics', Pearson Addison Wesley (12th Edition)**

20ES02 Fundamentals of Programming Language-1 (ETC,Instru)

Teaching Scheme:
Lecture: 1 Hr/week

Examination Scheme:
End-Sem: 25 Marks

Credits: 1

Course Objectives:
To facilitate the learners:
1. To learn the fundamentals of building blocks of computer system.
2. To develop problem solving ability by developing an algorithm, flowchart for given problem.
3. To implement the logic / solution for given problem using C programming language.
4. To understand the decision and iteration interpretation in a programming language.

Course Outcomes:
By taking this course, the learner will be able to:
1. Illustrate the use of algorithms, flow charts and components of computer systems.
2. Demonstrate the use of appropriate control structure for program development.
3. Make use of variables, data types, operators, expressions, strings and arrays for program development.
4. Solve the given problem using functions.

Unit 1: Introduction **(2)**
Introduction to components of a Computer System, types of programming languages.
Introduction to Algorithm: As flow chart, pseudo code, as a program.

Unit 2: Fundamentals of Procedural Programming Language **(1)**
Keywords, Identifiers, Constants and Variables, concept of memory, Structuring procedural program using exemplary language such as C.

Unit 3: Data Types and operators **(2)**
Data types, Typecasting, variable scope, Operators, Basic Input and Output Operations, Expressions and Precedence of Operators.
Illustration using real life examples and use cases.

Unit 4: Control Structures **(2)**

Selection (if-else ladder), Iteration (for loop, while loop).
Illustration using real life examples and use cases.

Unit 5: Arrays and String **(2)**
Introduction to linear structure (Arrays) and Strings,String functions
Illustration using real life examples and use cases.

Unit 6: Functions **(2)**

Use of function for modularization, Parameter passing.
Illustration using real life examples and use cases.

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-Hall Inc., 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

20ES02 Fundamentals of Programming Language-1 (Mech)

Teaching Scheme:
Lecture: 1 Hr/week

Examination Scheme:
End-Sem: 25 Marks

Credits: 1

Course Objectives:
To facilitate the learners:

1. To learn the fundamentals of the building blocks of computer system.
2. To develop problem solving ability by developing an algorithm, flowchart for the given problem.
3. To implement the logic / solution for giving problem using a programming language.
4. To understand the decision and iteration interpretation in a programming language.

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

1. Illustrate the use of algorithms, flow charts and components of computer systems.
2. Demonstrate the use of appropriate control structure for the program developer.
3. Make use of variables, data types, operators, expressions, strings and arrays for program development.
4. Solve the given problem using functions.

__Unit – I: Introduction (05)

Problem solving, problem solving by using computer and Logic building, Introduction to computer, Anatomy of a computer, Python interpreter, Python language elements, Lines and indentation, identifiers, keywords, operators, delimiters and literals, statements, Numbers: Integers, complex, floating point, Variable types, assignments

Unit – II: Operators and Expressions (05)

Sequences: strings, lists, numpy arrays, tuples, Boolean values, Dictionaries, Numeric operations, Conditional expression

Unit – III: Loops and Functions (04)

Loops, Functions, file operations, exceptions, inbuilt libraries and functions for scientific computing and plotting.

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 Inter-disciplinary 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/)

20ES03 SUSTAINABLE ENGINEERING

Teaching Scheme:
Lectures: 3 Hrs/Week
Tutorial: 1 Hr/Week
Credits: 4

Examination Scheme:
In-Semester : 50 Marks
End-Semester : 50 Marks

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

CO1: Identify the need of sustainable development

CO2: Analyze the challenges posed at the interface of natural & man-made environment

CO3: Distinguish between conventional & green building with respect to environmental efficiency

CO4: Apply the knowledge of sustainability in the area of water & energy conservation

CO5: Distinguish between smart cities with other cities with respect to quality criteria

CO6: Specify the role of different stakeholders in sustainable development

Unit – I: Introduction to sustainable engineering **(05)**

Need and concept of sustainability, Principles of sustainability, Pillars of sustainable development, Multidisciplinary approach for sustainable development, Case study on Innovative technologies

Unit – II: Environmental sustainability **(06)**

Concept of natural and built environment , Concept of integrated built environment, Environmental global issue - Urban sprawl , Role of individual to protect environment

Unit – III: Green materials and green building **(06)**

Basic concept of Green buildings & its co-relation with sustainability, Material selection for sustainable design of green building, Concept of circular economy, Concept of IGBC, Green building certification, Methods for increasing energy efficiency of buildings

Unit – IV: Sustainable use of water and energy resources **(08)**

Water resources – use and conservation of water ,sustainable use of drinking water – waste water management- case study

Energy resources – Renewable and non-renewable sources of energy – conservation of non-renewable energy sources – case study, Definition & case study on LCA.

Unit – V: Smart City **(05)**

Concept and features of smart city, Strategies, Concept of smart village, Two case studies.

Unit – VI: Role of community and society in sustainable development **(06)**

Role of government,Global environmental agreements and protocols (Montreal& Kyoto protocol), Copenhagen summit, Role of citizen, Contribution of NGOs - social networking , Case study

Text Books:

1. *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. *DT Alle*DR Shonnard*n,-* Green engineering: environmentally conscious design of chemical processes

5. R.Rajagopalan **– Environmental Studies from Crisis to Cure – *Oxford Publication, Third edition,2016.***
6. A`Sankar R.N.- **Environmental Management** - *Oxford Publication, First edition,2015.*
7. *Shah, Kale, Patki – **Building planning and Built environment** -Tata McGraw Hill*

Websites:

Down to Earth - Magazine (hard copy and softcopies available)-
www.unsdsn.org/ For the World
-www.cseindia.org - For India
- indiaenvironmentalportal.org.in
- TERI - www.teriin.org
-cwmi.css.cornell.edu
-rodaleinstitute.org

20ES04 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**)**

(01)

Unit – 2

Orthographic Projection Theory of projections, methods of obtaining orthographic views, sectional orthographic projections, Missing views.

(08)

Unit – 3

Isometric Views Isometric axes, Isometric scale, isometric projections and views, construction of isometric view from given orthographic views**.**

(08)

Unit – 4

Development of Solids Parallel line development, radial line development, methods to transfer points for development of prisms, pyramids, cylinder and cone.

(05)

Unit – 5

Engineering Curves Construction of ellipse, parabola, hyperbola, involute, cycloid, Archimedean spiral, helix on cone and cylinder. **(06)**

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.

20BS04L Physics Laboratory

Teaching Scheme	**Examination Scheme**
2 hours per week	In-SEM Exam : Term work (25 M)
Number of Credits : 1	End-SEM Exam : NA

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 (CO) for Physics Lab - 20BS04L
By taking this course, the students will 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 :
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.

20ES02L Fundamentals of Programming Language -I Lab (ETC, Instru)

Teaching Scheme:
Practical: 2 Hr/week
Credits: 1

Examination Scheme:
In-Sem: 25 Marks

Course Objectives:

To facilitate the learners:
1. To learn the fundamentals of C programming for logic building.
2. To implement 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 and structures of C programming language.

Course Outcomes:

By taking this course, the learner will be able to:
1. Apply logic development skills to solve simple real life problems.
2. Implement, test and execute developed logic or algorithm to C program using appropriate data type, operators.
3. Implement the given problem using appropriate control structures available in C language.
4. Identify different functions for a problem to construct a modular solution.

Following example list of problems are grouped into A, B and C, with increasing level of difficulty and understanding. Group A problem statements addresses the concepts of constant, variable, data type, operator and expressions. Group B problem statements addresses the concept of control structures and Group C includes problem which can be solved using functions and string concepts along with the concept covered in Group A and Group B.
Assignments can be framed and expanded in such a way that it explores concepts, language constructs, logic of solution and simple application. Students will be encouraged to solve open problems in different domains. Course tutor will set up assignments to challenge students through code debugging, code improvisation and code transformation. Course tutor will appropriately adopt assignments on similar lines as the examples shown here.

Instructors can conduct a total 10 assignments . Four assignments from Group A, four assignments from Group C and two assignments from Group C.

Example List of Assignments

(Minimum 10 assignments to be implemented, covering maximum Four from each Group. Assignment number 9, 10, 11 from Group C can be considered as extra assignments. Students can explore more on C constructs to implement these assignments.) :-

Group A

Group A problem statements addresses the concepts of constant, variable, data type, operator and expressions.

1) Write C programs for basic problems Engineering Mathematics and Physics like area calculation, sin wave calculation, speed calculation, determine type of trainagle, verify pythogarous theorem etc.
2) Write C program to convert feet to inches, convert inches to centimeters, and convert centimeters to meters. Write a program that prompts a user for a measurement in feet and converts and outputs this value in meters. Facts to use: 1 ft = 12 inches, 1 inch = 2.54 cm, 100 cm = 1 meter.
3) Write a C program to swap 2 numbers.
4) Write C program to convert Kilograms to grams, convert grams to milligrams and vice a versa.
5) Write C program to convert Dollar to Rupees, convert Euro to Rupees, and vice a versa.
6) Write C program for temperature conversion Degree to Fahrenheit and vice a versa.
7) Write a C program to convert specified days into years, weeks and days.
8) Write a C program that accepts three integers and find the maximum of three.

Group B

Group B problem statements addresses the concept of control structures such as for loop, while loop.

1) Write C program to calculate Least common multiple (LCM) and Greatest Common Divisor (GCD) of given number.
2) Write C program to check whether the given number is prime or not.
3) Write C program to print a given pattern.
4) Write a C program to obtain the first 25 numbers of a Fibonacci sequence. In a Fibonacci sequence the sum of two successive terms gives the third term. Following are the first few terms of the Fibonacci sequence: 1 1 2 3 5 8 13 21 34 55 89...
5) Write C program for simple interest and compound interest calculation.

Group C

Group C includes problem which can be solved using functions and string concepts along with the concept covered in Group A and Group B.

1) Write a C program to swap 2 integers using user defined functions (call by value, call by reference).
2) Write a program in C to compute the factorial of the given positive integer using function.
3) Write a menu driven program to perform following operations using Array of integers like (accept, display, sum of all numbers, search a number, maximum and minimum of number).
4) Write a menu driven program to perform string operations.
5) Write a program in C to compute addition / subtraction / multiplication of two matrices.

6) Write a C program to perform employee operations such as accept, display, search by name, search by number, update a record. Explore the possibility of modularity for implementation.
7) Write a C program to perform bank account related operations such as accept, display, withdraw and deposit money, check balance.
8) A string is provided from the user. Calculate the total number of characters in the string and the total number of vowels in the string with the number of occurrence in the string.
9) 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
10) 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
11) Two friends issued 5 books each from the library, Write a program in C to compute set operations
   i. List of all books with them
   ii. List common titles with them
   iii. List of books with friend1 but not with friend 2

20ES02L Fundamentals of Programming Language Lab -1(Mech)

Teaching Scheme:
Practical: 2 Hr/week
Credits:01

Examination Scheme:
In-Sem: 25 Marks

Course Objectives:
To facilitate the learners:
1.To learn the fundamentals of python programming for logic building.
2.To implement solution of a given problem using appropriate data type, operators of python language.
3.To understand the decision and iteration interpretation in a programming language.
4.To implement the logic using list, strings, functions and structures of python programming language.

Course Outcomes:
By taking this course, the learner will be able to:
1. Apply logic development skills to solve simple real life problems.
2. Implement, test and execute developed logic or algorithm to python program using appropriate data type, operators.
3. Implement the given problem using appropriate control structures available in the python language.
4. Identify different functions for a problem to construct a modular solution.

List of assignments to be done in Python:
1. Learn logic building using tools such as 'scratch'.
2. Demonstration of installation and configuration of Anaconda and Spyder.
3. A) Accept input (number, name) from the user and print the same.
   B) Display the numbers from 1 to 10.
4. Create an empty dictionary, add elements to the dictionary, update the key values and display the elements of the dictionary.
5. A) Create a tuple, add elements to the tuple and display the elements of the tuple.
   B) Swap two numbers using tuples and display the initial and swapped contents of the tuples.
6. Perform string manipulation functions (concatenation, substring, comparison, palindrome)
7. Find the maximum or minimum number in a given list.
8. Calculate factorial using functions.
9. Generate Fibonacci series using recursion.
10. Implement file operations.
11. Calculate area/circumference of a circle for a given radius using:

a. formula
b. inbuilt function from numpy library.

12. Plot sin(x) and cos(x) functions for values of x between 0 and pi. Use inbuilt libraries numpy and matplotlib.

20ES04L Engineering Graphics Lab

Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/week	In Semester: 25 marks
Credits: 1	

Course Objectives:

To familiarize student about1

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 **(20 Hrs.)**

- 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 **(08 Hrs.)**

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

20ES07 Technical Skill Development Laboratory

Teaching Scheme:

Practical: 2 Hrs/Week

Examination Scheme:

In-Semester:25 Marks

Course Objective: Student will able to learn

I. To identify tools, work material and measuring instruments useful for assembly dissemble of products and different machining operations
2. To handle tools and instruments and use them to prepare joints of specific shape and size.
3. To install software and Operating system on computers

Course Outcome: Student will able to

1. select appropriate tools/equipment for measurement and manufacturing.
2. troubleshoot hardware software in computer systems.
3. produce joints of specific shape, size and material
4. assemble and disassemble components of a product.
5. Implement safety measures required to be taken while using the tools and machines

Sr. No.	Content :	Hrs
1	Use of measuring devices and instruments : Vernier Calliper, Micrometer, Digital Multi-meter, Tachometer, Lux meter etc.	2
2	Assembly -disassembly of products: Electric Iron, Water Purifier, Fan, Mixer Grinder etc.	4
3	Use of joining methods: Soldering and Welding.	4
4	Study and Hands on different day to day machining operations: such as drilling, tapping PVC pipe fitting, hacksaw cutting and filing.	2
5	Use of Machine Tool (Lathe machine)	6
6	Basic troubleshooting computer System in Hardware and Software. Installing and Uninstalling software's (OS 4 APPS) Computer system security aspects (Physical and logical)	6

**NOTE: Practical No. 5 is For Mechanical Engineering Branch and Practical No. 6 is for COMP/IT/E&TC/INSTRU Branch

Text Books:

I. Elements of Mechanical Engineering - Hajra Choudhury & others, Media Promoters 2010.
2. The Elements of Workshop Technology - Vol I & Il, SK. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, I Ith edition 2001 others, Media Promoters and Publishers, Mumbai.

Reference:

I. Workshop manual prepared by Department of Mechanical Engineering.

Basic Sciences and Humanities

Autonomous Programme Structure (Revision-1)
F. Y. B. Tech. Sem-II
E&TC / Instru / Mech Programmes
A. Y.: 2020-21 Onwards

F. Y. B. Tech. Second Semester									
Course Code	**Course Title**	**Teaching Scheme Hours / Week**			**Examination Scheme**			**Marks**	**Credit**
20BS03	Multivariate Calculus	3	1	0	50	50	0	100	4
20BS02	Chemistry	3	0	0	50	50	0	100	3
20ES01	Basic Electrical and Electronics Engg.	3	0	0	50	50	0	100	3
20ES05	Fundamentals of Programming Language- 2 (E/IN)	3	0	0	50	50	0	100	3
20ES05M	Engineering Mechanics (Mech)	2	1	0					
20ES06	Geo Informatics	3	0	0	50	50	0	100	3
20BS02L	Chemistry Lab	0	0	2	25	0	0	25	1
20ES01L	Basic Electrical and Electronics Engg Lab	0	0	2	25	0	0	25	1
20ES05L	Fundamentals of Programming Language- 2 Lab	0	0	2	25	0	0	25	1
20ES05ML	Engineering Mechanics Lab	0	0	2					
20ES06L	Geo Informatics Lab	0	0	2	25	0	0	25	1
Total		**15**	**2**	**8**	**350**	**250**	**00**	**600**	**20**
Grand Total		**24**			**600**			**600**	**20**

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

Cummins College of Engineering For Women ★ MKSSS's Karve Nagar, Pune 411052.

APPROVED BY
Chairman Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052

20BS03 Multivariate Calculus

Teaching Scheme:
Lectures: 3 Hrs/Week
Tutorial: 1 Hr/Week
Number of Credits: 4

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

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 of multivariate functions.

CO2: Apply partial differentiation to applications like maxima minima, construction of linear model etc.

CO3: Solve double integral, triple integral over the region.

CO4: Determine physical parameters using double and triple integral.

Course Content:

Unit – I: Partial differentiation **(09)**

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. **(07)**

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 **(10)**

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 **(09)**

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 **(07)**

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, (*40th edition), (2008).

3. Hughes-Hallett et al., '**Calculus - Single and Multivariable',** *John-Wiley and Sons,* (3rd Edition), (2003).

4. Maurice Weir, Joel Hass, '**Thomas' Calculus'**, *Pearson India*, (13th edition), (2016).

Reference Books:

1. J. E. Marsden, A. J. Tromba and A. Weinstein, '**Basic Multivariable Calculus'**, *Springer,* (3rd edition), (1993).

2. G. B. Thomas and R. L. Finney, '**Calculus and Analytic geometry'**, *Pearson, Reprint* (9th 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* (4th edition), (2009).

20BS02 Chemistry

Teaching Scheme	**Examination Scheme**
Lectures: 3Hrs/week	In-Semester: 50 Marks
Credits: 3	End-Semester: 50 Marks

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

The students will 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)

20ES01 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 α and β, 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)

20ES05 Fundamentals of Programming Language-2 (ETC, Instru)

Teaching Scheme:
Lecture: 3 Hr/week

Examination Scheme:
In-Sem: 50 Marks
End-Sem: 50 Marks
Credits: 3

Course Objectives:

To facilitate the learners:

1)To understand and apply object-oriented principles for application development.
2)To develop programming applications using Java.
3)To make use of class, object, constructor.
4)Learn programming construct of Java.

Course Outcome:

By taking this course, the learner will be able to:

1) Develop basic object oriented program using class, object and constructor.

2) Differentiate between different types of polymorphism

3) Demonstrate object-oriented programming concepts of exceptions using inbuilt classes and user-defined exceptions

4) Make use of principles of object-oriented programming language Java to solve given problem

Unit-I : Introduction to Object Oriented Programming Paradigm (5)

Role and need of programming languages, characteristics of a good programming language, introduction to various programming paradigms. Need of object-oriented paradigm, basic concepts of object oriented programming (OOP), benefits of OOP. General characteristics for OOP, Object oriented concepts: Class, Object, abstraction, encapsulation, polymorphism, and inheritance.
Illustration through real life examples and use cases

Unit-II : Introduction to Java Programming Language (6)

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-III : Polymorphism **(5)**

This keyword, static method, function overloading, argument passing, constructor overloading. String and Array's in Java, Java Collection Framework – Arraylist, HashSet
Illustration through real life examples and use cases

Unit-IV: Inheritance **(6)**

Types of inheritance, base class and derived class, access specifiers, method overriding.
Illustration through real life examples and use cases

Unit-V: Abstract Class, Interfaces and Packages **(6)**

Abstract class, interfaces, run time polymorphism. Creating and importing packages.
Illustration through real life examples and use cases

Unit-VI: Exception Handling in Java **(5)**

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

Text Books:

1) Herbert Schilt, "JAVA Complete Reference", Tata McGraw Hill, (9thEdition), (2014)
2) Eckel B., "Thinking in Java", Pearson Education, (3rd Edition)

Reference Books:

1. Kathy Sierra & Bert Bates, "Head First Java", Oreilly publication,(2nd Edition) (2009)
2. Barry Burd "Beginning Programming with Java for Dummies", Oreilly publication, (5th Edition) (2017)
3. Paul Deital and Harvey Deital,"Java How to program", Prentice Hall Publication,(9th Edition) (2011)

20ES05M Engineering Mechanics (Mech)

Teaching scheme	**Examination scheme**
Lectures: 2hrs/week	In-Sem Exam: **50** Marks
Tutorial: 1hr/week	End-Sem Exam: **50** Marks
Number of Credits: 3	

Course Objectives:

1. To familiarize the **concepts of equilibrium and friction**.
2. To study and analyze the motion of moving particles and bodies**.**

Course Outcomes:

CO1: Apply the concept of force, moment and equilibrium in two and three dimensional systems with the help of FBD

CO2: Estimate force of friction, C.G. and Moment of Inertia of the bodies.

CO3: Analyze the motion of a particle to find the relation between velocity and acceleration.

CO4: Analyze particles in motion using force and acceleration, work-energy and impulse-momentum principle.

Unit-I: Rigid body: Statics (06)

Equivalent force systems, Equations of equilibrium, free body diagram, reactions.

Static, intermediately and partial constraints, two and three force systems.

Structures: 2D truss, method of joints, method of selection. Frame, beams, types of loading and supports. Shear force and bending moment diagrams.

Unit-II: Friction (03)

Dry friction (static and kinetic) wedge friction, disk friction, belt friction, journal bearings, wheel friction and rolling resistance

Unit-III: Center of Gravity and Moment of Inertia (04)

First and second moment of inertia and mass. Radius of gyration, parallel axis theorem, product of inertia, rotation of axes and principal M.I. by direct method. Composite bodies.

Unit-IV: Kinematics of Particles (04)

Rectilinear motion, curvilinear motion, rectangular, normal-tangential, polar, cylindrical co-ordinates, relative and constrained motion, space curvilinear motion.

Unit-V: Dynamics of Particles (03)

Force, mass and acceleration, work-energy, impulse-momentum principle, impact of bodies.

Unit-VI: Kinetics of Rigid Bodies (04)

Translation, fixed axis rotation, general planner motion, work-energy, power, potential energy, impulse-momentum and associated conservation principle, Euler equation of motion and its applications.

Text-Books:

1. R. C. Hibbeler, 'Engineering Mechanics (statics and Dynamics), 12th Edition, Pearson
2. A. Nelson, 'Engineering Mechanics (statics and Dynamics), 12th Edition, Mc Graw Hill Education.

Reference Books:

1. Timoshenko and Young, 'Engineering Mechanics', Tata Mc-Graw Hill, New Delhi.
2. Mclean, and Nelson, 'Theory and problems of Engineering Mechanics (Statics and Dynamics)', Schaum Series.
3. Beer and Johnson, 'Vector Mechanics for Engineers-Dynamics' McGraw Hill Education.
4. Engineering Mechanics (Statics and Dynamics)', Dorling Kindersley (India) Pvt. Ltd. Pearson Education.
5. Dr. R. K. Bansal , Sanjay Bansal, 'A Text book of Engineering Mechanics', Lakshmi publications.

20ES06 GEO-INFORMATICS

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

Course Objectives:

1. To introduce the science and technologies involved in Remote sensing
2. To understand the application of GIS in various fields
3. To explain the earth and mapping principles
4. To learn basics about the Geodata & GIS software

Course Outcomes:

After completion of course, students will be able to

CO1: Analyse the parameters affecting visual interpretation of physical features of an image

CO2: Justify use of various types of maps applicable in different scenarios

CO3: Identify use of components of GIS for spatial and attribute data relationship

CO4: Apply GPS technologies to real world examples using an understanding of GPS theory

CO5: Relate GIS and remote sensing technologies with maps, images and apps

Unit – I: Principles of remote sensing **(05)**

Concept of Remote Sensing, Working Principle, Types of remote sensing , Platforms of remote sensing , Output of remote sensing – photography, satellite imaginary and visual interpretation data

Unit – II: Data interpretation method in remote sensing (05)

Types of data, Visual interpretation of images-Natural and false colour composites, Image resolution, Limitations, Applications

Unit – III: Photogrammetry & Cartography (06)

Fundamentals of aerial photography, satellite images, virtual images, Image processing, Digitalization of maps

Cartography: Conventional Maps, Definition, Map Basics Elements/components of map, Map Scale, Large & Small Scale maps, Thematic maps , Coordinate system , Polar & Cartesian (Latitude-Longitude & x, y coordinates)

Unit – IV: Geographical information system (GIS) & Database management for geoinformatics (08)

GIS : Concept & definition of GIS (based on components, based on functions), GIS vs. Conventional Mapping, Components of GIS, Working Principle of GIS, Strengths of GIS, Geoinformatics Vs. GIS

Database management for geoinformatics : GIS Data and Data Models, Concept of Query, Concept of Spatial Analysis

Unit – V: Global Positioning System (GPS) (05)

History of GPS, Types of GPS, Working principle, Applications of GPS, Case study

Unit – VI: Application of geoinformatics (07)

Case studies to be used for demonstration-

Navigational services : available on phones (travel direction from A to B), Vehicle tracking system / Fleet management : Cabs, City buses, Trains, Aircrafts, City Planning (urban sprawl, master planning) , Solid waste management (identifying location for waste disposal site, route optimization of waste collection, online/offline monitoring of waste collection); Identifying suitable location for business outlet (Pizza hut, Teco bell, General Motors), GIS for location based services (courier & other home delivery services) – Fedex, DHL, Telecom sector uses GIS (planning of OFC network, identifying suitable location for mobile towers, marketing, operations), Disaster Management using GIS (modelling & simulation tools – through videos)

Text Books:

1. **Information Systems**, *Prentice-Hall of India, New Delhi, 2006.*
2. Ian Heywood, Sarah Cornelius and Steve Carver -**An Introduction to Geographical Information Systems**- *(4th Edition) by 2012*
3. A.M. Chandra, S.K. Ghosh,- "**Remote Sensing and Geographical Information System**", *1 st Edition, Narosa Publishing house, 2007.*

Reference Books:

1. 1. Peter A. Burrough and Rachael A. Mc. Donnell- **Principles of Geographical Information** System, *Oxford University Press Inc., New York, 2004.*
2. 2. Ian Heywood, Sarah Cornelivs and Steve Carver, **An Introduction to Geographical Information System**, *Pearson Education Pvt .Ltd., New Delhi, 2007.*
3. Arthur H. Robinson et al. **Elements of Cartography**, *V Edition, John Wiley & Sons, New Delhi, 2002.*
4. Misra, R.P.and Ramesh, A**, Fundamentals of Cartography concept**-*Publishing Company, New Delhi, 2002.*
5. Lillesand M. Thomas and Ralph W.Kiefer **- Remote Sensing and Image Interpretation**

20BS02L Chemistry Laboratory

Teaching Scheme:
2 hours per week
Number of Credits: 1

Continuous assessment
Term Work: 25 Marks

Course outcomes

CO	On completion of this course, student will 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.

20ES01L Basic Electrical and Electronics Engineering Lab

Teaching Scheme:
Practical: 2 Hrs./Week
Credits: 1

Examination Scheme:
Term Work: 25 marks

Course Outcomes:

After completion of course, students will be able to

- Perform basic domestic wiring
- Apply circuit laws to find the parameters of given electrical network
- Build a basic regulated DC power supply
- Obtain frequency response of CE amplifier
- 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.

20ES05L Fundamentals of Programming Language Lab-2 (ETC, Instru)

Teaching Scheme:
Practical: 2 Hr/week
Credits: 1

Examination Scheme:
In-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:

1) Develop basic object oriented program using class, object and constructor
2) Develop readable and reusable code using inheritance and polymorphism
3) Make use of exceptions using inbuilt classes and user defined exceptions
4) Develop application using object oriented programming language Java to solve given problem

A large part of ESFL205 lab would be for understanding the basic concepts of object-oriented programming and implementation of some real-world simple applications. Assignment statements are in brief and should be implemented in JAVA programming language. Faculty members are encouraged to expand problem statements with variations. Assignments can be framed and expanded in such a way that it explores concepts, language constructs, logic of solution and simple application. Students will be encouraged to solve open problems in different domains. Faculty will appropriately adopt assignments on similar lines as the examples shown here.

Example List of assignments:-

Group A: Assignment to write program in OO language to understand concept of data abstraction and encapsulation

1. Write a MyDate class which has attributes as day, month and year. Create five objects of MyDate and display them.
2. Design a user defined abstract data type 'Complex' in Java. Write a program to perform arithmetic operations of two complex numbers.
   A complex number has a real part and an imaginary part.

a) Given the values of real part and imaginary part of a complex number, the magnitude of the complex number can be calculated as square root of the sum of squares of real part and the imaginary part.
b) The argument of the complex number can be calculated as tan inverse of ratio of imaginary part(numerator) and real part(denominator)
c) The complex number can be added to another complex number and the answer of the addition is a complex number. When one adds two complex numbers, the real parts of each of the complex numbers is added which becomes a real part of the answer and imaginary part of each complex number is added together which becomes imaginary part of the answer. Both these results are real and imaginary parts for a complex number which is the answer of the addition complex conjugate of the complex number can be calculated by negating the imaginary part of the complex number
d) The complex number can be subtracted from another complex number and the answer of the subtraction is a complex number.
e) When one subtracts a complex number from the other, the real part one complex number is subtracted from the other and the result becomes a real part of the answer and imaginary part of one complex number is number is subtracted from the other and the result of subtraction becomes imaginary part of the answer. Both these results are real and imaginary parts for a complex number which is the answer of the subtraction.

3. 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.

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. Write a JAVA program to perform String operations using String/String Buffer class
   a) Write a program that reads a word and then prints the first character, the last character, and the characters in the middle. For example, if the input is Cummins, the program prints Cummins.

b) Write a program that reads a name (such as Ranbeer Rishi Kapoor) and then prints a monogram consisting of the initial letters of the first, middle, and last name (such as RRK).

Group B: Assignment to write program in OO language to understand concept of class inheritance and polymorphism.

1. Implement Java program to calculate area and perimeter of various shapes-circle, triangle and rectangle.
2. Create an application like book shop and maintain the inventory of books that are being sold at the shop
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. A company has many employees. An employee has employee Id, basic salary, house rent allowance, dearness allowance, profession tax and total salary. An employee has an address. The address has apartment number, apartment name, road and PIN code.

   The total salary of an employee is the summation of basic salary, house rent allowance which is 20 percent of basic salary, dearness allowance which is 45 percent of basic salary. The take home salary is calculated after deducting profession tax from which is 7 percent of basic salary from the total salary. When an employee is appointed, he is assigned with an employee Id and basic salary. One can ask for total salary of the employee and take-home salary of the employee.
   Identify a class/classes from the above statement, identify the attributes, the data types, the behaviour. Test your program for ten employees
   Display all the details of the employees as per id and as per pin code.
   Display take home salary for all the employees, display the tax to be deducted across all employees.
6. Reading material has title and price. A book is a reading material. It has ISBN number. A magazine is a reading material, it has 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. Write all of them clearly.
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 propeller.

Group C: Assignment to write program in OO language to understand concept of exception handling

1) Write a program to catch various in-built exceptions (try, catch and finally block)

2) Create User defined exception to check the specific conditions for systems like recruitment etc and throw the exception if the criterion does not met in Java.

3) Consider student data consist of fields such as roll number, name, and marks of various subjects. Write a program using inbuilt and user defined exceptions to avoid invalid entry.

20ES05ML Engineering Mechanics Lab (Mech)

Teaching scheme **Examination scheme**

Practical: 2hrs/week In-Sem Exam: **25** Marks

Number of Credits: 1

Course Objectives:

1. To demonstrate the basic principles of Engineering Mechanics namely Engineering Statics and Engineering Dynamics.

Course Outcomes:

CO1: Verify law of Force Polygon

CO2: Verify the law of moments using parallel force apparatus

CO3: Analyze co-efficient of friction, C.G. and M.I. of the system

CO4: Estimate mechanical advantage, velocity ratio and Mechanical efficiency of a mechanical system

List of Experiments

1. To verify the law of force polygon.
2. To verify the law of moments using parallel force apparatus. (simply supported type).
3. To determine the co-efficient of friction between wood and various surface (like leather, wood, aluminum) on an inclined plane.
4. To find the forces in the members of jib crane.
5. To determine the mechanical advantage, velocity ratio and mechanical efficiency of a screw jack.
6. To determine the mechanical advantage, velocity ratio and mechanical efficiency of the wheel and axle.
7. Verification of force transmitted by members of given truss.
8. To verify law of moments using bell crank lever.
9. To find the C.G. and Moment of Inertia of an irregular body experimentally and verify using computational method.

20ES06L GEO-INFORMATICS Lab

Teaching Scheme:

Practical : 2 Hr/Week

Credit1: 1

Examination Scheme:

Term Work: 25 Marks

Course Objectives:

1. To introduce students basics of spatial data and its creation.
2. To learn basics about the Geodata & GIS software.

Course Outcomes:

After completion of course, students will be able to

CO1: **Interpret** satellite images and their characteristics with the use of software features

CO2: **Apply** basic data visualization concepts for identification of physical features

CO3: **Use software to interpret** aspatial attribute data and relate it with spatial data

CO4: **Use software to interpret** vector layer and relate it with attribute data

List of Experiments

1) Exploring Digital Map
2) Study and observations of paper map and digital map
3) Measurement of area using Digital planimeter.
4) Study of Layers, Display Controls, Locating a place
5) Adding place marks - Saving KMZ/ KML files

6) Study of ground profile between given two points

7) Visual Interpretation of multispectral image

8) Creating csv file (attribute data) and importing in GIS platform

9) Understanding QGIS interface

10) Working with vector data – Point, Line, Polygon

Autonomous Program Structure of Second Year B. Tech. Third Semester (Mechanical Engineering)
Academic Year: 2021-2022 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem.	End Sem.	Practical	Oral		
BSME301	Calculus and Statistics (C&S)	3	1	0	50	50	0	0	100	4
20ME301	Engineering Metallurgy (EM)	3	0	0	50	50	0	0	100	3
20ME302	Engineering Thermodynamics (ET)	2	1	0	50	50	0	0	100	3
20ME303	Machining and Machine Tool Operations (MMTO)	3	0	0	50	50	0	0	100	3
20ME304	Strength of Materials (SOM)	3	1	0	50	50	0	0	100	4
20HS 301	Universal Human Values-II	2	1	0	50	50	0	0	100	3
20ME305L	Computer Aided Machine Drawing lab (CAMD Lab)	0	0	4	25	0	25	0	50	2
20ME301L	Engineering Metallurgy Lab (EM Lab)	0	0	2	25	0	0	25	50	1
20ME303L	Machining and Machine Tool Operations Lab (MMTO Lab)	0	0	2	25	0	25	0	50	1
20AC301	Audit Course (AC)	0	0	2	0	0	0	0	0	-
	Total	**16**	**4**	**10**	**375**	**300**	**50**	**25**		
	Grand Total	**30**			**675**		**75**		**750**	**24**

S. Y. B. Tech. – Semester-I

Course Code	Calculus & Statistics	L	T	P
20BSME301		3	-	-
Pre-requisite	First order linear ordinary differential equations, Basics of Vector Algebra, Integration – basic properties, standard results, Beta & Gamma Functions, Basics of probability.	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To provide sound knowledge of engineering mathematics
2. Strengthen thinking power to analyze
3. Solve engineering problems in their respective areas.

Course Outcomes:

Students will be able to

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

1 Solve the higher order linear differential equation and apply it to the mass-spring system.
2 Compute the transforms of simple discrete and continuous functions and solve partial differential equation.
3 Apply the concepts of vector calculus to find vector differentiation and vector integration.
4 Apply the concepts of probability distributions and statistics to interpret the data.

Unit/Module: 1	Higher Order Linear Differential equation and application	6 hours	CO: 1

Higher order Linear differential Equation with constant coefficients, Applications in solving Engineering problems. Mass Spring system, Damping effects, Resonance.

Unit/Module: 2	Transforms	8 hours	CO: 2

Fourier Transforms: Finite Fourier Sine transform, Finite Fourier Cosine transforms, Inversion formula for Sine transform, Inversion formula for Cosine transform. Finite Fourier Sine and Cosine Transforms of derivatives. Discrete Time Fourier Transforms (DTFT) of standard sequences, Existence of DTFT, Properties of DTFT, Inverse DTFT.

Laplace Transform: Definition of Laplace transform , Inverse Laplace transform , Laplace and InverseLaplace Transform of standard functions and problems.

Unit/Module: 3	**Partial Differential Equations**	**5 hours**	**CO: 3**
Basic Concepts, Types of P.D.E. (Hyperbolic, Elliptic, Parabolic). Use of Finite Fourier Transforms for solving of P.D.E			
Unit/Module: 4	**Vector Differentiation**	**4 hours**	**CO: 4**
Physical interpretation of vector differentiation, vector differential operator, Gradient, Divergence, Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, vector identities.			
Unit/Module: 5	**Vector Integration**	**5 hours**	
Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem.			
Unit/Module: 6	**Statistics and Probability Distribution**	**6 hours**	
Measure of Central tendency, Measure of Dispersion, Probability, Random variables, Distributions – Binomial , Poisson, Normal , Weibull.			
	Total Lab hours:	**34 hours**	

Text Books:

1.	B. S. Grewal, „Higher Engineering Mathematics ", Khanna Publications.
2.	B. V. Ramana, „Higher Engineering Mathematics ", Tata McGraw Hill Publications (2007)
3.	Peter V. O'neil,'Advanced Engineering Mathematics' ,Thomson Brooks / Cole, Singapore (5th edition) (2007).

Reference Books:

1.	C.R.Wylie, L.C. Barrette, „Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi.(6th edition)(2003)
2.	Erwin Kreyszig ,'Advanced Engineering Mathematics' Wiley Eastern Ltd. (8th Student Edition), (2004).
3.	S.C. Gupta, V.K. Kapoor, 'Fundamental of Mathematical Statistics', S. Chand & Sons (10th revised edition) (2002).

Course Code	Engineering Metallurgy	L	T	P
20ME301		3	-	-
Pre-requisite	Engineering Physics, Engineering Chemistry, Engineering mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

Course prepares students to

1. Understand type of materials
2. Understand properties of materials.
3. Understand Constraints in Engineering Industry
4. Correlate the constraints and materials

Course Outcomes:

Students will be able to.

1. Correlate the relationship between processing-structure-property-performance of materials to define and evaluate properties relevant to engineering
2. Define and evaluate properties relevant to mechanical engineering
3. Cite usual types of failures in materials correlate the structure and integrity of materials with common failures and write their causes
4. Read binary phase diagram, predict and quantify phase transformation using phase diagrams.
5. Specify metals and alloys used in engineering industry.
6. Select method for modification of properties.

Unit/Module: 1	Crystal Structure:	6hours	CO: 1

Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Unit/Module: 2	Mechanical Property measurement:	6hours	CO: 2

Tensile, compression and torsion tests; Young"s modulus, relations between true and engineering stress- strain curves, generalized Hooke"s law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.Introduction to non-destructive testing (NDT

Unit/Module: 3	Failure theories:	8 hours	CO: 3

Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue,			
Unit/Module: 4	**Phase diagrams:**	**6 hours**	**CO: 4**
Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.			
Unit/Module: 5	**Metals and alloys:**	**6 hours**	**CO: 5**
Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys			
Unit/Module: 6	**Heat treatment of Steel:**	**6 hours**	**CO: 6**
Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening			
	Total Lecture hours:	**36 hours**	

Text Books:

1.	Callister's Material Science and Engineering", W.D. Callister, D.G.Rethwisch, Wiley, 2016, Second edition.
2.	Materials engineering, science, processing and design, Michael Ashby, Hugh Shercliff, David Cebon, Butterworth-Heineman, 2008

Reference Books:

1.	"Properties of Engineering materials", R.A. Higgins, ELBS, Edward Arnold, 1988.
2.	"Material Science & Engineering." Raghavan V., Prentice Hall of India, New Delhi. 2003
3.	"Material selection in mechanical design', Michael Ashby, Butterworth-Heinemann, 3/e, 2005
4	An Introduction to properties, Applications and design, Third edition, Ashby and Jones, Butterworth Heinemann.
5.	Relevant ISO and Indian standards

Course Code	Engineering Thermodynamics	L	T	P
20ME302		2	1	-
Pre-requisite	Engineering Physics, Engineering Mathematics, Engineering Chemistry	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To state and illustrate laws of thermodynamics
2. To understand concept of entropy and availability.
3. To get conversant with properties of steam, vapor processes and steam trap.
4. To analyze the performance of various thermodynamics cycles.

Course Outcomes:

Students will be able to

1. Students will be able to apply laws of Thermodynamics to various processes.
2. Students will understand the concept of entropy and availability.
3. Students will gain the knowledge about steam properties and steam trap.
4. Students will be able to do performance calculations for various thermodynamic cycles.

Unit :- 1	Laws of Thermodynamics	6 hours	CO: 1

First law of thermodynamics, second law of thermodynamics, zeroth law of thermodynamics. First law applied to closed system and open system, Second law of thermodynamics, Corollaries of Carnot theorem, Second law applied to heat engine, heat pump and refrigeration cycles.

Unit :- 2	Entropy	4 hours	CO: 2

Clausius Inequality, Entropy – a system property, Evaluation of entropy change for solids,

liquids and ideal gases, Principle of increase of entropy- entropy generation.

Unit :- 3	Properties of Steam	5 hours	CO: 3

Formation of steam, Properties of steam, First law applied to steam processes, Steam trap.

Unit :- 4	Thermodynamic Vapour Cycles	5 hours	CO: 4

Carnot cycle, Rankine cycle , Reheat and Regeneration

Unit :- 5	Thermodynamic Gas Cycles	5 hours	CO: 4

Otto cycle, Diesel cycle, Dual cycle

	Total hours:	**25 hours**	

Text Books and Reference Books	
1.	Principles of Engineering Thermodynamics- Moran, Shapiro, Boettner, Baily Eighth Edition, Wiley Publication.
2.	P. K. Nag, Engineering Thermodynamics, 5th Edition, Tata McGraw Hill Publications
3.	C.P. Arora, Engineering Thermodynamics, Tata McGraw Hill
4.	S. Domkundwar, C. P. Kothandaraman, Anand Domkundwar, Thermal Engineering, Dhanpat Rai Publishers
5.	Cengel and Boles, „Thermodynamics – An Engineering Approach", 7th Edition, Tata Mc Graw Hill Publication.
6.	Rayner Joel, "Basic Engineering Thermodynamics", Addison Wesley Longman

Course Code	Machining and Machine Tool Operations (MMTO)	L	T	P
20ME303		3	-	-
Pre-requisite	--	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To familiarize with the basic concepts of machining science.
2. To acquaint with various single and multipoint cutting tools designing processes.
3. To make the students understand the economics of machining process

Course Outcomes:

Students will be able to

1. Identify different machining operation requirements for components considering economics of machining.
2. Select an appropriate single or multipoint cutting tool parameter to evaluate cutting force, power, tool life and surface finish for machining operation.
3. Apply features and applications of non-traditional machining processes.
4. Incorporate use of different locating and clamping devices for jigs and fixture design.
5. Understand the need of automation and its use in manufacturing.

Unit/Module: 1	Machine tools	12 hours	CO: 1
Material removing (turning, drilling and milling) & finishing processes (grinding, lapping, honing) process parameters, economics of machining			
Unit/Module: 2	**Metal Cutting Theory**	**10 hours**	**CO: 2**
Single and multipoint cutting tools (hobs and form tools), tool geometry and materials. Theory of chip formation in metal machining, force relationships and the merchant equation, power and energy relationships in machining, Tool life and tool wear.			
Unit/Module: 3	**Non-conventional machining processes**	**7 hours**	**CO: 3**
USM, WJM/WJAM, Chemical Machining, ECM, EDM, LBM, EBM, IBM process parameters and applications.			
Unit/Module: 4	**Jig & Fixture**	**6 hours**	**CO: 4**

Jig, fixtures types (basic and modular) and applications, design of jigs and fixtures.			
Unit/Module: 5	**Automation**	**7 hours**	**CO: 5**
CNC types, systems, codes, manufacturing automation (machining center, FMS).			
	Total Lecture hours:	**42 hours**	

Text Books:	
1.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication.
2.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.
Reference Books:	
1.	Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group.
2.	Jigs and Fixture, P.H. Joshi, Tata McGraw-Hill
3.	Metal Cutting Principles (2nd Edition), by Milton Clayton Shaw, Oxford University Press.

Course Code	Strength of Materials	L	T	P
20ME304		3	1	--
Pre-requisites	Engineering Mechanics	Syllabus Version		
		V:1.1		

Course Objectives:

1. Define stresses, strains and elastic constants and evaluate the principal stresses and principal planes
2. Explain basic concepts of shear force and bending-moment.
3. Determine the maximum Bending and shear stress in a given beam.
4. Develop slope and Deflection equations for beams subjected to various loads.
5. Evaluate the buckling strength of columns and torsional strength of circular members

Course Outcomes:

Students will be able to

1. Evaluate principal stress and principal strain.
2. Draw SF and BM diagrams for various beams under different loading conditions.
3. Formulate the bending and shear stresses equations and be able to draw bending and shear stress diagrams.
4. Formulate slope and deflection equations for beams subjected to various loads.
5. Determine torsional strength and buckling strength.

Unit :1	Simple and Compound Stress and Strain	10 hours	CO: 1

Stress, strain, Hooke‟s law, Poisson‟s ratio, Modulus of Elasticity, Modulus of Rigidity, and Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram, factor of safety. Stresses and strains in determinate and indeterminate, homogeneous and composite bars under concentrated loads and self-weight. Temperature stresses in simple members, Normal and shear stresses on any oblique plane. Concept of principal planes, derivation of expression for principal stresses and maximum shear stress, position of principal planes and planes of maximum shear. Graphical solution using Mohr‟s circle of stresses. Principal stresses in shaft subjected to torsion, Bending moment and axial thrust Concept of equivalent torsion and bending moments

Theories of Elastic Failure :-Maximum Principal Stress Theory, Maximum shear stress theory, Maximum distortion Theory, Maximum Strain theory

Unit : 2	Shear Force and Bending Moment Diagrams	6 hours	CO: 2

Shear force and bending moment diagrams for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load and couple, Relationship between rate of loading,

shear force and bending moment. Maximum bending moment and position of points of contra flexure.

Unit : 3	Bending and Shear Stresses in Beams	8 hours	CO: 3

Bending stresses : Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (rectangular, I,T,C) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance and section modulus.

Shear stresses: Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses, shear connection between flange and web.

Unit : 4	Slope and Deflection of Beams.	6 hours	CO: 4

Relation between bending moment and slope, slope and deflection of determinate beams, double integration method (Macaulay‟s method), derivation of formula for slope and deflection for standard cases.

Unit : 5	Torsion and Buckling.	6 hours	CO: 5

Torsion of circular member: Stresses, strain and deformations in determinate shafts of solid and hollow, homogeneous and composite circular cross section subjected to twisting moment, derivation of torsion equation, stresses due to combined torsion, bending and axial force on shafts.

Buckling of columns: Concept of buckling of columns, derivation of Euler‟s formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, safe load on columns

	Total Theory Lecture hours:	36 hours	

Tutorial Assignments

1.	Solving numerical on simple stress and strains
2.	Analytical and Graphical Solution (Mohr‟s Circle) for compound stresses.
3.	Drawing SFD and BMD for standard beam and loading conditions.
4.	Determine bending stresses and shear stresses in the beam.
5.	Finding slope and deflection at various locations for standard beam and loading conditions.
6.	Determination and Graphical representation using Python. **(Any One)** *a)* Determine Principal Stresses, Maximum shear stresses and their locations by plotting Mohr's Circle using Python. *b)* Plot SFD and BMD for a given beam using Python. *c)* Find Bending/Shear Stresses and plot Bending/Shear Stress distribution using Python.

Text Books:	
1.	Strength of Materials S. Ramamrutham, Dhanpat Rai Pvt. Ltd.
2.	Elements of Strength of Materials, Timoshenko and Young Affiliated East West Press.
3.	Mechanics of Materials S. S. Rattan, TMH Pvt. Ltd.
4.	Mechanics of Structures S. B. Junnarkar, Charotar Publication
5.	S.S Bhavikatti,"Strength of Materials", Third Edition Vikas Publishing house Pvt Ltd, New Delhi.
Reference Books:	
1.	Mechanics of Materials, by Russell C. Hibbeler
2.	Introduction to Mechanics of Solids - by E.P. Popov, Prentice Hall Publication.
3.	Singer and Pytel - Strength of materials - Harper and row Publication.
4.	B.K. Sarkar - Strength of Material - Tata McGraw Hill New Delhi.
5.	Beer and Johnston - Strength of materials - CBS Publication.

Course Code	Universal Human Values-II	L	T	P
20HS301		2	1	--
Pre-requisites	Nil	Syllabus Version		
		V:1.1		

Course Objectives:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Course Outcomes:

CO1 : Understand human values which is only the solution of most of the present-day problems and a sustained solution could emerge only through understanding of value-based living
CO2: Compare desires of „I" and „Body" distinctly. If any desire appears related to both, students are able to see that the feeling is related to I while the physical facility is related to the body
CO3: Develop Natural acceptance (intention) which is always for living in harmony which leads to fulfillment in relationships.
CO4:Understand the whole existence to see the interconnectedness in the Nature
CO5:Make use of sustainable solutions to the problems in the society and the Nature

Module 1	Introduction to Value Education	6 hours	

Understanding Value Education: Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Right Understanding, Relationship and Physical Facility : Happiness and Prosperity – Current Scenario : Method to Fulfill the Basic Human Aspirations.

Module 2	Harmony in the Human Being	6 hours	

Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body - The Body as an Instrument of the Self - Understanding Harmony in the Self - Harmony of the Self with the Body - Programme to ensure self-regulation and Health.

Module 3	Harmony in the Family and Society	6 hours	

Harmony in the Family – the Basic Unit of Human Interaction: Values in Human-to-Human Relationship - 'Trust' the Foundational Value in Relationship, -„Respect" as the Right Evaluation - Understanding Harmony in the Society - Vision for the Universal Human Order.			
Module 4	**Harmony in the Nature/Existence**	**4 hours**	
Understanding Harmony in the Nature - Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature - Realizing Existence as Coexistence at All Levels - The Holistic Perception of Harmony in Existence.			
Module 5	**Implications of the Holistic Understanding – a Look at Professional Ethics**	**6 hours**	
Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct - A Basis for Humanistic Education, Humanistic Constitution and Universal Human order - Competence in Professional Ethics - Holistic Technologies, Production Systems and Management Models-Typical Case Studies - Strategies for Transition towards Value-based Life and Profession.			
	Total Theory Lecture hours:	**28 hours**	

Text Books:

1. R. R. Gaur, R. Asthana, G. P. Bagaria, "The Textbook A Foundation Course in Human Values and Professional Ethics", *Excel Books*, *New Delhi,* (2nd Revised Edition), (2019).
2. R. R. Gaur, R. Asthana, G. P. Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", *Excel Books*, *New Delhi,* (2nd Revised Edition), (2019).

Reference Books:

1. A. Nagaraj,"Jeevan Vidya: EkParichaya", *Jeevan Vidya Prakashan, Amarkantak,* (1999).
2. A.N. Tripathi, "Human Values", *New Age Intl. Publishers, New Delhi*, (2004).
3. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth", *Prakash books Publishers*, *Daryaganj, New Delhi.*
4. E. F. Schumacher, "Small is Beautiful", *Harper Collins Publishers, Noida, Uttar Pradesh*, (2010).
5. Cecile Andrews, "Slow is Beautiful", *New Society Publishers, Canada.*
6. J. C. Kumarappa, "Economy of Permanence", *Sarva Seva Sangh Prakashan, Wardha, Sevagram*, (2017).
7. Pandit Sunderlal, "Bharat Mein Angreji Raj", *Prabhat Prakashan, New Delhi* (2018).
8. Dharampal, "Rediscovering India", Society for Integrated Development of Himalayas, (2003).
9. Mohandas Karamchand Gandhi, "Hind Swaraj or Indian Home Rule", *Navajivan Publication House, Ahemadabad.*
10. Maulana Abdul Kalam Azad, "India Wins Freedom", *Orient BlackSwan,*(1989).
11. Romain Rolland,"Swami Vivekananda", *Advaita Ashrama Publication*, *Ramkrishna Math,* (2nd Edition), (2010).
12. Romain Rolland, "Gandhi", *Srishti Publishers & Distributor,* (2002).

Course Code	Engineering Metallurgy Lab (EM-L)	L	T	P
20ME301L		**-**	**-**	**2**
Pre-requisite	Engineering Physics, Engineering Chemistry, Engineering mathematics	**Syllabus Version**		
				V:1.1

The assessment will consist of two components:

1. Evaluation for performing practical and attending demonstrations in predefined closed system of lab instructions (Demonstration and exercise type of lab activity: **5 marks**)
2. Task based performance (Structured enquiry type and open ended enquiry type of lab activity: **20 marks**)

Course Objectives:

Course prepares students to

1. To provide first-hand experience of facilities for materials property testing and treating.
2. To provide an understanding of structures in material and their relation to properties

Course Outcomes:

Students will be able to.

1. Implement safety measures required in the laboratory
2. Measure mechanical properties and propose testing method for mechanical properties considered in design, quality assurance and servicing of engineering components
3. Inspect components for materials integrity using equipments in the laboratory.
4. Identify the phases in metals and alloys and measure grain size using metallography techniques to provide interpretation of microstructures and prepare a laboratory report.
5. Specify metals and alloys and find equivalents using standards.
6. Modify properties of steel by modifying microstructure using different heat treatments

Unit/Module: 1	**Laboratory safety:**	2 **hours**	**CO: 1**
Introduction to laboratory and safety			
Unit/Module: 2	**Mechanical Property measurement:**	6**hours**	**CO: 2**
Tension, hardness and Impact tests.			
Unit/Module: 3	**Inspection of Components:**	**2 hours**	**CO: 3**

Non destructive test			
Unit/Module: 4	**Metallography:**	**6 hours**	**CO: 4**
Study of microstructures of ferrous and non ferrous metals and alloys			

Unit/Module: 5	**Metals and alloys specification:**	**2 hours**	**CO: 5**
Study and use standards for specification of metals and alloys.			
Unit/Module: 6	**Modification of material properties:**	**6 hours**	**CO: 6**
Heat treatment of metals and alloys			
	Total Lecture hours:	**24 hours**	

Text Books:

3.	Callister's Material Science and Engineering", W.D. Callister, D.G.Rethwisch, Wiley, 2016, Second edition.
4.	Materials engineering, science, processing and design, Michael Ashby, Hugh Shercliff, David Cebon, Butterworth-Heineman, 2008

Reference Books:

1.	"Properties of Engineering materials", R.A. Higgins, ELBS, Edward Arnold, 1988.
2.	"Material Science & Engineering." Raghavan V., Prentice Hall of India, New Delhi. 2003
3.	"Material selection in mechanical design', Michael Ashby, Butterworth-Heinemann, 3/e, 2005
4	An Introduction to properties, Applications and design, Third edition, Ashby and Jones, Butterworth Heinemann.
5.	Relevant ISO and Indian standards

Course Code	Machining and Machine Tool Operations Lab (MMTO-L)	L	T	P
20ME303L		-	-	2
Pre-requisite	None	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To familiarize with the basic concepts of machining science.
2. To acquaint with various single and multipoint cutting tools designing processes.
3. To make the students understand the economics of machining process

Course Outcomes:

Students will be able to

1. Identify different machining operation requirements for components considering economics of machining.
2. Select an appropriate single or multipoint cutting tool parameter to evaluate cutting force, power, tool life and surface finish for machining operation.
3. Apply features and applications of non-traditional machining processes.
4. Understand the need of automation and its use in manufacturing.

Lab Work

1.	Demonstration of physical hazards, safety and precautions.
2.	Experimental studies on the cutting tool angle measurement.
3.	Machining of mechanical components using CNC machine (Lathe/Mill/HMC/VMC). Manufacturing drawing with appropriate geometrical and dimensional tolerances, detailed process planning to be included.
4.	Composite job machining involving minimum four operations, employing operations on lathe/CNC, precision turning, screw cutting, boring etc.
5.	Cutting Force in Turning Process-an Experimental Approach by using dynamometers.
	Total Lab hours: **22 hours**

Text Books:

3.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication.
4.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.

Reference Books:	
1.	Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group.
2.	Jigs and Fixture, P.H. Joshi, Tata McGraw-Hill
3.	Metal Cutting Principles (2nd Edition), by Milton Clayton Shaw, Oxford University Press.

Course Code	Computer Aided Machine Drawing Lab (CAMD-L)	L	T	P
20ME305L		-	-	4
Pre-requisite	Engineering Graphics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Conversant with conventional representation of common features and standards
2. Understand the basics of projections and dimensioning techniques
3. Aware of drawing the threaded fasteners and riveted joints
4. Understand the use of dimensional and geometrical tolerances
5. Accustomed to the use of 3-D modeling software
6. Aware of 3-D printing technology

Course Outcomes:

Students will be able to

1. Interpret machine components and represent it through IS conventions
2. Understand the conventional methods of representing threaded fasteners and riveted joints
3. Apply tolerances of size, forms & positions
4. Create 3-D part and assembly model of mechanical system
5. Create manufacturing drawing with all the details
6. Create components using 3-D printing machine

Unit/Module: 1	Conventional Representation	2 hours	CO: 1

Need of graphical language, importance of machine drawing, drafting equipment (from instrument to current software). Principles of drawings: BIS conventions, ISO standards, IS conventions of springs, gear, shaft, pipe, bar, washer, knurling, array of holes, ratchet and pawl angle etc.

Unit/Module: 2	Basics of Projections and dimensioning	2 hours	CO: 5

Projections– dimensioning, relative position of views.

Sectioning– Cutting planes and section, hatching lines, half sections, aligned sections, offset sections, sectioning revolved, removed sections, local sections.

Dimensioning– principle of dimensioning, dimensioning of common features e.g. diameter, radii, chords, arcs, angles, countersunk, counter drilled holes, counter-bore holes, chamfered and countersunk holes on curved surfaces, spot faces, chamfers, tapered features. Addition of letters and symbols, special indications.

Unit/Module: 3	**Threaded Fasteners and Riveted joints**	**2 hours**	**CO: 2**
Threaded Fasteners– Different screw threads, metric and BSW threads, Square thread and multi start threads. Nut bolts, Washers, Setscrew, Locknuts and foundation bolts. **Locking devices–** lock nut-castle nut-Studs-Tap bolt-Machine screws washers- Keys-sunk key-Gib head key. (For a given standard diameter with proportions). **Riveted joints–** Forms and proportions of river heads, Different views of different types of riveted Lap and Butt joints.			
Unit/Module: 4	**Limit, fits, tolerances and Geometrical dimensioning and tolerancing**	**4 hours**	**CO: 3**
Limits, fits and tolerances– tolerancing and limit systems, symbols for tolerances, deviation and fits, method of tolerancing, tolerance grade, fits- system of fits, classification of fits, selection of fits, methods of indicating fits on drawing. **Geometrical tolerance–** Need, geometrical characteristics of symbols, characteristics (such as straightness, flatness, circularity, cylindricity, etc) its symbols and interpretations.			
Unit/Module: 5	**Part Modelling**	**12 hours**	**CO: 4**
Parametric solid modeling - fundamentals, transform the parametric 2-D sketch into a 3D solid, feature operations, Free form feature modeling, design by features, feature recognition.			
Unit/Module: 6	**Assembly Modelling**	**14 hours**	**CO: 4**
Defining relationship between various parts of machine, creation of constraints, and generation of exploded view. Animation of the motions of assembly.			
Unit/Module: 7	**Production Drawing**	**10 hours**	**CO: 5**
Generation of manufacturing drawing from parts and assembly 3-D model with representation of appropriate dimensioning and tolerancing.			
Unit/Module: 8	**Introduction to 3-D printing**	**6 hours**	**CO: 6**
Introduction to use of 3-D printing technology for manufacturing of a component.			
	Total Lab hours:	**52 hours**	

Lab Work

1.	Assignment on drawing IS conventions, threaded fasteners and riveted joints using the basics of projections and dimensioning rules. (to be completed manually)
2.	Assignment on solid modeling of a machine component. (minimum 10 machine components)
3.	Assignment on parametric solid modeling of a machine component using various commands and features of the software. (minimum 2 machine components)
4.	Assignment on assembly modeling using proper mating conditions and generation of exploded view. (minimum 5 assemblies)
5.	Assignment on creating production drawing with the limit, fits and tolerance representation.

6.	Design and Manufacturing of an assembly (4-5 components) using 3-D printing.
Text Books:	
1.	N. D. Bhat, "Machine Drawing", Charotor publishing house, Bombay.
2.	R. K. Dhavan, "Machine Drawing", S. Chand and Company.
3.	N. D. Junnarkar, "Machine Drawing", Pearson Education.
4.	IS: SP46- Engineering drawing practice for schools and colleges, B.I.S. Publications.
5.	IS: 696- Code of practice for general engineering drawing B.I.S. Publications.
6.	IS: 2709- Guide for selection of fits, B.I.S. Publications.
7.	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
8.	IS: 8000- Part I, II, III, IV, geometrical tolerancing of technical drawing – B.I.S. Publications
Reference Books:	
1.	P. S. Gill, "A textbook of Machine Drawing", revised edition, K Kataria and Sons, New Delhi, 2008, ISBN 81-85749-79-5.

Autonomous Program Structure
Second Year B. Tech. Fourth Semester
(Mechanical Engineering)
Academic Year: 2021-2022 Onwards

Course Code	Course Title	Teaching Scheme Hours/ Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem	End Sem	Practical	Oral		
20ES401	Elements of Electrical and Electronics Engineering	3	1	0	50	50	0	0	100	4
20ME401	Analysis and Synthesis of Mechanisms (ASM)	2	1	0	50	50	0	0	100	3
20ME402	Fluid Mechanics (FM)	2	1	0	50	50	0	0	100	3
20ME403	Casting, Forming and Joining Processes (CFJP)	3	0	0	50	50	0	0	100	3
20ME404	Machine Design (MD)	3	1	0	50	50	0	0	100	4
20ME405L	Design Lab – I (SOM & ASM)	0	0	2	25	0	0	25	50	1
20ME402L	Fluid Mechanics (FM) Lab	0	0	2	25	0	25	0	50	1
20ME403L	Machine Shop (MS) Lab	0	0	2	25	0	25	0	50	1
20AC401	Audit Course (AC)	0	0	2	0	0	0	0	0	0
	Total	**14**	**4**	**8**	**325**	**250**	**50**	**25**		
	Grand Total	**26**			**575**		**75**		**650**	**20**

S. Y. B. Tech. – Semester-II

Course Code	Elements of Electrical and Electronics Engineering	L	T	P
20ES401		3	1	0
Pre-requisite	20ES01 Basic Electrical and Electronics Engineering	Syllabus Version		
		V:1.1		

Course Objectives:

1. To study principle of operation of DC machines and speed control of DC motors
2. To understand three phase induction motor working and its applications
3. To study Electrical drive system required to drive machines
4. To get acquainted with Electric Vehicle (EV) technology and subsystems
5. To understand Arduino IDE; an open source platform and its basic programming features
6. To interface Atmega328 based Arduino board with different devices and sensors

Course Outcomes:

At the end of this course students will demonstrate the ability to:

- Describe the working principle, characteristics and applications of D.C motor and Induction motor.
- Apply fundamental speed control methods of D.C motor and Induction motor.
- Describe different electrical drive systems and explain emerging technology of Electric Vehicle (EV)
- Explain Microcontroller Architecture of ATMega328 and Arduino IDE
- Interface external peripherals and sensors to ATMega328

Unit :- 1	DC Machines

Construction, working principle of DC Machine, emf equation of DC Machine. Working principle of DC motor. Types of DC motor, back emf, torque equation for DC motor, characteristics of DC motor (series, shunt and compound), Braking of D.C. Motor, methods for speed control of DC shunt and series motors, Industrial applications.

Unit :- 2	Three phase Induction Motor

Constructional feature, working principle of three phase induction motors, types, torque equation, torque slip characteristics, power stages and efficiency. Types of starters, Braking of induction motor, methods of speed control & Industrial applications.

Unit :- 3	**Electrical Drives and Introduction to Electric vehicles**

Electrical Drives: Advantages of Electrical Drives, Parts of electrical drives, choice of electric drive, Status of ac and dc drives, Brush less dc motor drives, stepper motor drives, synchronous motor variable speed drive.
Introduction to electric vehicles: Brief history of Electric Vehicle (EV), Components of EV, Benefits of EV Types of EVs such as Battery EV, Hybrid EV, Plug-in EV, Fuel Cell EV and their comparison, Challenges faced by EV technology

Unit :- 4	**Introduction to Microcontrollers**

Introduction to microcontroller and microprocessors, role of embedded systems, open source embedded platforms, Atmega 328P-features, architecture, port structure, sensors and actuators, data acquisition systems, introduction to Arduino IDE- features, IDE overview, programming concepts: variables, functions, conditional statements.

Unit :- 5	**Peripheral Interface - 1**

Concept of GPIO in Atmega 328P based Arduino board, digital input and output, UART concept, timers, interfacing with LED, LCD and keypad, serial communication using Arduino IDE

Unit :- 6	**Peripheral Interface – 2**

Concept of ADC in Atmega 328P based Arduino board, interfacing with temperature sensor (LM35), LVDT, strain gauge, accelerometer, concept of PWM, DC motor interface using PWM

Total Theory Lecture hours:	**40 hours**	

Text Books:

1. Electrical Machines-D P Kothari and I J Nagrath, Tata McGraw Hill ,Third Edition
2. Electrical Machinery-S.K. Bhattacharya, TTTI Chandigad
3. Fundamentals of Elecrical drives-G K Dubey
4. Ajay Deshmukh-Microcontrollers Theory and Applications, TATA McGraw Hill
5. Arduino microcontroller processing for everyone -Steven F Barret,Morgan and Claypool Publisher.
6. C programming with ardino - Warwick Smith Elektor Publication
7. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press
8. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Ed, CRC Press
9. Application notes from "ATMEL micro controller data book.

List of Tutorials:

	Name of the Tutorial
1	Introduction to Microprocessors and Microcontrollers
2	Case studies on Embedded Systems and Applications.
3	Interfacing of LED with Arduino UNO to observe different patterns of LEDs.
4	Interfacing of LCD with Arduino UNO to display the messages.
5	Display data using serial communication using Arduino UNO.
6	Interfacing of Temperature Sensor LM35 to display temperature.
7	Speed control of DC Motor.
8	Speed control of Induction Motor.

Course Code	Analysis and Synthesis of Mechanisms	L	T	P
20ME401		3	1	0
Pre-requisite	Engineering Mechanics	Syllabus Version		
				V:1.1

Course Objectives:

To make students

1. To understand the fundamentals of Mechanisms.
2. To understand analysis of mechanisms by analytical and graphical methods.
3. To understand dimensional synthesis of mechanisms by analytical and graphical methods.
4. To understand the kinematics of Gears and Gear Trains.
5. To understand kinematics of friction

Course Outcomes:

Students will be able to

1. Identify the nature of kinematic pair, chains and Mechanism.
2. Construct and analyze velocity and acceleration polygon of Simple mechanism by analytical and graphical method.
3. Perform dimensional synthesis of mechanisms by analytical and graphical methods.
4. Evaluate Speed ratio and Torque for Gear and Epicyclic Gear train.
5. Evaluate torque transmission in clutches and braking torque in brakes.

Unit :- 1	Fundamentals and Types of Mechanisms	8 hours	CO: 1

Kinematic Link, types of links, kinematic pair, types of constrained motion, types of kinematic Chains, types of joints, mechanism , machine, degree of freedom, Kutzbach criterion, Grubler's criterion, Grashoff's law, four bar chain and its inversion, Slider crank and its inversion, double slider crank and its inversion, straight line mechanism, Peaucellier Mechanism, Scott Rusell Mechanism, Grasshopper Mechanism, Watt Mechanism. Steering Gear Mechanism, Condition for correct steering, Davis and Ackermann Steering Gear Mechanism.

Unit :- 2	Displacement, Velocity, and Acceleration Analysis of Mechanism	11 hours	CO: 2

Kinematics of Rigid Bodies: Types of motions, position velocity and acceleration
Analytical and Graphical method for displacement, position analysis of links with vector and complex algebra methods, Loop Closure equation, chase solution, input and output curves, transmission angle.

Analytical Method-velocity and acceleration analysis for four bar and slider crank mechanisms using vector and complex algebra methods Graphical Method-velocity and acceleration polygons for simple mechanisms as well as for the mechanisms involving the Coriolis component of acceleration. ICR Method.			
Unit :- 3	**Dimensional Synthesis of Mechanism-Analytical and Graphical Method**	**9 hours**	**CO: 3**
Introduction to Synthesis of Mechanism-Type, number and dimensional synthesis, task of dimensional synthesis, path, function and motion generation(body guidance), precision positions, Chebychev spacing, Mechanical and structural errors. Graphical Method: Two and three position synthesis of four bar and slider crank mechanisms. Analytical Method: Three position synthesis of four bar mechanism using Freudenstein's Equation.			
Unit :- 4	**Kinematics of Gear and Gear Train**	**8 hours**	**CO: 4**
Gear Terminology, law of gearing, forms of teeth, path of contact, arc of contact, Number of pairs of teeth in contact (contact ratio), Interference in involute gears, minimum number of teeths, interference between rack and pinion, helical and spiral gear, terminology in helical gear, velocity ratio and centre distance of helical gear, Worm and Worm gear, velocity ratio and centre distance of worm gear, Efficiency of helical, spiral and worm gear. Kinematics of Bevel Gear. Gear Train: types of gear train, Analysis of Epicyclic Gear train.			
Unit :- 5	**Friction**	**4 hours**	**CO: 5**
Laws of Friction, coefficient of friction, screw thread, pivots and collars, friction clutches, rolling friction, Greasy Friction, Friction axis of link, film friction.			
	Total Theory Lecture hours:	**40 hours**	
Tutorial Assignments			
1.	Fundamentals of Mechanisms and Degree of Freedom of Mechanism		
2.	Mechanisms and Its Inversions		
3.	Planar Kinematics of Rigid body		
4.	Planar Kinetics of Rigid body		
5.	Displacement Analysis of Mechanism: Analytical and Graphical Method		
6.	Velocity and Acceleration Analysis of Mechanism: Analytical and Graphical Method		
7.	Dimensional Synthesis of Mechanism analytical method		
8.	Kinematics of Gears		
9.	Analysis of Epicyclic Gear Train		
Text Books:			

1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Asok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.

Reference Books:	
1.	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
2.	Hartenberg, Richard Scheunemann, and Jacques Denavit. „Kinematic Synthesis of linkages". McGraw-Hill, 1964.
3.	Shiley J. E. and Uicker J.J. , „Theory of Machines and Mechanism", McGraw Hill Inc
4	Ashok G. Ambekar, „Mechanisms and Machine Theory", Prentice Hall,India
5.	Sadhu Singh, „Theory of Machines", Pearson
6.	Hall A. S. „Kinematics and Linkage Design",Prentice Hall
7.	Wilson C.E., Sandler J.P. „Kinematics and Dynamics of Machinery", Pearson Education
8.	Erdman A.G. and Sandor G. N. „Mechanism Design, Analysis and Synthesis Vol-I, Prentice Hall

Course Code	Fluid Mechanics	L	T	P
20ME402		2	1	-
Pre-requisite	Engineering Physics, Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Applying the mass conservation principle, to engineering problems.
2. Applying the momentum and energy equations to engineering problems.
3. Evaluating head loss in pipes and conduits.
4. Introduction to formation of boundary layer, drag and lift concept associated with it

Course Outcomes:

Students will be able to

1. Apply mass conservation principle to the given system.
2. Understand energy conservation principle for fluid flow.
3. Calculate the pressure drop for a given system.
4. Explain the boundary layer formation on the flat plate.

Unit :- 1	Fundamental Concepts of Fluid Flow	2 hours	CO: 1
Fundamental definitions, Flow characteristics, Classification of fluids, Fluid properties			
Unit :- 2	**Flow Kinematics**	**4 hours**	**CO: 1**
Equations for acceleration, Continuity equation, Irrotational and rotational flow, Potential and stream functions.			
Unit :- 3	**Integral Analysis of Fluid Flow**	**6 hours**	**CO: 2**
Finite control volume analysis (Reynolds Transport Theorem) , Euler and Bernoulli‟s theorems, Applications, Venturi and Orifice meter, Pitot Tube			
Unit :-4	**Pipe Flows**	**5 hours**	**CO: 3**
Types of flow, Reynolds experiment, Laminar flow between parallel plates, Laminar flow in pipes, turbulent flow in pipes. Darcy-Weisbach equation, Moody diagram, Energy losses in pipelines, Minor losses.			

Unit :- 5	**Differential Analysis of Fluid flow**	**6 hours**	**CO: 2,3**
Introduction to Navier- Stokes equations, Exact solutions for simple cases of flow, Plane Poiseuille flow (Pipe and Channel), Coutte flow, Flow on inclined plane			
Unit :- 6	**Flow past immersed Bodies**	**2 hours**	**CO: 4**
Concepts of boundary layer, Drag and lift on immersed bodies.			
	Total hours:	**25 hours**	

Text Books:

1.	Munson, Okiishi, Young, „Fluid Mechanics", 7th Ed, Wiley, 2016.
2.	Cengel, Cimbala, „Fluid mechanics", Tata Mcgraw hill publishing

Reference Books:

1.	Gupta and Gupta, „Fluid Mechanics", 3rd Ed, New Age publications, 2016.
2.	Kundu, Cohen, Dowling, „Fluid Mechanics", Elsevier India
3.	K. Muralidhar, G. Biswas, „Advance Fluid Mechanics", 3rd Edition, Narosa Publishing House
4.	Fox, Mcdonald, „Fluid Mechanics", 8th Edition, Wiley.

Course Code	Casting, Forming and Joining Processes (CFJP)	L	T	P
20ME403		3	-	-
Pre-requisite	Machining and Machine Tool Operations	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To study basic production processes
2. To study how to select appropriate production processes for a specific application

Course Outcomes:

Students will be able to

1. Understand basics of manufacturing, elements of casting, construction of pattern, gating system, different types of casting method and their application.
2. Various welding technologies' fundamentals should be recognized, analyzed, and configured.
3. Analyze principles and working of different forming processes such as sheet metal working, forging, rolling and extrusion.
4. Identify different machining operation requirements for non-metal components.

Unit/Module: 1	Metal Casting Processes	9 hours	CO: 1

Dispensable and permanent mould processes, Analysis of melting, pouring and solidification phenomena, design of pattern, core, feeder and gating system, Casting defects and inspection.

Unit/Module: 2	Joining Processes	9 hours	CO: 2

Introduction, Fusion and solid-state welding, Brazing and soldering, Weld joint design, cooling rate, and joint properties, Heat affected zone, Friction stir welding, reduced pressure EB welding, Metal to composite joining, Welding defects and inspection

Unit/Module: 3	Bulk Deformation	9 hours	CO: 3

Plastic deformation and yield criteria, bulk deformation, cold versus hot working. Analysis (load and force estimation) and defects in deformation processes forging, rolling, drawing and extrusion.

Unit/Module: 4	**Sheet Metal forming**	**8 hours**	**CO: 3**
Sheet metal shearing, deep drawing, bending and their applications, drawing ratio, forming limit diagram and analysis			
Unit/Module: 5	**Polymer Processing and sustainable manufacturing**	**7 hours**	**CO: 4**
Polymer basics, Injection molding process and analysis, Compression molding, Blow molding, Introduction to composite manufacturing, Environmental impact in Micro-device manufacturing, cutting tool sustainability, MQL in Machining.			
	Total Lecture hours:	**42 hours**	

Text Books:	
1.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication
Reference Books:	
1.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.
2.	Mechanical Engineers' Handbook, Volume 3: Manufacturing and Management, Myer Kutz, Wiley.
3.	Manufacturing processes Vol. 1 and 2, P. N. Rao, Tata McGraw-Hill.

Course Code	Machine Design	L	T	P
20ME404		3	1	-
Prerequisite	Strength of machine elements (S.O.M.)	Syllabus Version		
		V:1.1		

Course Objectives: To make students

1. To design simple machine elements subjected to static loads.
2. To compute the torque transmission capacity by the given power screw.
3. To analyze the machine elements subjected to fluctuating loads.
4. To apply A.S.M.E. code for shaft design.
5. To calculate the size of a mechanical joint, subjected to eccentric load.
6. To determine the spring dimensions for a given requirement.

Course Outcomes:

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

1. design simple machine elements subjected to static loads.
2. compute the torque transmission capacity by the given power screw.
3. analyze the machine elements subjected to fluctuating loads.
4. apply A.S.M.E. code for shaft design.
5. calculate the size of a mechanical joint, subjected to eccentric load.
6. design helical spring for given requirements.

Unit/Module: 1	Introduction to design engineering	4 hours	CO: 1

Phases and interactions in design process, design considerations, design tools and resources, design engineer's professional responsibilities, standards and codes, economics aspects.

Unit/Module: 2	Failure Prevention: Design against static load	6 hours	CO: 1

Modes of failures, combined stresses, principal stresses, failure theories and their selection, eccentric loading, design of simple machine elements subjected to static loading.

Unit/Module: 3	Failure Prevention: Design against fluctuating load	6 hours	CO: 3

Fatigue failure, endurance limit and its modifying factors, endurance strength, design for infinite and finite life for completely reversed and fluctuating loads.

Unit/Module: 4	Design of machine elements-I: Transmission Shafts	6 hours	CO: 4

Shaft design based on strength, deflection considerations, torsional and lateral rigidity, ASME code for

shaft design, critical speed of shafts, design of keys and splines.			
Unit/Module: 5	**Design of machine elements-II: Mechanical Springs and Power Screws**	**6 hours**	**CO: 2,6**
Stress and deflection analysis of helical springs, design for static and fatigue loading, springs in combination, leaf springs. Torque analysis of power screws, standard threads, thread and collar friction, efficiency and stresses in power screws.			
Unit/Module: 6	**Design of machine elements-III: Mechanical Joints**	**6 hours**	**CO: 5**
Bolts of uniform strength, fastener stiffness and member stiffness, threaded joints subjected to axial loading and eccentric loading in different planes. Strength of butt and fillet welded joints in torsion and bending, sizing of welded joints subjected to direct and eccentric loads.			
	Total hours:	**34 Hours**	

Reference Books:

1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd
2.	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3.	Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4.	Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5.	"Design Data",P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7.	Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum"s Outline Series.
8.	Michael Nikowitz, „Advanced Hybrid and Electric Vehicles, System Optimization and Vehicle Integration", Springer International Publishing Switzerland 2016.
9.	Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals", CRC PRESS.

Text Books:

1.	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

Course Name	Design Lab- I (ASM & SOM-L)	L	T	P
Course Code	20ME405	-	-	2
Pre-requisite	Analysis and Synthesis of Mechanism, and Strength of Materials	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To understand the fundamentals of Mechanisms for Practical Application.
2. To understand dimensional synthesis of mechanisms by graphical methods
3. To understand the Cam jump phenomenon, Epicyclic Gear Train and Gyroscopic principle
4. To determine experimental data include universal testing machines and torsion equipment.
5. To determine stress analysis and design of beams subjected to bending and shearing loads using several methods.

Course Outcomes:

Students will be able to

1. Draw Mechanisms for practical Application
2. To understand dimensional synthesis of mechanisms by graphical methods
3. To understand and perform experiment for Cam Jump phenomenon , Epicyclic Gear Train and Gyroscopic principle
4. Understand the basic concepts of stress, strain, deformation, and material behaviour under different types of loading (axial, torsion, bending).
5. Perform stress analysis and design of beams subjected to bending and shearing loads using several methods.

Lab Work (Any 8)

1.	To draw mechanisms for Practical Application and straight line mechanisms.
2.	To Synthesize the 4-bar mechanism using relative pole method and inversion methods with 3-precision points.
3.	To synthesize the slider crank mechanism using relative pole method and inversion methods with 3-precision points.
4.	Epicyclic Gear Train
5.	Cam Jump Phenomenon
6.	Gyroscopic Principle

7.	Tension test		
8.	Compression Test		
9.	Direct Shear Test		
10.	Bending Test		
11.	Torsion Test		
12.	Impact test		
	Total Lab hours:	**18 hours**	

Text Books:	
1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Asok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.
3.	Strength of Materials S. Ramamrutham, Dhanpat Rai Pvt. Ltd
Reference Books:	
1.	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
2.	Hartenberg, Richard Scheunemann, and Jacques Denavit. „Kinematic Synthesis of linkages". McGraw-Hill, 1964.
3.	Mechanics of Materials, by Russell C. Hibbeler
4.	Singer and Pytel - Strength of materials - Harper and row Publication.

Course Code	Fluid Mechanics Lab	L	T	P
20ME402L		-	-	2
Pre-requisite	Engineering Physics, Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Applying the mass conservation principle, to engineering problems.
2. Applying the momentum and energy equations to engineering problems.
3. Evaluating head loss in pipes and conduits.
4. Introduction to formation of boundary layer, drag and lift concept associated with it

Course Outcomes:

Students will be able to

1. Students will understand the basic experimental techniques in fluid mechanics.
2. Students will be present the results in the graphical form.
3. Students will able to measure the pressure drop in a pipe determine friction factor.
4. Students will able to understand the process of calibration of flow meters.

Lab Work

1.Measurement of Viscosity and Sp. Gravity

2.Measurement of Pressure and velocity

3.Measurement of coefficient of orifice

4.Verification of Bernoulli's theorem

5.Calibration of Venturi/Orifice meter

6.Flow visualization using Reynolds Apparatus

7.Measurement of coefficient of friction in pipe

8.Verification of momentum equation

9.Project based learning thermal engineering starts

Total Lab hours:- 18 hrs

Text Books:

1.Munson, Okiishi, Young, 'Fluid Mechanics', 7th Ed, Wiley, 2016.

2.Cengel, Cimbala, 'Fluid mechanics', Tata Mcgraw hill publishing

Reference Books:
1. Gupta and Gupta, 'Fluid Mechanics', 3rd Ed, New Age publications, 2016.
2.Kundu, Cohen, Dowling, 'Fluid Mechanics', Elsevier India
3.K. Muralidhar, G. Biswas, 'Advance Fluid Mechanics', 3rd Edition, Narosa Publishing House
4.Fox, Mcdonald, 'Fluid Mechanics', 8th Edition, Wiley.

Course Code	Machine Shop Lab (MS-L)	L	T	P
20ME403L		-	-	2
Pre-requisite	Machining and Machine Tool Operations	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To study basic production processes
2. To study how to select appropriate production processes for a specific application

Course Outcomes:

Students will be able to

1. Various welding technologies' fundamentals should be recognized, analyzed, and configured.
2. Analyze principles and working of different forming processes.
3. Identify different machining operation requirements for non-metal components.
4. Identify different machining operation requirements for assembly manufacturing.

Lab Work

1.	A demonstration of any one welding technique out of TIG/ MIG/Resistance/Gas welding. A job drawing to be prepared by an individual institute with details of welding process parameters with weld joint design such as edge preparation, type and size of electrode used, welding current, voltage etc.
2.	Demonstration of the usage of manufacturing processes like casting, forging, sheet metal.
3.	Manufacturing of Fibre-reinforced Composites by hand lay-up process or spray lay-up techniques.
4.	Demonstration on any one plastic component like bottle, bottle caps, machine handles etc. by injection moulding process/ by additive manufacturing process.
5.	Demonstration on grinding operations, measurement of surface roughness produced and estimation of machining time.
6.	Composite job machining involving minimum four components, employing operations on lathe, precision turning, screw cutting, boring etc. and involving the use of milling and grinding operations. Raw material selection and / estimation, process planning and sales presentation.

	Total Lab hours:	**22 hours**	

Text Books:	
1.	Fundamentals of modern manufacturing, Fifth Edition, Mikell P. Groover, Wiley Publication
Reference Books:	
1.	Manufacturing, Engineering and Technology SI, Serope Kalpakjian, Steven R. Schmid, Prentice Hall.
2.	Mechanical Engineers' Handbook, Volume 3: Manufacturing and Management, Myer Kutz, Wiley.
3.	Manufacturing processes Vol. 1 and 2, P. N. Rao, Tata McGraw-Hill.

Autonomous Program Structure of
Third Year B. Tech. Fifth Semester
(Mechanical Engineering)
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	Practical	Oral		
20ME501	Computer Aided Engineering (CAE)	3	0	0	50	50	0	0	100	3
20ME502	Heat Transfer (HT)	3	1	0	50	50	0	0	100	4
20ME503	Power Train Design (PTD)	2	1	0	50	50	0	0	100	3
20ME504	Industrial Inspection & Quality Control (IIQC)	2	0	0	50	50	0	0	100	2
20ME505	Numerical Methods (NM)	2	1	0	50	50	0	0	100	3
20OEHS501	Open Elective I (Humanities)	3	0	0	25	0	0	25	50	3
20ME501L	Computer Aided Engineering (CAE) Lab	0	0	2	25	0	25	0	50	1
20ME504L	Industrial Inspection & Quality Control (IIQC) Lab	0	0	2	25	0	0	25	50	1
20ME505L	Numerical Methods (NM) Lab	0	0	2	25	0	25	0	50	1
20ME506L	Thermal Lab (ET & HT)	0	0	2	25	0	0	25	50	1
20ME507L	Design Lab- II (MD & PTD)	0	0	2	25	0	0	25	50	1
20AC501	Audit Course (AC)	0	0	2	0	0	0	0	0	-
	Total	**15**	**3**	**10**	**400**	**250**	**50**	**100**	**800**	**23**
	Grand Total	**28**			**650**		**150**			

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

T. Y. B. Tech. -- Semester-I

Course Code	Computer Aided Engineering (CAE)	L	T	P
20ME501		3	-	-
Pre-requisite	Engineering Graphics, Engineering Mathematics, Computer Aided Machine Drawing, Strength of Materials			

Course Objectives:

To make students

1. To apply the homogeneous transformation of geometric 2D/3D CAD entities
2. To model the curves and surfaces geometry
3. To compute stresses, strains, and deflection in the given problem under static loading
4. To compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods for solving 2D structural problems
5. To understand generalized FEM procedure along with the type of analysis and meshing technique

Course Outcomes:

Students will be able to

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

1. Apply homogeneous transformation matrix for geometrical transformations of 2D & 3D CAD entities for basic geometric transformations
2. Model the curves and surfaces geometry
3. Apply finite element methods to solve 1D structural problems
4. Compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods to solve 2D structural problems
5. Understand generalized FEM procedure along with the type of analysis and meshing technique

Unit/Module: 1	Computer Graphics	8 hours	CO: 1

Transformations (2D & 3D): Introduction, Formulation, Translation, Shear, Rotation, Scaling and reflection, Homogeneous representation, Concatenated transformation, Mapping of geometric models, Inverse transformations, Introduction to 3D transformation

Projections: Orthographic, Isometric, Perspective projections

Unit/Module: 2	Curve and Surface Modeling	6 hours	CO: 2

Curves – Introduction, Analytical curves (Line, circle, ellipse, parabola, hyperbola), Synthetic curves (Hermite Cubic Spline, Bezier, B-Spline Curve) Surfaces – Introduction, Surface representation, Analytic surfaces, Synthetic Surfaces, Hermite bicubic, Bezier, B-Spline, Coons patch surface, Applications in freeform surfaces			
Unit/Module: 3	**One Dimensional Finite Element Analysis**	**8 hours**	**CO: 3**
One Dimensional Problem: Finite element modeling, coordinate and linear shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, (stepped bar, spring in series and parallel), Temperature Effects, Penalty approach, Trusses: Introduction, 2D Trusses, Element stiffness matrix for truss, Assembly of Global Stiffness Matrix, load vector			
Unit/Module: 4	**Two Dimensional Finite Element Analysis**	**8 hours**	**CO: 4**
Plane Stress/Strain problems in 2D elasticity, constitutive relations, Constant Strain Triangle (CST), Liner Strain Rectangle (LSR), displacement function, Pascal"s triangle, compatibility, and completeness requirement, geometric isotropy, convergence requirements, strain filed, stress filed. Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations			
Unit/Module: 5	**Practical Finite Element Analysis**	**6 hours**	**CO: 5**
Introduction: Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads and constraints), General FEM procedure, Applications of FEM in various fields, p and h formulation, Advantages and disadvantages of FEM Type of Analysis: Linear static, nonlinear, dynamic, buckling, thermal, fatigue, CFD, Crash Introduction to meshing. Types of the element, meshing Techniques. 1D, 2D, and 3D Meshing, Mesh quality check. Effect of mesh density in the critical region, Effect of biasing in the critical region			
	Total hours:	**36 hours**	

Text Books:

1.	Ibrahim Zeid and R. Sivasubramanian, CAD/CAM - Theory and Practice, Tata McGraw Hill Publishing Co. 2010
2.	Daryl Logan, A First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd., 6th Edition 2017

3.	Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
4.	Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune
Reference Books:	
1.	J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw Hill, 2003
2.	Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India

Course Code	Heat Transfer	L	T	P
20ME502		3	1	-
Pre-requisite	Physics, Calculus, Fluid Mechanics	Syllabus Version		
		V:1.1		

Course Objectives:

Course prepares students to

1. To apply laws of heat transfer to ascertain the heat transfer
2. To formulate heat conduction equation using given boundary conditions
3. To identify the requirement of extended surfaces for heat transfer enhancement
4. To determine heat transfer rate in forced and natural convection
5. To predict the radiation heat transfer with the use of radiation shield for given application
6. To calculate efficiency of heat exchanger

Course Outcomes:

Students will be able to

1. apply laws of heat transfer to ascertain the heat transfer rate in steady and transient state heat conduction in solids
2. formulate the equation for heat conduction with heat generation applying suitable BC"s
3. evaluate the requirement of extended surfaces for heat transfer and calculate the heat transfer enhancement using it.
4. analyse the convective heat transfer rate using appropriate correlations
5. predict the heat transfer rate in radiation mode and with the use of radiation shield
6. calculate the efficiency of heat exchanger for given set of operating conditions

Unit/Module: 1	Steady State Conduction Heat Transfer	10 hours	CO: 1,2,3

Modes of Heat transfer, Fourier's law of heat conduction. Steady heat conduction in 1 – D systems. Heat conduction in composite slab, cylinder and sphere, Heat conduction with internal heat generation. Heat transfer through extended surfaces. Critical radius of insulation and insulating materials

Unit/Module: 2	Transient Heat Conduction Analysis	4 hours	CO: 1

Transient heat conduction in solids using lumped heat capacity analysis

Unit/Module: 3	Convection Heat Transfer	8 hours	CO: 4

	Mechanism of convection heat transfer, Energy Equation, Forced convection over flat plate, cylinder and sphere. Concepts of thermal and velocity boundary layer, Empirical correlations. Forced Convection in a pipe, thermal Entrance region, Empirical correlations, Reynolds and Colburn's analogy. Non dimensional parameters and its significance. Natural convection over vertical flat plate and cylinder. Non dimensional parameters and its significance		
Unit/Module: 4	**Radiation Heat Transfer**	**8 hours**	**CO:5**
	Fundamental concepts and laws of radiation, Black and Gray body radiation analysis, Radiation between two gray surfaces, Radiation shields.		
Unit/Module: 5	**Heat Exchangers**	**8 hours**	**CO: 6**
	Introduction and classification. Overall heat transfer coefficient. Heat exchanger analysis using LMTD and NTU method. Effectiveness of heat exchanger.		
	Total Lecture hours:	**38 hours**	

Text Books:

1.	F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley
2.	Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited.
3.	S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press

Course Code	Powertrain Design	L	T	P
20ME503		2	1	-
Prerequisite	Strength of machine elements, Machine Design	Syllabus Version		
		V:1.1		

Course Objectives:

To make students
1. To apply AGMA equations to design a spur and helical gear pair based on strength.
2. To analyze the forces and strengths for designing bevel and worm gears for the required power transmission.
3. To evaluate the tensions and stresses to design/select a flexible drive.
4. To compute the required dynamic load rating for a given bearing to select it from the manufacturer's catalog.
5. To describe the features of transmission systems used for automotive and industrial applications.
6. To elaborate various configurations and operations of hybrid electric vehicles.

Course Outcomes:

After successful completion of the course, student will be able to
1. apply AGMA equations to design a spur and helical gear pair based on strength.
2. analyze the forces and strengths for designing bevel and worm gears for the required power transmission.
3. evaluate the tensions and stresses to design/select a flexible drive.
4. compute the required dynamic load rating for a given bearing to select it from the manufacturer's catalog.
5. describe the features of transmission systems used for automotive and industrial applications.
6. elaborate various configurations and operations of hybrid electric vehicles.

Unit/Module: 1	Elements of transmission systems- Rigid Drives	8 hours	CO: 1,2

Rigid drives-I: Classification and selection of rigid drives, conjugate action, standard tooth systems, force analysis, modes of failures, gear design based on AGMA strength equations and for dynamic load, thermal considerations.

Unit/Module: 2	Anti-friction Bearings and Flexible Drives	8 hours	CO: 3

Modes of failures, static and dynamic load ratings, equivalent dynamic load, reliability and survival of bearing, load-life relationship and selection of bearings from manufacturers catalog.
Power rating, tensions, stresses and selection from manufacturers catalog for flexible drives.

Unit/Module: 3	Mechanical Transmission Systems	4 hours	CO: 4

Manual transmission systems (MT), Automatic transmission systems (AT), hydraulic torque converter, epicyclic gear train. Gear boxes for automobiles and industrial use: Constant mesh, sliding mesh, synchromesh, differential and planetary gearbox.

Unit/Module: 4	**Transmission in Electric and Hybrid Vehicles**	**8 hours**	**CO: 5**
Constructional, operational and performance features, transmission configurations, torque-speed characteristics, sizing of motor and components, motors, power splitting concepts and interface within powertrain system, powertrain architecture -parallel, series and combined, types of EVs, vehicle layout and packaging options, energy devices & combinations, duty cycles in Indian cities, performance, sustainability assessment.			
	Total hours:	**28**	

Reference Books:

1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd
2.	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3.	Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4.	Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5.	"Design Data",P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7.	Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum‟s Outline Series.
8.	Michael Nikowitz, „Advanced Hybrid and Electric Vehicles, System Optimization and Vehicle Integration‟, Springer International Publishing Switzerland 2016.
9.	Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals‟, CRC PRESS.

Text Books:

1.	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

Course Code	Industrial Inspection & Quality Control (IIQC)	L	T	P
20ME504		2	-	-
Pre-requisite	Manufacturing Process, Machine Drawing	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes:

Students will be able to

1. Interpret/apply GD&T for a part drawing
2. Analyze the given part drawing / inspection requirement to select a suitable instrument / gauge / inspection method.
3. Specify type and dimension of limit gauges
4. Apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problems.
5. Apply Statistical Quality Control tool(s) to analyse and interpret the data.

Unit/Module: 1	Geometric Dimensioning, Tolerancing and Inspection Needs	6 hours	CO: 1

- **GD&T Basics**: Need and Rules, Features and Material Conditions [MMC & LMC] Regardless of Feature's Size & Rule, Functional Gauging,
- **Datums**: Types, Selection & Datums Control, MMB and LMB, Adding GD&T to a Design;
- **Feature Control Frame**: SLOF for Drawings (Size, Location, Orientation & Form)
- **Form Tolerances**: (Surface, Median Line/MMC): Straightness, Flatness, Circularity, Cylindricity **Orientation Tolerances**: (Surface, Axis): Parallelism, Perpendicularity Angularity Profile Tolerances: Profile of a Surface and Line – Basics, Profile (Modifiers)
- **Location Tolerances**: True Position Concentricity, Symmetry: Runout Tolerances, Circular and Total Runout and Real Life Example

Unit/Module: 2	Inspection Gauge and Dedicated Metrology	8 hours	CO: 1,2

- **Design of Gauges:** Tolerances, Limits and Fits [IS 919-1993], Taylor‟s principle, Types of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design (numerical).

- **Comparators:** Mechanical, Pneumatic, Optical, Electrical (LVDT)
- **Gear Metrology and Thread Metrology:** Types of errors, dedicated instruments and applications

Unit/Module: 3	**Advances in Industrial Inspection**	**3 hours**	**CO: 1**

- **Coordinate Measuring Machine (CMM):** Fundamental features of CMM – development of CMMs – role of CMMs – types of CMM and Applications, – types of probes
- **Machine Vision Systems:** vision system measurement – Multisensory systems.
- **Interferometer:** Principle, NPL Interferometer
- **Laser Metrology:** Basic concepts, laser types, laser interferometers, and applications
- **Industry 4.0:** Inspection 4.0

Unit/Module: 4	**Quality: Tools, Techniques and System**	**8 hours**	**CO: 3**

Quality: Characteristics & elements, Cost vs Value, Deming‟s cycles & 14 Points, Juran Trilogy
***Quality Tools*:** 7 QC Tools, Quality Function Deployment, FMECA, 5S, Kaizen, Poka yoke, Kanban, Six Sigma: DMAIC - Concept and application
Quality Management System: Introduction to ISO 9001, TS-16949, ISO-14000.

Unit/Module: 5	**Statistical quality control and Acceptance Sampling**	**8 hours**	**CO: 4**

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (**X & R** Chart) & Attribute (**P & C** Chart),
Process Capability Indices: (cp, cpk, ppk), Statistical Process Control (Numerical).
Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)

	Total Lecture hours:	**25 hours**	

Text Books:

4.	Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
5.	I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
6.	Jain R.K., Engineering Metrology, Khanna Publication.
7.	Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
8.	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
9.	Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
10.	Basterfield D. H., Quality control, Pearson Education India, 2004.

11.	Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.
Reference Books:	
1.	ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
2.	Juran J. M., Quality Handbook, McGraw Hill Publications.
3.	Online Education resources: viz. NPTEL web site: **(1)** nptel.ac.in/courses/112106179 **(2)** www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html; **(3)** www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; **(4)** freevideolectures.com › Mechanical › IIT Madras (5) nptel.ac.in/courses/112107143/37.

Course Code	Numerical Methods	L	T	P
20ME505		2	1	-
Pre-requisite	Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To understand numerical errors and error propagation.
2. To apply numerical methods for finding the root of the equation.
3. To solve simultaneous linear algebraic equations by numerical methods.
4. To use numerical methods for curve fitting and interpolation.
5. To apply numerical methods for integration and differentiation
6. To implement numerical techniques for ordinary and partial differential equations.

Course Outcomes:

Students will be able to

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

1. Understand errors and error propagation.
2. apply numerical method for finding root of the equation
3. solve simultaneous linear algebraic equations by numerical methods
4. use numerical methods for curve fitting and interpolation
5. apply numerical methods for integration and differentiation
6. Obtain an approximate solution of ordinary and partial differential equations applying numerical techniques.

Unit/Module: 1	Root of Equations and Errors	3 hours	CO: 1, 2
Bisection method, Newton Raphson method, Successive approximation method Types of errors, error propagation			
Unit/Module: 2	**Simultaneous Linear Algebraic Equations**	**4 hours**	**CO: 3**
Gauss elimination method, LU decomposition method, Thomas algorithm for tridiagonal matrix, Gauss Seidel method, Jacobi iterative method			
Unit/Module: 3	**Curve Fitting and Interpolation**	**6 hours**	**CO: 4**

Least square technique- straight line, quadratic equation, power equation, exponential equation Interpolation- Newton‟s forward interpolation, Lagrange‟s Interpolation, Spline interpolation			
Unit/Module: 4	**Numerical Integration and Differentiation**	**4 hours**	**CO: 5**
Numerical Integration: trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Gauss quadrature two point formula and three point formula, double integration Numerical Differentiation:			
Unit/Module: 5	**Ordinary and Partial Differential Equations**	**8 hours**	**CO: 6**
Euler‟s method, Heun‟s method, Runge Kutta fourth order method, Runge Kutta second order method for simultaneous ordinary differential equations. PDE: Finite difference method, Elliptic equation , parabolic equation			
	Total Course hours:	**25 hours**	

Texts and Reference materials:

1.	Steven C Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill
2.	Steven C Chapra, Applied numerical methods with MATLAB for engineers and scientists, Tata McGraw Hill
3.	Dr. B.S. Grewal, Numerical methods in Engineering and science, Khanna Publishers
4.	E. Balagurusamy, Numerical methods, Tata McGraw Hill
5.	Laurene Fausett, Applied Numerical analysis using MATLAB, PHI
6.	P.Kandasamy, K.Thilagavathy, K.Gunavathi, Numerical Methods, S. Chand

Course Code	Computer Aided Engineering (CAE) Lab	L	T	P
20ME501L		-	-	2
Pre-requisite	Strength of material, Computer Aided Machine Drawing			

Course Objectives:

1. To prepare a program in MATLAB/OCTAVE tool for finding transformations of CAD object
2. To formulate 1D FEM problem for static structural analysis
3. To use finite element tool for solve bar, beam, and truss problem of static structural
4. To use finite element tool for static structural of mechanical components

Course Outcomes:

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

1. Develop program in MATLAB tool for finding transformations of CAD object
2. Write a program to formulate 1D FEM problem for static structural analysis and solve
3. Compute stresses, strains, and deflection in the given 1D and 2D problem under static loading
4. Analyze plane stress/plane strain problem under static loading
5. Compute stresses, strains, and deflection of any mechanical component using 3D elements

Lab Work:

1. Build and execute a computer program on concatenated Transformation
2. Program to formulate a static structural analysis of stepped bar/beams
3. Static structural analysis of stepped bar/beam using FEA tool
4. Program to formulate a static structural analysis of truss
5. Static structural analysis of trusses using FEA tool
6. Static structural analysis of any mechanical element/part/component i.e. plate with a hole, bracket, seat belt hook, etc.
7. Static structural analysis of any mechanical component using 3D elements
8. Static structural analysis of any mechanical assembly

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

Course Name	**Industrial Inspection & Quality Control (IIQC) Lab**	L	T	P
Course Code	**20ME504 L**	-	-	2
Pre-requisite	Manufacturing Process, Machine Drawing	**Syllabus Version**		
		V:1.1		

Course Objectives:

To make students

1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes: Students will be able to

1. Demonstrate the use of different length and angle measuring instruments and comparators.
2. Calibrate the measuring instrument and design the limit gauges
3. Select and apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
4. Apply Statistical Quality Control tool(s) to analyse and interpret the inspection data.

Part [A] Experiment no. 1 and 6 are mandatory. Perform any three from experiment no. 2 to 5 & any three from experiment no. 7 to 10.

Expt. No.1	Measurement of linear and angular dimensions using standard measuring instruments.	2 hours	CO: 1 and CO: 2
Expt. No.2	Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, MSA (Gauge R & R).	2 hours	
Expt. No.3	Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)	2 hours	
Expt. No.4	Verification of dimensions & geometry of given components using Mechanical comparator.	2 hours	
Expt. No.5	Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.	2 hours	
Expt. No.6	Demonstration of surfaces inspection using optical flat/interferometers.	2 hours	
Expt. No.7	Determination of geometry & dimensions of given composite object / single point tool, using profile projector and tool maker‟s microscope.	2 hours	

Expt. No.8	Measurement of thread parameters using floating carriage diameter measuring machine.	2 hours	
Expt. No.9	Measurement of spur gear parameters using Gear Tooth Vernier, Span Micrometer/ Gear Rolling Tester.		
Expt. No.10	Determination of given geometry using coordinate measuring machine (CMM).		
Part [B] Statistical Quality Control (SQC) (Any Two assignments) **Note - Use of computational tools [such as Minitab / Matlab / MS Excel] are recommended**			
Assignment1	Note: For completing this assignment.... 1. The templates ('.excel format') for drawing/developing Pareto Chart, Cause and Effect Diagram, FMEA sheet, 5S Sheet & Kaizen Sheet. 2. Make a screenshot and paste it in the '.ppt format' are made available on Google Classroom. Part - I: Select any product / process and complete following steps... i. Identify & enlist its Quality Characteristics, ii. Identified Failure Modes [related to identified Quality Characteristics], iii. Prepare Check Sheet, iv. Draw Pareto Chart to prioritize quality characteristics, v. Draw Cause and Effect Diagram, vi. Develop FMEA Sheet Part - II: Study any reference / case study available with you (in books or downloaded from internet) related to 5S activity & Kaizen activity then use attached formats of 5S & Kaizen Sheets, prepare it accordingly & add it (ie. its screenshot) in the same template file attached in '.ppt format' to complete this assignment... [Note: Any opportunity of implementing 5S & Kaizen activity at any possible work place like, industry, workshops, shops, your home etc... you are most welcome. Only you need to explain it properly in the given format].	Out of the class activity. [As per selected task for completing this assignment]	CO: 3
Assignment2	Q.1. Instructions... for Variable type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Plot Control Charts of Variables 4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ?	Out of the class activity. [As per selected task for completing this assignment]	CO: 4

	Q.2. Instructions... for Attribute type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Control Charts of Attribute,		
	4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ? Q. 3. Differentiate between single, double & multiple sampling plans.		
	Total Lecture hours:	**25**	

Text Books:	
1	Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
2	I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
3	Jain R.K., Engineering Metrology, Khanna Publication.
4	Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
5	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
6	Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
7	Basterfield D. H., Quality control, Pearson Education India, 2004.
8	Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.
Reference Books:	
1.	ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
2.	Juran J. M., Quality Handbook, McGraw Hill Publications.
3.	Online Education resources: viz. NPTEL web site: (1) nptel.ac.in/courses/112106179 (2) www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html; (3) www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; (4) freevideolectures.com › Mechanical › IIT Madras (5) nptel.ac.in/courses/112107143/37.

Course Code	Numerical Methods Lab	L	T	P
20ME505 L		-	-	2
Prerequisite	Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

1. To use numerical methods to solve problems
2. To use mathematical solver.
3. To prepare flowcharts for numerical methods.
4. To write programs for numerical methods

Course Outcomes:

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

1. Apply numerical methods to solve engineering problems.
2. Employ mathematical solver for numerical methods.
3. Prepare flowcharts for numerical methods.
4. Write programs for numerical methods.

Lab Work:

1. To prepare flowcharts and write programs for finding Root of Equation: i)Newton Raphson method ii) Successive approximation method iii) bisection method
2. To prepare flowcharts and write programs for Simultaneous Linear Algebraic Equations: i) Gauss elimination methods ii) LU decomposition method iii) Tridiagonal matrix algorithm iv) Jacobi iteration method v) Gauss Seidel method
3. To prepare flowcharts and write programs for Curve Fitting : i) straight line ii) quadratic equation iii) power equation iv) exponential equation
4. To prepare flowcharts and write programs for Interpolation : i) Newton‟s forward interpolation ii) Lagrange interpolation iii) Inverse Lagrange Interpolation
5. To prepare flowcharts and write programs for Numerical Integration : i) Newton Cotes methods ii) Gauss quadrature methods iii) double integration
6. To prepare flowcharts and write programs Ordinary Differential Equations: i) Heun‟s methods ii) Runge Kutta method- 4th order iii) RK2 method for simultaneous ODE
7. To prepare flowchart and write program for Partial Differential Equation : parabolic explicit method

Text Books/References:	
1.	Steven C Chapra, Applied Numerical Methods with MATLAB for engineers and Scientists, McGraw Hill Education

Course Code	Thermal Lab	L	T	P
20ME506 L		-	-	2
Pre-requisite	Manufacturing Process, Machine Drawing	Syllabus Version		
		V:1.1		

Course Objectives:

1. To conduct experiments involving steady state heat transfer phenomenon
2. To analyze and process the experimental data/observations to ascertain the heat transfer
3. To illustrate the results in the graphical form
4. To Compare the results with available theoretical/experimental results and deduce the conclusion from it
5. To study the boiler construction and working

Course Outcomes:

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

1. Conduct experiments involving steady state heat transfer phenomenon
2. Analyze and process the experimental data/observations to ascertain the heat transfer rate
3. Illustrate the results in the graphical form to find the nature of temperature variation over time and length
4. Compare the results with available theoretical/experimental results and deduce the conclusion from it
5. Understand the construction and working of industrial boiler and its accessories

Lab Work:

1. Determination of Thermal Conductivity of insulating powder
2. Determine heat transfer through composite solid
3. Determination of heat transfer coefficient in Natural Convection
4. Determination of heat transfer coefficient in Forced Convection
5. Determination of Emissivity of a Test surface
6. Determination of Stefan Boltzmann Constant
7. Determination of critical heat flux for given wire
8. Determination of temperature distribution along the fin length
9. Trial on parallel and counter flow heat exchanger
10. Visit to the industry for the study of boiler construction and operations

Text Books/References:

1.	R. C. Sachdeva, „Fundamentals of Engineering Heat and Mass Transfer" New Age International Publishers
2.	R. K. Rajout, „Thermal Engineering", Laxmi Publications

Course Code	Design Lab II	L	T	P
20ME507 L		-	-	2
Prerequisite	Strength of machine elements, Machine design, Transmission system design.	Syllabus Version		
		V:1.1		

Course Objectives:

1. To explain the design process, various design considerations and theories of failures.
2. To design/select the required machine elements for the given application.
3. To design the mechanical system (assembly) for the given application.
4. To present the design work in the form of reports and drawings.

Course Outcomes:

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

1. explain the design process, various design considerations and theories of failures.
2. design/select the required machine elements for the given application.
3. design the mechanical system (assembly) for the given application.
4. present the design work in the form of reports and drawings.

Lab Work: The lab work will begin in semester IV and conclude at the end of semester V.

A. **Assignments** based on,
   i) Design process, design considerations, standards in design.
   ii) Engineering materials, their features, applications and selection.
   iii) Principal stresses and theories of failures.
   iv) Manufacturing and assembly considerations in design.

B. **Case studies** based on any three of the following engineering applications,
   - Design of a mechanical joint for a roof truss/valve mechanism/foundation bolt.
   - Design of a mechanical coupling for a compressor/pump/gear box.
   - Design of turnbuckle for stay rope/jib crane.
   - Select a belt from the manufacturer's catalogue for the given application.
   - Select a bearing from the manufacturer's catalogue for the required application.

C. **Comprehensive Design Project (Project Based Learning):**
   - Comprehensive project to design a transmission system (gear box) for the specified application.
   - The project work is carried out by a group of 3-5 students.
   - The project involves identification of functional requirements, configuration of specifications, selection of mechanisms, preparation of layout, design of individual elements and the overall assembly.
   - Each group will present the design project work by preparing a design report and drawings by using suitable software.

Text Books/References:	
1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design",McGraw Hill Publication Co. Ltd.
2	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements", Prentice Hall International.
3	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
4	P.S.G. Design Data, PSG College of Technology Coimbatore.
5	Bhandari V.B ,"Machine Design Data Book", Tata McGraw Hill Publication Co. Ltd.

Third Year B. Tech. Sixth Semester
(Mechanical Engineering)
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	Practical	Oral		
20ME601	Robotics and Control Systems (RCS)	3	0	0	50	50	0	0	100	3
20ME602	Applied Thermodynamics (AT)	2	1	0	50	50	0	0	100	3
20ME603	System Dynamics - Modeling and Simulation (SDMS)	2	1	0	50	50	0	0	100	3
20ME604	Turbo Machines (TM)	2	1	0	50	50	0	0	100	3
20OEHS601	Industrial Engineering and Operation Research (IIOR)	3	0	0	50	50	0	0	100	3
20OE601	Open Elective II	3	0	0	50	50	0	0	100	3
20ME601L	Robotics and Control Systems (RCS) Lab	0	0	2	25	0	0	25	50	1
20ME602L	Applied Thermodynamics (AT) Lab	0	0	2	25	0	0	25	50	1
20ME603L	System Dynamics - Modeling and Simulation (SDMS) Lab	0	0	2	25	0	25	0	50	1
20ME604L	Turbo Machines (TM) Lab	0	0	2	25	0	0	25	50	1
20OE601L	Open Elective II Lab	0	0	2	25	0	0	25	50	1
	Total	**15**	**3**	**10**	**400**	**250**	**25**	**125**	**800**	**23**
	Grand Total	**28**			**650**		**150**			

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

T. Y. B. Tech. -- Semester-II

Course Code	Robotics and Control Systems	L	T	P
20ME601		3	0	0
Prerequisite	Basic Mathematics, Engineering Mechanics, Elements of Electrical and Electronics Engineering	Credit : 03		

Course Objectives:

To familiarize the students

1. Basics of Robotics
2. Robotic control and Actuation
3. Control Technology
4. System Modelling, Stability and Control actions.

Course Outcomes:

At the end of the course, student will be able to

1. Identification of the basic Robotic systems components and performance parameters
2. Understand the fundamentals of Robotic sensory and actuation systems
3. Analyze the robotic kinematics
4. Identify the basic control systems and it‟s classifications
5. Prepare the system model and can perform the stability analysis of the model
6. Analyze the different controller modes and perform the frequency domain analysis

Unit 1	Introduction to Robotics	5 hours	CO : 1

Basic concepts, Laws of Robotics, Classification, Structure of Robots, Point to point and continuous path control system, Robot performance measurement characteristics- accuracy, resolution, repeatability, precision, dexterity, Industrial Applications.

Unit 2	Robotic Sensors & Actuation	6 hours	CO : 2

Classification, Selection and application, Need for sensors and vision system is robotic control.
Sensors: Light,Soud,Temperature,Contact,Proximity,Distance,Pressure,Tilt,Navigation,Acceleration GPS, IMU, Vision, PVDF Tactile(Construction, working and selection)
Actuation: Selection of Drives, Actuators and transmission system of manipulator.

Machine Vision System: Vision system devices, image acquisition, Masking, Sampling and Quantization, Image processing techniques, Noise reduction, Edge detection, Segmentation.

Unit 3	**Robot Kinematics**	**6 hours**	**CO : 3**
Transformation matrices ,link and joint, Denavit- Hartenberg (D-H) parameters, kinematics redundancy, kinematics calibration, inverse kinematics Static force and velocity in manipulators, Motion of the manipulator links, Jacobians, Singularities, static forces, Jacobian in force domain.			
Unit 4	**Control System**	**6 hours**	**CO : 4**
Definition, Classification- open loop and closed loop control system, case studies, Feedback and Feed Forward Control System, Transfer Function, Block diagram reduction techniques, Signal flow Graphs- Mason's Gain Formula			
Unit 5	**System Modelling and Stability**	**7 hours**	**CO : 5**
Basic system Models: Thermal, Fluid, Hydraulic, Mechanical: Spring-Mass-Damper system equations Stability Analysis in S-Domain: The concept of stability , Poles and Zeros of system – Routh-Hurwitz‟s stability criterion – qualitative stability and conditional stability – Limitations of Routh-Hurwitz‟s stability. Root Locus Technique: Concept of root locus – Construction of root locus. Time domain Response analysis.			
Unit 6	**Controllers and Frequency Response Analysis**	**6 hours**	**CO : 6**
Controllers: On-Off,P,I,D,PI,PD and PID Controller working principle. **Frequency domain specifications**, Bode plot diagrams-Determination of Phase margin and Gain margin, Stability analysis from Bode plots, Polar plots.			
	Total Lecture hours:	**36 hours**	

Text Books:

1.	S.K.Saha, "Introduction to Robotics", 2nd edition, TataMcGraw Hill Publication,
2.	John J. Craig, "Introduction to Robotics: Mechanics & Control", 3rd edition, Pearson Education.
3.	Ogata K., "Modern Control Engineering" Prentice Hall of India
4.	Nagrath I.J., & Gopal M, "Control system Engineering." Wiley Eastern Reprint
5.	C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi

Reference Books:

1.	Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons
2.	W. Bolton: Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Third Edition, Pearson Education (Low Price Edition)

Course Name	Applied Thermodynamics	L	T	P
Course Code	20ME602	2	1	-
Pre-requisite	Engineering Thermodynamics, Fluid Mechanics, Heat Transfer	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. understand performance parameters of reciprocating air compressor.
2. understand and analyze refrigeration cycles
3. understand various psychrometric processes
4. understand performance parameters of gas turbines.

Course Outcomes:

Students will be able to

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

1. Evaluate isothermal and volumetric efficiency of reciprocating compressor.
2. Analyze refrigeration cycles and calculate COP.
3. Plot psychrometric processes and perform air conditioning load calculations.
4. Calculate the efficiency and power developed for a gas turbine

Unit/Module: 1	Reciprocating Air Compressors	6 hours	CO: 1
Computation of work done, Isothermal efficiency, Volumetric efficiency, Multi staging of compressor, Capacity control of compressor			
Unit/Module: 2	**Refrigeration**	**6 hours**	**CO: 2**
Vapor compression cycle, Multistage refrigeration, Vapor absorption cycle			
Unit/Module: 3	**Psychrometry**	**6 hours**	**CO: 3**
Basic concepts and definitions, Psychrometric chart, Analysis of various psychrometric processes			
Unit/Module: 4	**Gas Turbines**	**6 hours**	**CO: 4**
Working of Brayton Cycle, Thermal Efficiency, Work ratio, maximum & optimum pressure ratio, Actual cycle, Effect of operating variables on thermal efficiency, Inter-cooling, Reheating, and Regeneration cycle			
	Total Course hours:	**hours**	**24**

Text Books:	
1.	S. Domkundwar, C.P. Kothandaraman, A. Domkundwar, Thermal Engineering, Dhanpat Rai & Co
2.	Arora C.P. Refrigeration and Air Conditioning, Tata McGraw-Hill
3.	Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Ltd
4.	V. Ganeshan, Gas Turbines, Tata Mcgraw Hill

Course Name	System Dynamics – Modeling and Simulation	L	T	P
Course Code	20ME603	2	1	0
Pre-requisite	Analysis and Synthesis of Mechanisms, Machine Design, Power Train Design	Credit: 03		

Course Objectives:

1. To understand the methods to find natural frequency of system subjected to undamped free vibrations
2. To analyze the system subjected to vibrations with viscous/coulomb damping
3. To calculate the amplitude and phase difference for various cases of forced vibrations
4. To determine natural frequencies and mode shapes of multiple degree of freedom system
5. To explain the features and applications of various dynamic modeling techniques

Course Outcomes:

Upon completion of this course, the student will be able to,

1. evaluate the natural frequency of system subjected to undamped free vibrations
2. analyze the system subjected to vibrations with viscous/coulomb damping
3. calculate the amplitude and phase difference for various cases of forced vibrations
4. determine natural frequencies and mode shapes of multiple degree of freedom system
5. understand features and applications of various dynamic modeling techniques

Unit 1	Fundamentals of Dynamic System	4 hours	CO: 1

Elements of a vibratory system, S.H.M., degrees of freedom, modeling of a system, concept of linear and non-linear systems, equivalent spring, linear and torsional systems. Matrix Algebra

Unit 2	Single Degree of Freedom Systems – Free and Forced Vibrations	6 hours	CO: 2

Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.
Forced vibrations of longitudinal and torsional systems, simple harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor and phase difference, force and motion transmissibility
Different types of damping, free vibrations with viscous damping - over damped, critically damped and under damped systems, dry friction damping.

Unit 3	Multiple Degree of Freedom Systems - Undamped Vibrations	6 hours	CO: 3

Free vibration of spring coupled systems – longitudinal and torsional, natural frequency and mode shapes. Eigen value and Eigen vector by Matrix method, Geared systems.

Unit 4	**Frequency Response and Vibration**	**6 hours**	**CO: 4**
Digital and Fast Fourier Transform, Frequency Response of first and second order Systems, Vibration Isolator and Vibration Absorption, Response to General Periodic Inputs			
Unit 5	**Dynamic Modeling and Simulation**	**6 hours**	**CO: 5**
Introduction to Laplace Method for Step input, impulse input to SDOF, Laplace Transform, Response for First Order Models, State Space system, Simulations using MATLAB and SIMULINK, Base Excitation, Rotating Imbalance			
	Total Lecture hours:	**28 hours**	

Text Books:	
1.	William J. Palm III, Modeling, Analysis, and Control of Dynamic Systems, Wiley,latest edition
2.	Rao S. S., „Mechanical Vibrations", Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd.
Reference Books:	
1.	William J. Palm III, System Dynamics, Mc-Graw Hill, latest edition
2.	Grover G. K., „Mechanical Vibrations", Nem Chand and Bros.
3.	Thomson, W. T., „Theory of Vibration with Applications", CBS Publishers and Distributors.
4.	V P Singh, „Mechanical Vibrations", Dhanpat Rai & Sons.
5.	Kelly S. G., „Mechanical Vibrations", Schaum„s outlines, Tata McGraw Hill Publishing Co. Ltd.
6.	Meirovitch, „Elements of Mechanical Vibrations", McGraw Hill.
7.	M.L.Munjal, „Noise and vibration control", Cambridge University Press India Private Limited.
8.	Bies, D. and Hansen, C., „Engineering Noise Control - Theory and Practice", Taylor and Francis.

Course Name	Turbo Machines	L	T	P
Course Code	20ME604	3	1	-
Pre-requisite	Physics, Calculus, Fluid Mechanics	Syllabus Version		
		V:1.1		

Course Objectives:

Course prepares students to

1. differentiate between impulse and reaction turbine
2. illustrate inlet and outlet conditions of a turbomachine with the help of velocity triangles
3. calculate the head requirement and efficiency of a centrifugal pump
4. determine the slip and efficiency of a centrifugal compressor

Course Outcomes:

Students will be able to

1. Compute the power developed and efficiency of hydraulic turbine
2. Determine head developed by a centrifugal pump and power required to operate it
3. Calculate the diagram efficiency and diagram power for a given steam turbine
4. Perform calculations for the power developed and efficiency for gas turbine
5. Construct velocity triangles and calculate thermal efficiency of centrifugal compressor

Unit/Module: 1	Introduction	4 hours	CO: 1

Turbo machines (Hydraulic & Thermal), Classification of Turbo machines, Comparison with positive displacement machines, Fundamental equation governing turbo machines, Concepts of Velocity triangle and impact of jet on curved vanes

Unit/Module: 2	Hydraulic Turbines	8 hours	CO: 2

Pelton wheel- Construction, principle of working, velocity diagrams and analysis, design aspects,
Reaction Water Turbines : Classifications, Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, degree of reaction,

Unit/Module: 3	Steam Turbine	8 hours	CO: 3

Steam Turbines: Classifications (Axial and Radial), construction details, compounding of steam turbines, velocity diagrams and analysis of Impulse and reaction turbines (single stage), governing of steam turbines

Unit/Module: 4	**Centrifugal Pump**	**8 hours**	**CO:4**
Classification of rotodynamic pumps, components of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, specific speed, performance characteristics of centrifugal pump, Cavitation, open, semi open impeller pumps			
Unit/Module: 5	**Centrifugal Compressor**	**8 hours**	**CO: 5**
Classification of rotodynamic compressors, blowers, fans. Centrifugal compressor: Construction, flow process on T-S Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input, dimension parameters, surging, choking, stalling.			
	Total Lecture hours:	**36 hours**	

Text Books:

1	Jagdish Lal, Hydraulic Machines, Metropolitan Book Company
2	Kadambi & Prasad, An Introduction To Energy Conversion: Turbomachinery - Vol. III, New Age International
3	William W. Peng, Fundamentals of Turbomachinery, John Wiley & Sons.
4	Turbines, Compressors & Fans, S.M. Yahya, Tata-McGraw Hill
5	S.L. Dixon, Fluid Mechanics, Thermodynamics of Turbomachinery, IV edition, Butterworth-Heinemann Publ., 1966.
6	R. K. Rajput Hydraulic Machines, S. Chand
7	V. Ganeshan, Gas Turbines, Tata Mcgraw Hill

Course Name	**Industrial Engineering and Operations Research [IEOR -** OEHS]	**L**	**T**	**P**
Course Code	**20OEHS601**	**3**	**-**	**-**
Pre-requisite	Manufacturing Process, Industrial Inspection, Quality Control	**Syllabus Version**		
		V:1.1		

Course Objectives:

Course prepares students to

1. Effectively explain production planning and Control functions.
2. Understand different types of analysis using industrial engineering techniques viz. Method Study and Work Measurements
3. Develop mathematical skills to analyse Project Scheduling arising from a wide range of applications.
4. Understand procedure for Replacement and Queuing System analysis

Course Outcomes:

Students will be able to

1. Analyze different types of production planning functions viz. productivity analysis, Aggregate and Capacity production planning, forecasting, inventory control,
2. Apply method study and work measurements technique to solve industrial problem,
3. Analyze the given Project for optimum schedule and sequence.
4. Analyze the given industrial situation to optimize replacement decision and queuing problem

Unit/Module: 1	**Industrial Engineering, Productivity and PPC**	**6 hours**	**CO: 1**

- **Industrial Engineering:** Objectives, Functions & Tools; Production Systems and Organisation structures: Types, Strategies & Principles
- **Productivity Analysis:** Definition, Factors Affecting the Productivity, Productivity models and index (numerical);
- **Production Planning and Control:** Functions of PPC, Aggregate production planning; Capacity Planning, ERP

Unit/Module: 2	**Production Forecasting and Facility Planning**	**6 hours**	**CO: 1**

- **Forecasting Techniques**: Qualitative and Quantitative Methods: Causal and time series models, moving average, exponential smoothing, trend and seasonality (Numerical)
- **Facility Layout Planning**: Factors Influencing, Material Flow Patterns, Tools & Techniques

used

- **Inventory Control:** Inventory costs, Types of inventory models - Deterministic and Probabilistic, Concept of EOQ, purchase model without shortages (Numerical); ABC and VED Analysis (Numerical).

Unit/Module: 3	**Method Study and Work Measurements**	**8 hours**	**CO: 2**

- **Method Study:** Definition, objective and procedural steps; activity recording tools, Human factors considerations; Value Engineering
- **Work measurement:** Definition, objectives and techniques: **Time study & Work sampling**, (numerical); **Synthetic motion studies**: PMTS and MTM, MOST

Unit/Module: 4	**Project Scheduling**	**8 hours**	**CO: 3**

- **Critical Path Method (CPM)**: Network Diagram;
- **Program Evaluation and Review Technique (PERT)**: Problems, Time Cost Trade Off (Crashing),
- **Jobs Sequencing**: „N" Jobs & 2 / 3 Machines
- **Jobs Assignment**:

Unit/Module: 5	**Replacement and Queuing System analysis**	**8 hours**	**CO: 4**

- **Replacement analysis**: Maintenance cost increases with time and the value of money remains same / increases during the period; replacement of items that fail completely and suddenly.
- **Queuing System analysis**: M / M / 1 / (/ FIFO); (FCFS/ /): (Birth – Death process)

	Total Lecture hours:	**36 hours**	

Text Books:

1.	Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH
2.	Zandin K.B. - Most Work Measurement Systems, ISBN 0824709535, CRC Press, 2002.
3.	Industrial engineering and management by O. P. Khanna, Dhanpatrai publication
4.	Industrial Engineering , Martend Telsang, S. Chand Publication
5.	Industrial Organisation & Engineering Economics by Banga and Sharma, Khanna publication.
6.	Prem Kumar Gupta and D S Hira, Operations Research, S Chand in publication 2007.
7.	J. K. Sharma, Operations Research: Theory And Application, Laxmi pub. India.

Reference Books:

1.	H.B. Maynard, KJell, Maynard"s Industrial Engineering Hand Book, McGraw Hill, Education, 2001
2.	Taha, H. A. 2007, Operations Research, 8th Edn, Pearson.

Course Name	Robotics and Controls Lab	L	T	P
Course Code	20ME601L	-	-	2
Pre-requisite	Engineering Mechanics, Elements of Electrical and Electronics Engineering	Syllabus Version		

Course Objectives:

To familiarize the students with the

1. Basics of robots and robotic manipulator components
2. Control system and controller actions
3. Industrial application of robotics and Controllers

Course Outcomes:

Students will be able to

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

1. Identify the elements of robotics and apply the knowledge to design simple control system.
2. Perform forward and Inverse kinematic analysis of robotic system.
3. Integrate different types of sensors and control the basic robotic motion.
4. Identify and Apply the knowledge of basic concepts of robotic system and its components.

1	Study components of an industrial robot (PUMA, KUKA, FANUC, MTAB , UR , Etc) and its DH parameters.
2	Forward kinematics and validation using suitable software (Robo Analyser/ MatLab or any other free software tool).
3	Inverse kinematics of an industrial robot and validation using any open source software
4	Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro controllers in a robotic system. (Free software, Matlab)
5	Control experiment using available hardware or software. (Open source or Matlab).
6	Tunning of PID Controller for suitable application.

	7	Small group project work relevant to Industrial automation.		
	8	Industrial visit to any Robotic assembly line or Robot assisted manufacturing.		
		Total Lab hours:	**hours**	**20**

Textbooks:	
1.	Introduction to Robotics : J. Craig , Pearson
2.	Robot Dynamics and Control, Spong & Vidyasagar, Mc Graw Hill
3.	Robotics : Subir K Saha , Mc GrawHill
4.	Industrial Robotics : M. P. Groover, Ashish Dutta , McGraw Hill
5.	S.R.Deb, "Robotic Technology and Flexible Automation".TataMcGraw Hill Publication.

Course Name	Applied Thermodynamics Lab	L	T	P
Course Code	20ME602 L	-	-	2
Prerequisite	Engineering Thermodynamics, Fluid Mechanics, Heat Transfer	Syllabus Version		
		V:1.1		

Course Objectives:

1. To study performance parameters of I C Engines.
2. To conduct trial and do performance calculations for reciprocating air compressor
3. To evaluate performance of refrigeration cycles
4. To analyze various psychrometric processes

Course Outcomes:

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

1. Conduct trial on IC engines and calculate performance parameters.
2. Conduct trial on reciprocating air compressor to ascertain volumetric and isothermal efficiency.
3. Compute performance parameters of vapor compression refrigeration system
4. Perform a trial on air conditioning tutor to understand different psychrometric processes.

Lab Work:

1. Study and trial on petrol engine.
2. Study and trial on Diesel engine
3. Morse Test on multi cylinder petrol/Diesel engine for determination of friction power.
4. Trial on vapor compression test rig.
5. Trial on ice plant test rig.
6. Trial on air conditioning test rig.
7. Trial on two stage reciprocating air compressor.
8. Visit to the air conditioning plant.
9. Assessment of mini project in Thermal Engineering.

Text Books/References:

1.	V. Ganesan, Internal Combustion Engines, Tata McGraw Hill
2.	M.L. Mathur and R.P. Sharma, A course in Internal Combustion Engines, Dhanpat Rai Publications
3.	S. Domkundwar, C.P. Kothandraman, A. Domkundwar, Thermal Engineering, Dhanpat Rai & CO
4.	Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill

Course Name	System Dynamics – Modeling and Simulation Lab	L	T	P
Course Code	20ME603L	-	-	2
Prerequisite	1.Analysis and Synthesis of Mechanisms 2.Machine Design 3.Power Train Design	Syllabus Version		
Co -requisites:	System Dynamics - Modeling and Simulation	V:1.1		

Course Objectives:

1.To understand the methods to find natural frequency of system subjected to undamped free vibrations
2.To determine natural frequencies and mode shapes of multiple degree of freedom system
3.To understand the implications of rotating imbalance
4.To explain the features and applications of various dynamic modeling techniques

Course Outcomes:

Upon completion of this course, the student will be able to,

1.evaluate the natural frequency of system subjected to un-damped free vibrations
2.determine natural frequencies and mode shapes of multiple degree of freedom system
3. perform experiment of rotating imbalance
4. understand features and applications of various dynamic modeling techniques

Text Books/References:

	William J. Palm III, Modeling, Analysis, and Control of Dynamic Systems, Wiley, latest edition

List of Experiments:

1	MATLAB and some Functions
2	Data Acquisition Basics + SDOF Undamped
3	Cantilever Beam (SDOF System)
4	SDOF Simulation – MATLAB SIMULINK –Underdamped Free Vibrations
5	SIMULINK Examples and Numerical Methods
6	Air Track SDOF and 2DOF Free Vibration
7	Eigenvalue in MATLAB/Simulation of 2 DOF system
8	Rotating Imbalance

Course Name	Turbo Machines Lab	L	T	P
Course Code	20ME604L	-	-	2
Pre-requisite	Fluid dynamics	Syllabus Version		

Course Objectives:

To make students

1. To conduct experiments involving various parameters of different turbo machines
2. To calculate hydraulic and overall efficiency of a given hydraulic turbine
3. To Illustrate the characteristics in the graphical form
4. To Compare the results with available characteristic curves and deduce the conclusion from it

Course Outcomes:

Students will be able to

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

1. conduct experiments involving various parameters of different turbo machines
2. calculate hydraulic and overall efficiency of a given hydraulic turbine
3. Illustrate the characteristics in the graphical form
4. Compare the results with available characteristic curves and deduce the conclusion from it

1. Verification of impulse moment principle using impact of jet on curved vane
2. Study and constant speed trial on impulse water turbine (Pelton wheel) and plotting of main and operating characteristics
3. Study and constant head trial on impulse water turbine (Pelton wheel) and plotting of main and operating characteristics
4. Study and constant speed trial on any hydraulic reaction turbine and plotting of main and operating characteristics
5. Study and constant head trial on any hydraulic reaction turbine and plotting of main and operating characteristics
6. Study and trial on centrifugal pump and plotting operating characteristics Study and trial of rotary compressors.
7. Visit to hydro/steam power plant and report to be submitted.
8. Performance Test on Gear (Oil) Pump Test Rig

	Total Lab hours:	hours	20

Autonomous Program Structure of
Final Year B. Tech. Seventh Semester
(Mechanical Engineering)
Academic Year: 2023-2024 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem	End Sem	Practical	Oral		
20ME701	Internship/Project	0	0	30	200	0	0	100	300	15
20HS702	Economics and Personal Finance (EPF) (Online)	2	0	0	100	0	0	0	100	2
	Grand Total	**32**							**400**	**17**

Credits	Marks	Teaching Hrs / week	Evaluation Mode
Internship / Project = 15	300	30	Presentations + Oral
HS- EPF (Online) = 3	100	2	ISE + ESE

Duration of Internship / Project :

1. Full Internship 6 Months
2. Full Project 6 Months
3. Combination : Internship 3 Months + Projects 3 Months
   (June-Aug + Sep- Nov)

For Internship / Project:
In-Sem-Reviews =Two ; ESE = One Review with external (Final)

Final Year B. Tech. -- Semester-I

Course Name	Economics and Personal Finance	L	T	P
Course Code	20HS701	3	-	-
Pre-requisite	Engineering Mechanics, Strength of Materials, Engineering Metallurgy			

Course Objectives: To make students

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 successful completion of the course, student 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/Module: 1	Macro Economics: Understanding Indian Economy- Domestic and International	3 hours	

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/Module: 2	Microeconomics: Understanding behaviors of Consumers, Firms and Markets	5 hours	

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/Module: 3	**Personal Finance and Taxation I: Personal Financial strategies Background Concepts**	**6 hours**	
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/Module: 4	**Personal Finance and Taxation II:** Personal Financial strategies **Goal Setting and Tax, Credit and Risk Management**	**7 hours**	
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/Module: 5	**Personal Finance and Taxation III: Personal Financial strategies Investments in Bonds, Stocks and Mutual Funds, Retirement Planning**	**7 hours**	
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.			
	Total Lab hours:	**28 hours**	

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

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**		
	Grand Total	**20**			**625**		**25**		**650**	**19**

*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 I/O 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

Course Name	Programme Elective – II 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 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 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. 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. 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. 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 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 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 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 Advanced Refrigeration and Air Conditioning	L	T	P
Course Code	20PEME804_A	3	-	-
Prerequisite	1. Heat Transfer 2. Fluid Mechanics 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 Selection Criteria			
Unit/Module: 5	**Air Distribution System**	**6 hours**	**CO: 5**
Ducts - Air flow through simple duct system. Pressure losses in duct Method of duct system design- equal friction, velocity reduction method, static regain method 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 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

Course Name	Programme Elective – II Lab 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 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 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
Lectures: 3 Hours / Week

Examination scheme:
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
Lectures: 3 Hours / Week

Examination scheme:
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)

Introduction 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
Lectures: 3 Hours / Week

Examination scheme:
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
Lectures**:** 3 Hours / Week
Tutorial : 1 Hour/ Week

Examination scheme:
ISE**:** 50 Marks
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
Lectures**:** 3 Hours / Week

Examination scheme:
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
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 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
Lectures**:** 3 Hours / Week
Tutorial: -

Examination scheme:
In Semester: 50 Marks
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
Lectures**:** 3 Hours / Week

Examination scheme:
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, 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
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/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
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 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
Lectures**:** 3 Hours / Week

Examination scheme:
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:
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
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* , (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/