

Curriculum for PG Degree Course in MTech. Computer Engineering
(Academic Year: 2024-25 Onwards)

First Year | Semester-I

Course Code	Course Title	Teaching Scheme Hours / Week			Cr	Examination Scheme			Total Marks
		L	T	P		ISE	ESE	Pr/Or	
24PCMCE101	Research Methodology	3	0	0	3	50	50	0	100
24PCMCE102	Distributed Systems	4	0	0	4	50	50	0	100
24PCMCE103	Advanced Databases	4	0	0	4	50	50	0	100
24MOE101	A. Intellectual Property Rights B. Organizational Behavior -	3	0	0	3	50	50	0	100
24PEMCE101	A. Cyber Security B. Human Machine Interaction C. Business Intelligence and Analytics	3	1	0	4	50	50	0	100
24PCMCE101L	Research Methodology Laboratory	0	0	2	1	25	0	0	25
24PCMCE103L	Advanced Databases Laboratory	0	0	2	1	25	0	0	25
Total		17	1	4	20	300	250	0	550



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24PCMCE101 RESEARCH METHODOLOGY

Teaching Scheme:

Lectures: 3 Hrs / Week

Examination Scheme:

In-Semester: 50 M

End Semester: 50 M

Credits: 3

Course Objectives

To facilitate the learner to

1. Introduce different research paradigms and methodologies.
2. Develop skills for designing and conducting research projects.
3. Familiarize with various data collection, analysis, and visualization techniques.
4. Enable to critically evaluate research literature and communicate research findings effectively.

Course Outcomes

By taking this course, the learner will be able to

1. Choose research paradigms, methodologies, tools and technologies relevant to the problem statement.
2. Evaluate research literature and communicate research findings effectively.
3. Make use of various data collection, analysis, and visualization techniques.
4. Develop skills for designing and conducting research projects

UNIT I: Foundations of Research

Meaning, Objectives, Motivation, Utility of Research, Types of Research- Exploratory Research, Descriptive Research and Explanatory Research, Methods of Research - Qualitative and Quantitative, Theory Building and Understanding the Language of Research (Concept, Construct, Definition, Variable), Characteristics of good research.

Case study: Discoveries of Great Computer Scientists

UNIT II: Problem Identification and Formulation in Research

Literature Review Process and Formulation of Research Questions, Importance of literature review in research, Search strategies for literature review.

Critical analysis and synthesis of literature, Gap analysis using literature review.

UNIT III: Experimental Design - Statistical Analysis of Data

Data Collection -Surveys and Questionnaires, Interviews, Observational studies, Case studies, Experimental research, Dataset repositories – Kaggle, GitHub,

Processing Operations, Elements/Types of Analysis, Univariate, Bivariate and Multivariate analysis. Descriptive statistics, Inferential statistics, Hypothesis-Characteristics and Types, Hypothesis Testing –Logic and Importance, The Null and Alternative Hypothesis

UNIT IV: Research Tools

Understanding and Using the Library and the Internet for Research, Documentation and Plagiarism checking Tools, Reference Managing tools, Formats and Styles (APA, Chicago, MLA, ASA), Grammar Checker Tools, AI tools.

UNIT V: Research Presentation and Communication

Research Paper / Proposal Writing, Structure and components of a research proposal, Writing research objectives and questions, Literature review in research proposals, Report/ Thesis writing, Grant writing
Communicating research findings to different audiences.

UNIT VI: Research Ethics

Ethical considerations. Informed consent and confidentiality, Plagiarism and academic integrity
Ethical Issues – Ethical Committees – Commercialization – copy right – royalty – Intellectual Property rights and patent law – Track Related aspects of intellectual property Rights –Reproduction of published material – Plagiarism – Citation and Acknowledgement –Reproducibility and accountability

Text Books:

1. Kothari, C.R., “Research Methodology: Methods and Techniques”, 2nd Edition, New Age International Publishers, New Delhi (2004) .
2. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners" 4th Edition (2023)
3. Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
4. S. P.Gupta, “Statistical Methods”, Sultan Chand & Sons, Paperback (2012)

Reference Books:

1. John W. Creswell, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" Sage Publication, 5th edition (2018)
2. Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams, "The Craft of Research" , University of Chicago Press; 4th edition (2016)

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3. Dennis Shasha and Cathy Lazere, “Out of their Minds: The Lives and Discoveries of 15 Great Computer Scientists” (1998)
<https://www.amazon.com/Out-their-Minds-Discoveries-Scientists/dp/0387982698>

Web References:

- What is research:
<https://www.cse.iitb.ac.in/~uday/soft-copies/what-is-research-part-1.pdf>
- https://onlinecourses.nptel.ac.in/noc22_ge08/preview
- Scholarly articles from peer-reviewed journals in computer engineering
- Online tutorials and resources on research methods and tools (e.g., Coursera, Khan Academy)
- <https://www.javatpoint.com/research-tools>
- How to Write a Great Research Paper :
<https://www.youtube.com/watch?v=WP-FkUaOcOM>
<https://www.youtube.com/watch?v=VEXaUHNmpQw>
- You and Your Research: <https://www.cs.virginia.edu/~robins/YouAndYourResearch.html>

24PCMCE101L RESEARCH METHODOLOGY LABORATORY

Teaching Scheme:

Practicals: 2 Hours / Week

Examination Scheme:

In Semester: 25 Marks

Credits: 1

Course Objectives

To facilitate the learner to

1. Introduce different tools to carry out research.
2. Develop skills for designing and conducting research projects.
3. Familiarize with various data collection, analysis, and visualization techniques.
4. Enable to critically evaluate research literature and communicate research findings effectively.

Course Outcomes

By taking this course, the learner will be able to

1. Choose research methodologies, tools and technologies relevant to the problem statement.
2. Examine research literature and communicate research findings effectively.
3. Make use of various data collection, analysis, and visualization techniques.
4. Develop skills for defining and conducting research projects

Suggestive list of Assignments

1. Learn to use Turnitin / Online plagiarism detection tools. Get acquainted with research terms likes h-index, i-index, citations, indexing etc.
2. Select a research topic by recursively referring to research papers and their citations (At Least 3).
3. Present a review of at-least five research papers listing their major strengths, weaknesses, methodology followed, algorithms used etc. Create a list of references in the standard format.
4. Present a gap analysis observed in the literature review, define a problem statements and identify atleast four research objectives. Prepare a 5-slide presentation of your research topic.
5. Assignments based on Univariate, Bivariate and Multivariate analysis. Descriptive statistics.
6. Create a survey questionnaire for data collection related to your research topic OR download appropriate dataset, preprocess it, analyse it using appropriate techniques and present this analysis.
 - a. Hypothesis Testing for the Population Proportion p
 - b. A Statistical Investigation using various software tools (R, Python etc)

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- c. Present analysis using various visualization tools.
7. Write a survey paper for your research topic / Create an outline of a research grant for your research topic.
8. Use LATEX for preparing Report and Presentation Slides.

24PCMCE102 DISTRIBUTED SYSTEMS

Teaching Scheme

Lecture: 4 Hrs/week

Examination Scheme

In semester: 50 marks

End semester: 50 marks

Credits: 4

Prerequisites: Operating Systems, Microprocessor Architecture

Course Objectives

To facilitate the learner to

1. Learn fundamental concepts of Distributed Systems.
2. Learn communication methodology in distributed systems.
3. Make use of Distributed File Systems and Consensus Mechanism.
4. Understand the various issues related to distributed databases and transactions.
5. Understand trends and applications of Distributed Systems.

Course Outcomes

By taking this course, the learner will be able to

1. Understand fundamental concepts of Distributed Systems.
2. Make use of communication mechanisms and synchronization algorithms in Distributed Systems.
3. Make use of consensus mechanisms, replication techniques and consistency models in Distributed Systems.
4. Apply different methods to solve issues related to distributed databases and transactions
5. Understand trends and applications of Distributed Systems.

UNIT I: Introduction to Distributed System

Introduction of distributed systems, Types of Distributed Systems, Architecture, Distributed Operating System, Interprocess Communication. Types of Communication, Remote Procedure Call- Remote Method Invocation. Message Oriented Communication: Simple Transient Messaging with Sockets, Message Oriented middleware, Brewer's CAP algorithm, Mutual Exclusion.

UNIT II : Interprocess Communication

Physical Clocks, Clock Synchronization Algorithms. Logical Clocks–Lamport's Logical clocks, Vector Clocks. Mutual Exclusion: Overview, Centralized Algorithm, Distributed Algorithm, Token-Ring Algorithm, Decentralized Algorithm, Election Algorithms: Bully Algorithm, Ring Algorithm.

UNIT III : Distributed File Systems and Consensus

Distributed consensus: Consensus in asynchronous systems, Consensus in synchronous systems, Paxo's algorithm, Failure detectors, File Service Architecture, Name Services, Directory Services, Case Study : Sun Network File System.

Distributed Shared Memory: Introduction, Design and Implementation Issues, Consistency Models.

UNIT IV: Distributed Transaction Processing

Distributed Database: Distributed DBMS Architecture, Distributed Data Storage, Query processing and decomposition, Distributed Transactions; Transactions and Concurrency Control: Introduction, Transactions, Nested Transactions, Locks, Optimistic Concurrency Control, Timestamp Ordering, Comparison of Methods for Concurrency Control; Distributed Transactions Introduction, Flat and Nested Distributed Transactions, Atomic Commit Protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks, Transaction Recovery.

UNIT V : Distributed Algorithms

Distributed Deadlock detection algorithms, Termination Detection in Distributed System, Self-Stabilization, Distributed Randomized Algorithms, DHT and P2P Computing.

UNIT VI : Trends and Applications in Distributed Systems

Trends in Distributed Systems, Map Reduce: Paradigm, Applications, Introduction to Spark, Introduction to Kafka, Peer to Peer Systems in Cloud Computing bit torrent, Grid Computing, Distributed ledger, Overview of security techniques in distributed systems.

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Text books :

1. George Coulouris, Jean Dollimore, Tim Kindberg, & Gordon Blair, “Distributed Systems –Concept and Design”, 5th Edition, Publisher: Pearson, ISBN – 978-13-214301-1.
2. Pradeep K Sinha, “Distributed Operating System”, Publisher: PHI. ISBN – 978-81-203-1380-4.

Reference Books :

1. Sukumar Ghosh, “Distributed Systems - An Algorithmic approach”.
2. A. Silberschatz, H. Korth, and S. Sudarshan.”Database Systems Concepts” McGraw-Hill, New York, 6 edition, (2010)
3. A.D. Kshemkalyani, M. Singhal, “Distributed Computing: Principles, Algorithms, and Systems” ISBN: 9780521189842, Cambridge University Press, March 2011.
4. Nancy Lynch, “Distributed Algorithms” Morgan Kaufmann Publishers, ISBN-13:978-1-55860- 348-6
5. Maarten van Steen, Andrew S. Tanenbaum, “Distributed System”, Third edition, version 3

Web references:

1. <https://nptel.ac.in/courses/106106168>
2. <http://www.digimat.in/nptel/courses/video/106102237/L01.html>
3. <https://archive.nptel.ac.in/courses/106/106/106106107/>

24PCMCE103 ADVANCED DATABASES

Teaching Scheme

Lectures: 4 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 4

Prerequisites : Database Management Systems

Course Objectives

To facilitate the learner to

1. Understand the transaction management and recovery concepts
2. Learn the various algorithms for query processing and optimization
3. Understand different techniques used in data mining and warehousing
4. Learn various types of advanced databases such as temporal, spatial and multimedia
5. Learn various security constraints and recent trends in databases

Course Outcomes

After completion of the course, students will be able to

1. Apply transaction management and recovery concepts to a given scenario
2. Make use of various algorithms for query processing and optimization
3. Analyze different techniques used in data mining and warehousing
4. Understand various types of advanced databases
5. Apply various security constraints and recent trends in real-life application

UNIT I: Transaction Management

Transaction, Transaction States, Concurrent Executions, Serializability, Recoverability
Concurrency Control: Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols

Recovery System: Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, ARIES (Algorithm for Recovery and Isolation Exploiting Semantics)

UNIT II : Query Execution and Optimization

Architecture of Query Execution Engines, Disk Access, Measures of Query Cost, Introduction to Physical-Query-Plan Operators, One-Pass Algorithms for Database Operations, Nested-Loop Joins, Two-Pass Algorithms Based on Sorting, Two-Pass Algorithms Based on Hashing, IndexBased Algorithms, Algorithms Using More Than Two Passes.

Query Optimization, SQL Query Writing vs. SQL Query processing, Reducing Complexity, Writing Efficient Queries, Ranking Results, Row Numbering, Windowing, Beating the Database Engine

UNIT III: Data Mining and Data Warehousing

Classification, Clustering, Association rule mining, Multimedia data mining, Web Mining, Data Warehouse Architecture, Schema Design (star vs snowflake), Schema Evolution, Incremental and Batch updates, Extract-Transform-Load (ETL), Data Cube and Online Analytical Processing (OLAP), ROLAP and MOLAP, Tools : Informatica and Cognos

Unit IV: Object Oriented, Temporal and Spatial Databases

Object Identity, Object structure, Type Constructors, Encapsulation of Operations, Methods, Persistence, Type and Class Hierarchies, Inheritance, Complex Objects, Object-oriented DBMS, Languages and Design: ODMG Model, Object Definition Languages (ODL), Object Query Languages (OQL)

Time Ontology, Structure, and Granularity, Temporal Data Models, Temporal Relational algebras.

Introduction to Spatial Database, Types of Spatial Data, Geographical Information Systems (GIS), Conceptual Data Models for Spatial Databases, Logical data models for spatial databases: raster and vector model, Physical data models for spatial databases, Clustering methods

UNIT V: Multimedia Databases

Fundamentals of Multimedia Database System, Data Access, Multimedia Information Modelling and Querying, Multimedia Database, Multimedia Communication, Multimedia Storage and Retrieval, Multimedia Programming

UNIT VI: Data Administration, Security and recent trends

Security issues faced by enterprises, Security architecture, Operating system security principles, Administration of users, Profiles, password policies, privileges and roles, Database application security models, Database auditing models, Database integrity Auditing, Application data auditing, Practices of database auditing

Database-as-a-Service (DBaaS), Hybrid and Multi-cloud Database Architectures, Dynamo – a structured storage system, Hadoop Distributed File System, MapReduce framework, HIVE

Textbooks:

1. Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom, “Database System: The Complete Book”, Pearson, 2nd edition (2008), ISBN-10: 0131873253, ISBN-13: 978-0131873254
2. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, McGraw Hill Education, 3rd edition (2014), ISBN-10: 9339213114, ISBN-13: 978-9339213114
3. Guojun Lu, “Multimedia Database Management Systems”, Artech House.
4. Shashi shekhar, Sanjay chawla, “Spatial database”, Pearson education

Reference Books:

1. Jiawei Han, Micheline Kamber, and Jian Pei, “Data Mining Concepts and Techniques”, 3rd Edition, Morgan Kaufmann, ISBN: 978-93-80931-91-3
2. Korth, Silberschatz and Sudarshan, “Database System Concepts”, Tata McGraw Hill, 6th edition (2013), ISBN-10: 9332901384, ISBN-13: 978-9332901384
3. C. Mohan, “ARIES: A Transaction Recovery Method Supporting Fine-Granularity Locking and Partial Rollbacks Using Write-Ahead Logging”, ACM Transactions on Database Systems, Vol. 17, No. 1, March, 1992, pp. 94–162.
4. P. Selinger, M. Astrahan, D. Chamberlin, Raymond Lorie and T. Price, “Access Path Selection in a Relational Database Management System”, Proceedings of ACM SIGMOD, pp 23-34, 1979
5. Jeffrey Dean and Sanjay Ghemawat, “MapReduce: Simplified Data Processing on Large Clusters”, Communications of the ACM, vol. 51, no. 1, pp. 107-113, 2008
6. W. Vogels, “Eventually Consistent”, ACM Queue, vol. 6, no. 6, December 2008
8. Goetz Graefe, “Query Evaluation Techniques for Large Databases”, ACM Computing Surveys, Vol. 25, No. 2, June 1993.

24PCMCE103L ADVANCED DATABASES LABORATORY

Teaching Scheme

Practical: 2 Hours / Week

Examination Scheme

In Semester: 25 Marks

Credit : 1

Course Objectives

To facilitate learners to

1. Study the fundamentals of transaction management and recovery system
2. Implement different types of joins and hashing techniques
3. Understand query processing and optimization techniques
4. Explore various OLAP operations on the given data

Course Outcomes

After completion of the course, students will be able to

1. Implement the concepts of transaction management and recovery
2. Analyse the various types of joins and hashing techniques
3. Analyse different queries on multidimensional data model
4. Implement various OLAP operations on the given data

Preamble:

The lab is designed in such a way that the student can apply the concepts of transaction management and recovery system. In this lab students can explore the different types of join and hashing techniques while writing complex queries. Students will make use of query optimization techniques to analyze the performance of query evaluation. They will explore various OLAP operations.

List of suggested Laboratory Assignments

1. Write a program to check if a given schedule is serial, serializable, conflict serializable.
2. Simulate recovery using undo, redo and undo-redo logging.
3. Simulate ARIES recovery system.
4. Implement hash-based natural join, sort-based natural-join.
5. Study MySQL/Postgres query optimizer code.
6. Comparing the query evaluation performance before and after applying query optimization techniques.
7. Perform a multidimensional data model using SQL queries. e.g., snowflake, star and fact constellation schema.

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8. Perform various OLAP operations such as: slice, dice, roll up, drill up etc.
9. Demonstration of typical database product installation.
10. Implementation of MapReduce algorithms for Matrix multiplication and GroupBy operation.

24PEMCE101A CYBER SECURITY

Teaching Scheme

Lecture: 3 Hours / Week

Tutorial: 1 Hours / Week

Examination Scheme

In semester: 50 marks

End semester: 50 marks

Credits: 4

Course Objectives

To facilitate the learner to

1. Provide a comprehensive understanding of the fundamental concepts of cyber security.
2. Analyze the various internet security domains.
3. Introduce students to various techniques and tools used in cyber security.
4. Apply the laws and compliance of cyber security.

Course Outcomes

By taking this course, the learner will be able to

1. Relate to the basics of cyber security.
2. Apply various techniques and tools used in cyber security.
3. Apply the cyber security principles for designing the cyber security plan.
4. Analyze internet security domains.

Unit I: Introduction to CyberSpace

History of Internet, Cyber Crime, Information Security, Computer Ethics and Security Policies, Guidelines to choose web browsers, Securing web browser, Antivirus, Email security, Guidelines for setting up a Secure password, Two-steps authentication, Password Manager, Wi-Fi Security

Unit II: Social media and Smartphone security

Part of Social media and Smartphone security, Guidelines for social media security, best practices for safer Social Networking, Basic Security for Windows, User Account Password, Smartphone Security, Android Security, IOS Security

Unit III: IT Security Act

Counter Cyber Security Initiatives in India, Cyber Security Incident Handling, Cyber Security Assurance IT Act, Hackers-Attack-Countermeasures, Web Application Security, Digital Infrastructure Security, Defensive Programming

Unit IV: Online Banking and POS Security

Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI Security, Security of Micro ATMs, e-wallet Security Guidelines, Security Guidelines for Point of Sales (POS)

Unit V: Cyber Security Threat Landscape and Techniques

Social Engineering, Types of Social Engineering, Working of a Cyber Criminal, Prevention of Cyber Crime, Cyber Security Threat Landscape, Emerging Cyber Security Threats, Cyber Security Techniques, Firewall

Text books:

1. Ariel Evans, Enterprise Cybersecurity in Digital Business (2022)
2. James Graham, Richard Howard, Ryan Olson, "Cyber Security Essentials, CRC Press, Taylor & Francis Group, 2011.
3. Kevin D. Mitnick , The Art of Deception: Controlling the Human Element of Security,(2003)

Reference Books:

1. J. M. Stewart, Network Security, Firewalls, and VPNs , 3rd edition, 2014.
2. William Stallings, Computer and Network Security, 3rd edition, 2017.
3. William Stallings and Lawrie Brown, Computer Security, Principles and Practice, 4th edition, 2018.
4. Raef Meeuwisse, Cybersecurity: A Beginner's Guide, 2nd edition, published in 2019.

Suggestive List of Tutorials:

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1. Study and compare various browsers based on their characteristics, with specific focus on security aspect.
2. Setup and configure a firewall.
3. Case study – Collect the cyber incidences and present them – root cause, mitigation techniques.
4. Read and discuss the research paper in the area of cyber security around the topics such as threats, attacks, and vulnerabilities.
5. Study and present various security laws and policies in the context of India and other countries.
6. Website study for security.
7. Preparing and understanding security audit and compliance reports.
8. Find out some popular password managers and evaluate them based on their characteristics.
9. Explore the Password cracker tools.
10. Study various web-based attacks such as Cross site scripting and SQL injection.
11. Understand vulnerability scanning/assessment by exploring tools like nmap.
12. Understand network security analysis with the help of tools like Wireshark.
13. Analyse various active attacks and passive attacks.

24PEMCE101B HUMAN MACHINE INTERACTION

Teaching Scheme

Lectures: 3 Hours / Week

Tutorial: 1 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 4

Course Objectives

To facilitate the learner to

1. Learn the fundamentals of Human Machine Interaction (HMI) and its design process
2. Learn various interaction design models and technologies.
3. Understand the concept of Digital Twin.
4. Understand the different applications of HMI in various domains.

Course Outcomes

By taking this course, the learner will be able to

1. Apply the concepts of HMI to enhance the user experience and user design requirement.
2. Utilise the fundamental aspects for designing and interaction technologies.
3. Make use of the concepts of Digital Twin to design models.
4. Model the user interface systems in various domains using HMI.

UNIT I: Fundamentals of Human Machine Interaction

Importance of physical Interface, user Interface, HMI fundamentals, User psychology, Reasoning and problem solving, Cognitive framework, User persona

UNIT II: Requirements and Design

Identifying the requirements, Data capturing methods and analysis, HMI design principles, User-centered design, Design process, Selection of Interaction Styles, Interactive Design, Paradigms of interaction, Ergonomics

UNIT III: Models and Interaction Technologies

HMI Models, Socio-Organizational issues, Challenges, Interaction for Devices, Smart Devices, Wearable and Implanted Devices, Smart sensors, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices

UNIT IV: Machine Interfaces

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Types, Multimodal interface, Human-machine interfaces related to pervasive computing, Biometrics, Audio interfaces, Eye-free interfaces, Gamification of interfaces

UNIT V: Digital Twin

Digital Twin concept, Characteristics, Types, Modelling levels, Augmented reality models, Simulation models, Digital Thread and Digital Shadow, Value, Virtual replicas of objects, systems and processes

UNIT VI: Recent Advances and Applications

Cyber Security, Mobility, Social Computing, Brain Machine Interface, Medical applications, Autonomous Vehicles, Accessibility for differently-abled people, Generative AI, Computer-Supported Cooperative Work (CSCW), Usable security, Cognitive computing

Text books:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, 'Designing the User Interface: Strategies for Effective Human-Computer Interaction', Pearson Education Limited (India),(2010).
2. Alan Dix, 'Human Computer Interaction', Pearson Education Limited (Third edition), (2004).
3. Rogers, Sharp, Preece, 'Interaction Design', Wiley Publications (India), (Third edition), (2014).
4. Wolfgang Kuhn, "Handbook Of Digital Enterprise Systems: Digital Twins, Simulation And Ai", 1st Edition, Kindle Edition, World Scientific; ISBN : 9811200734

Reference Books:

1. Wilbert O. Galitz, 'The Essential Guide to User Interface Design', Wiley Publications (Second edition), (2003).
2. Don Norman, 'The Design of Everyday Things', Basic Books, A member of the Perseus Books Group, (2013).
3. Stefen Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", Second Edition, Wiley, 2010.
4. Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs, "Building Industrial Digital Twins: Design, develop, and deploy digital twin solutions for real-world industries using Azure Digital Twins", First edition, Kindle Edition

Web Reference:

1. <https://www.coursera.org/courses?query=human%20computer%20interaction>
2. https://onlinecourses.nptel.ac.in/noc22_cs125/preview
3. <https://nptel.ac.in/courses/106103115>

4. <https://www.unrealengine.com/en-US>
5. <https://www.jetbrains.com/pycharm/>

Suggestive List of Tutorials:

1. Design human-machine interfaces that are intuitive and minimize user frustration while ensuring task efficiency.
2. Enhance robots' ability by different methods to recognize and respond to human emotions effectively and their implications on user trust.
3. List Empirical techniques can be used to evaluate the usability of existing human-machine interfaces and show the influence of redesign efforts based on these evaluations.
4. List the different ways in which you ensure that a wide range of users, including those with disabilities, are adequately considered and accommodated in the design of human-machine interfaces.
5. List challenges and benefits do collaborative robots (cobots) present in workplace environments. Methods to optimize the same for better human-robot teamwork.

24PEMCE101C BUSINESS INTELLIGENCE AND ANALYTICS

Teaching Scheme

Lectures: 3 Hours / Week

Tutorial: 1 Hour / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 4

Prerequisites : Foundational Knowledge in Mathematics and Statistics, Programming Skills in Python / R

Course Objectives

To facilitate the learner to

1. Understand the concepts of business intelligence and BI life cycle phases
2. Learn the concepts of descriptive analytics and storage
3. Understand predictive and prescriptive data analytics concepts
4. Learn decision support systems and decision-making techniques for expert systems
5. Learn different data visualization tools and recent trends in business intelligence

Course Outcomes

After completion of the course, students will be able to

1. Apply the knowledge of BI components and life cycle phases to different applications
2. Analyze the data and generate appropriate representations using BI and data visualization tools / libraries
3. Analyze the data storage and solution mechanism used in BI framework
4. Make use of Decision support systems to build the expert systems

UNIT I: Introduction

Business Intelligence (BI), Evolution of BI: Traditional BI and Modern BI, Framework for BI - BI Architecture, Drivers. BI life cycle, Enterprise Performance Life Cycle (EPLC), Challenges and Benefits of BI, Comparison of BI and Business Analytics (BA), Overview on Business Analytics - Descriptive, Predictive and Prescriptive Analytics. BI case study on Walmart / IKEA

UNIT II : Descriptive Analytics, Storage and Tools

Role of Data warehouse and data mining in BI, Real - Time Data warehouse, Business Reporting, Visual Analytics, and Business Performance Management, Key Performance Indicators, Data storage Solutions and its need, Example Solutions - AWS Amazon S3, IBM Enterprise Data Storage, BI Tools / libraries - Google Analytics 4, OpenRefine, Tableau, Microsoft Power BI

UNIT III: Predictive and Prescriptive Analytics

Predictive: Decision Tree, Ensemble Models, The Wisdom of Crowds, Bias Variance Tradeoff, Bagging, Boosting, Random Forests, Stochastic Gradient Boosting, Regression Models. Application Domains - Business forecasting, Text Analytics, Web Analytics, and Social Analytics

Prescriptive: Building Linear Optimization Models, Implementing Linear Optimization Models, Solving Linear optimization models, Case Study - Supply Chain Optimization

UNIT IV: Decision Support System

Decision Support Systems, Components, Phases of the Decision Making Process, DSS Capabilities, Certainty, Uncertainty, and Risk, Types of DSS, Comparison of DSS with BI and Decision Intelligence, Automated Decision Systems, Expert system, Knowledge Management and Collaborative Systems, Ethics in Decision Making and Support, DSS Case Studies

UNIT V: Data Visualization and trends

Interactive Visualizations, Storytelling with Dashboards, Scoreboards, Data Visualization tools and libraries - Grafana, Plotly, Seaborn, Bokeh, Ggplot.

Recent trends - Analytics Ecosystem, Cloud computing and BI, GenAI for Business Analytics

Textbooks:

1. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10th Edition, Pearson Global Edition, 2013
2. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples", MIT Press 2020, 2nd Edition

Reference Books:

1. Carlo Vercellis, "Business Intelligence – Data Mining and Optimization for Decision Making", Wiley Publications
2. Seema Acharya and Subhashini Chellappan, "Big Data & Analytics", Wiley Publications
3. David Dietrich, Barry Hiller, "Data Science & Big Data Analytics", EMC education services, Wiley publications, 2012
4. Swain Schepus, "Business Intelligence for Dummies", Wiley Publication, 2008, ISBN 978-0-470-12723-0

Web references:

1. <https://blog.fabrichq.ai/this-is-how-walmart-amazon-and-ikea-lead-with-business-intelligence-short-case-studies-418d10ad348d>
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Suggestive List of Tutorials:

1. Select and implement appropriate data preprocessing techniques for the given dataset using BI tool.
2. Analyze different data analytical methods using BI tools.
3. Demonstrate various data visualizations, histograms and multiple variable summaries.
4. Analyze the result of any 3 individual models from Neural Network (NN), KNN, Logistic Regression (LR), Naive Bayes (NB), Decision Tree (DT). Report the confusion matrix and classification accuracy on the test data for each of them.
5. Perform the hyper-parameters tuning to get a good accuracy and report the experiments you have done.
6. Construct an ensemble classifier using unweighted majority vote over the 3 models you have trained.
7. Draw framework for expert System for any real-life application such as Hospitals and medical facilities.