

COURSE STRUCTURE (R23) AND DETAILED SYLLABUS (IV YEAR)

COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence and Machine Learning)

**For
B.Tech., Four Year Degree Course
(Applicable for the batches admitted from 2023-24)**



LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution

Approved by AICTE & Permanently Affiliated to JNTUGV, Vizianagaram

Accredited by NAAC with "A" Grade and NBA (CSE, ECE, EEE & ME)

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COURSE STRUCTURE AND DETAILED SYLLABUS
B.TECH- COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence & Machine Learning)

IV Year I Semester						
S.No	Course Code	Course Name	L	T	P	Credits
1.	R23CSM-PC4101	Computer Vision	3	0	0	3
2.	R23BSH-HM4101	Managerial Skills for Engineers	2	0	0	2
3.		Professional Elective-IV	3	0	0	3
	R23CSM-PE4101.1	1. Responsible AI				
	R23CSM-PE4101.2	2. Quantum Computing				
	R23CSM-PE4101.3	3. Solve Business Problems with AI				
	R23CSM-PE4101.4	4. Cryptography and Network Security				
4.		Professional Elective-V	3	0	0	3
	R23CSM-PE4102.1	1. Agile Methodologies				
	R23CSM-PE4102.2	2. Big Data Analytics				
	R23CSM-PE4102.3	3. High Performance Computing				
	R23CSM-PE4102.4	4. Augmented Reality and Virtual Reality				
		Open Elective- III	3	0	0	3
		Open Elective- IV	3	0	0	3
	R23CSM-SC4101	Prompt Engineering	0	1	2	2
	R23BSH-MC4101	Entrepreneurship & Incubation(E&I)	2	0	0	-
	R23CSM-SI4101	Evaluation of Industry Internship	-	-	-	2
Total			19	1	2	21
Honor Course-4/Minor Course-4						

IV Year II Semester						
S.No	Course Code	Course Name	L	T	P	Credits
1.	R23CSM-PR4201	Internship	-	-	8	4
2.	R23CSM-PR4201	Project	-	-	16	8
Total			-	-	24	12

Open Electives Courses

Offering Department: Electronics and Communications Engineering

S.No	Course Code	Course Name	L	T	P	Credits
1	R23ECE-OE0001	Basics of Communication Systems	3	0	0	3
2	R23ECE-OE0002	Micro Processors and Interfacing	3	0	0	3
3	R23ECE-OE0003	Digital System Design using Verilog	3	0	0	3
4	R23ECE-OE0004	Fundamentals of Digital Image Processing	3	0	0	3
5	R23ECE-OE0005	Introduction to Internet of Things	3	0	0	3
6	R23ECE-OE0006	Wireless Sensor Networks	3	0	0	3
7	R23ECE-OE0007	Satellite Communication	3	0	0	3
8	R23ECE-OE0008	Fundamentals of Embedded Systems	3	0	0	3

Offering Department: Electrical and Electronics Engineering

S.No	Course Code	Course Name	L	T	P	Credits
1	R23EEE-OE0001	Renewable Energy Sources	3	0	0	3
2	R23EEE-OE0002	Energy Conservation and Management	3	0	0	3
3	R23EEE-OE0003	Electrical Safety & Standards	3	0	0	3
4	R23EEE-OE0004	Utilization of Electrical Energy	3	0	0	3

Offering Department: Mechanical Engineering

S.No	Course Code	Course Name	L	T	P	Credits
1	R23MEC-OE0001	Operations Research	3	0	0	3
2	R23MEC-OE0002	3D Printing Technology	3	0	0	3
3	R23MEC-OE0003	Statistical quality control	3	0	0	3
4	R23MEC-OE0004	Hybrid Vehicle Technologies	3	0	0	3
5	R23MEC-OE0005	Industrial Robotics	3	0	0	3
6	R23MEC-OE0006	Nano Materials	3	0	0	3
7	R23MEC-OE0007	AI and ML In Manufacturing	3	0	0	3
8	R23MEC-OE0008	Automation in Manufacturing	3	0	0	3

Offering Department: Computer Science and Engineering & Allied Branches

S.No	Course Code	Course Name	L	T	P	Credits
1	R23CSE-OE0001	Python Programming	3	0	0	3
2	R23CSE-OE0002	Data Structures Using C	3	0	0	3
3	R23CSE-OE0003	Operating System Concepts	3	0	0	3
4	R23CSE-OE0004	Introduction to Java Programming	3	0	0	3
5	R23CSE-OE0005	Database Management Systems Concepts	3	0	0	3
6	R23CSE-OE0006	Unix & Shell Programming	3	0	0	3
7	R23CSE-OE0007	Software Engineering	3	0	0	3
8	R23CSE-OE0008	Introduction to Data mining	3	0	0	3
9	R23CSE-OE0009	Fundamentals of Web Technologies	3	0	0	3
10	R23CSE-OE0010	Fundamentals of Computer Networks	3	0	0	3
11	R23CSE-OE0011	Basics of Cloud Computing	3	0	0	3
12	R23CSE-OE0012	Introduction to Machine Learning	3	0	0	3
13	R23CSE-OE0013	Essentials of Cyber Security	3	0	0	3
14	R23CSE-OE0014	Introduction to React JS	3	0	0	3
15	R23CSE-OE0015	Deep Learning	3	0	0	3
16	R23CSE-OE0016	DevOps	3	0	0	3
17	R23CSE-OE0017	Mobile Computing	3	0	0	3
18	R23CSE-OE0018	Java Full Stack Development	3	0	0	3
19	R23CSE-OE0019	Human Computer Interface	3	0	0	3
20	R23CSE-OE0020	Cryptography and Network Security	3	0	0	3
21	R23CSE-OE0021	Quantum Computing	3	0	0	3
22	R23CSE-OE0022	Big data Analytics	3	0	0	3
23	R23CSE-OE0023	Block Chain Technology	3	0	0	3
24	R23CSE-OE0024	Multimedia Application Development	3	0	0	3

25	R23CSE-OE0025	Mobile Adhoc Networks	3	0	0	3
26	R23CSS-OE0001	Operating Systems	3	0	0	3
27	R23CSS-OE0002	Redhat Linux	3	0	0	3
28	R23CSS-OE0003	Cloud Computing	3	0	0	3
29	R23CSS-OE0004	Distributed Operating System	3	0	0	3
30	R23CIT-OE0001	Basics of computer networks	3	0	0	3
31	R23CIT-OE0002	Cryptography and Network Security	3	0	0	3
32	R23CIT-OE0003	Mobile Computing	3	0	0	3
33	R23CIT-OE0004	Wireless sensor networks	3	0	0	3
34	R23CSM-OE0001	An Introduction to AI	3	0	0	3
35	R23CSM-OE0002	Introduction to Machine Learning using Python	3	0	0	3
36	R23CSM-OE0003	Foundation of Deep Learning for Engineering Applications	3	0	0	3
37	R23CSM-OE0004	Natural Language Processing – Frontiers Approach	3	0	0	3

Note: A student shall select open elective from the above list, excluding those from their respective discipline (i.e., only interdisciplinary courses).

Honors Courses

Note: The registered student shall acquire 18 credits through NPTEL/Offline Courses.

Track-I (Artificial Intelligence)

S.No	Year & Semester	Course Code	Subject title	L	T	P	C
1	II-II	R23CSM-HN2201	AI for Problem Solving.	3	0	0	3
2	III-I	R23CSM-HN3101	Social Network Analysis	3	0	0	3
3	III-II	R23CSM-HN3201	Deep Learning for Computer Vision	3	0	0	3
4	IV-I	R23CSM-HN4101	AI in X	3	0	0	3
5	II Year to IV Year	R23CSM-HNM001.1	Honors MOOCS-1	0	0	0	3
6	II Year to IV Year	R23CSM-HNM001.2	Honors MOOCS-2	0	0	0	3
Total							18

Track- II (Web Framework)

S.No	Year & Semester	Course Code	Subject title	L	T	P	C
1	II-II	R23CSM-HN2202	Angular JS Framework	3	0	0	3
2	III-I	R23CSM-HN3102	Design Patterns	3	0	0	3
3	III-II	R23CSM-HN3202	UX and UI Design Framework	3	0	0	3
4	IV-I	R23CSM-HN4102	Scalable Angular and Architecture Patterns	3	0	0	3
5	II Year to IV Year	R23CSM-HNM002.1	Honors MOOCS-1	0	0	0	3
6	II Year to IV Year	R23CSM-HNM002.2	Honors MOOCS-2	0	0	0	3
Total							18

Track III (Networks)

S.No	Year & Semester	Course Code	Subject title	L	T	P	C
1	II-II	R23CSM-HN2203	Introduction to Networks	3	0	0	3
2	III-I	R23CSM-HN3103	Switching, Routing, and Wireless Essentials	3	0	0	3
3	III-II	R23CSM-HN3203	Enterprise Networking, Security, and Automation	3	0	0	3
4	IV-I	R23CSM-HN4103	Wireless Sensor Networks	3	0	0	3
5	II Year to IV Year	R23CSM-HNMS03.1	Honors MOOCS-1	0	0	0	3
6	II Year to IV Year	R23CSM-HNMS03.2	Honors MOOCS-2	0	0	0	3
Total							18

Track IV (Security)

S.No	Year & Semester	Course Code	Subject title	L	T	P	C
1	II-II	R23CSM-HN2204	Cyber Security	3	0	0	3
2	III-I	R23CSM-HN3104	Secure Coding	3	0	0	3
3	III-II	R23CSM-HN3204	Vulnerability Assessment & Penetration Testing	3	0	0	3
4	IV-I	R23CSM-HN4104	Malware Analysis	3	0	0	3
5	II Year to IV Year	R23CSM-HNM003.1	Honors MOOCS-1	0	0	0	3
6	II Year to IV Year	R23CSM-HNM003.2	Honors MOOCS-2	0	0	0	3
Total							18

R23CSM-PC4101	COMPUTER VISION	L	T	P	C
		3	0	0	3

Course Educational Objective

- To introduce students to the fundamentals of image formation.
- To introduce students to the major ideas, methods, and techniques of computer vision and pattern recognition.
- To develop an appreciation for various issues in the design of computer vision and object recognition systems.
- To provide students with programming experience through the implementation of computer vision and object recognition applications.

Course Outcomes

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

- Understand image processing techniques required for computer vision.
- Describe image formation models.
- Understand feature extraction and motion estimation techniques.
- Apply segmentation algorithms for shape analysis.
- Implement image classification applications using object recognition methods.

UNIT-I: (10 Hours)

Introduction to Computer Vision, Relationship between Computer Vision, Image Processing and Artificial Intelligence, Basics of Digital Images and Pixels, Human Visual System, Applications of Computer Vision in Face Recognition, Medical Imaging, Autonomous Vehicles, Robotics and AR/VR, Introduction to Python and OpenCV Basics.

UNIT-II: (10 Hours)

Image Formation Process, Pinhole Camera Model, Basics of Light and Color, RGB and HSV Color Models, Orthographic and Perspective Projection, Camera Calibration Basics, Introduction to Stereo Vision, Depth Estimation Concepts, Basics of 3D Reconstruction from Images.

UNIT-III: (10 Hours)

Image Enhancement and Filtering, Edge Detection using Sobel and Canny Operators, Corner Detection. Introduction to Feature Extraction Techniques: SIFT, SURF and ORB. Texture Analysis Basics, Feature Matching, Optical Flow, Motion Detection and Motion Estimation, Introduction to Structure from Motion.

UNIT-IV: (10 Hours)

Image Segmentation: Thresholding, Edge-based and Region-based Segmentation, Watershed Segmentation, Morphological Operations, Contour Representation, Active Contours, Introduction to Fourier and Wavelet Descriptors, Basics of Semantic Segmentation.

UNIT-V: (08 Hours)

Image Classification, Object Detection using You Only Look Once, Introduction to U-Net and Mask R-CNN, Basics of Vision Transformers, Applications in Face Recognition and Autonomous Driving.

TEXT BOOKS:

1. D. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, Pearson, 2nd Edition, 2015.
2. E. Trucco and A. Verri, *Introductory Techniques for 3D Computer Vision*, Prentice Hall, 3rd Edition, 2016.

REFERENCEBOOKS:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Addison Wesley Longman, Inc., 2nd Edition, 1992.
2. \Richard Szeliski, *Computer Vision: Algorithms and Applications (CVAA)*, Springer, 2nd Edition, 2010.
3. Sonka, Hlavac, and Boyle, *Image Processing, Analysis, and Machine Vision*, Thomson, 4th Edition, 2011.
4. E. R. Davies, *Computer and Machine Vision*, Academic Press, 4th Edition, 2012.
5. Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012.
6. Mark Nixon and Alberto S. Aguado, *Feature Extraction and Image Processing for Computer Vision*, Academic Press, 3rd Edition, 2012.

R23BSH-HM4101	MANAGERIAL SKILLS FOR ENGINEERS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- Provide fundamental knowledge on Management, Administration, Organizational methodologies
- Equip with the knowledge of long term business value for the organization
- Explain basics of human resource management & marketing required for organization
- Identify issues and challenges In project selection criteria.
- Analyses the PERT/CPM techniques for better Project Management.

COURSE OUTCOMES:

- Apply principles of management & designs of organization in practical world.
- Realize concepts of business value development for organizational growth.
- Provided awareness of human resource management and marketing concepts.
- Determine effective project selection based on organizational needs.
- Develop PERT/CPM Charts for projects of enterprise and estimate time & cost of project.

Unit I:

INTRODUCTION TO MANAGEMENT: Management-Concept-Nature-Functions Evolution of Management Thought - Motivational theories- Decision making Process- Leadership styles-Principles of Organization- Features and types organizational structures.

Applications: Divide the class into two teams' old employees and new joiners and motivate the work environment with respect to excellent management and the supportive.

UNIT II:

BUSINESS ENVIRONMENT: Building business value through modernization; principles of value engineering; approaches and methods of business value development; SWOT analysis of business; and strategies for enhancing business value. **Applications:** Analyse a company's potentialities and business value

UNIT III:

HUMAN RESOURCES MANAGEMENT & MARKETING MANAGEMENT Human Resource Management: Definition and meaning; managerial and operative functions; job evaluation; and merit rating.

Marketing Management: Concept, meaning, nature, and functions of marketing; marketing mix; channels of distribution; and marketing strategies based on the product life cycle.

Applications: Apply human resource and marketing aspects in professional decision-making.

UNIT IV:

PROJECTS ELECTION: Project Selection and criteria of choice –Nature of project selection models-Types of project selection models-analysis under uncertainty

Applications: Estimation of perspectives of project and choose the correct one among available choices.

UNIT V:

PROJECT MANAGEMENT: Project planning and control- Project life cycle- Development of Network- Difference between Program Evaluation Review Technique and Critical Path Method- Identifying critical path.

Application: Analyze various parameter soft he project like critical path, crashing `etc. For best cost decisions according to operations of the project.

TEXT BOOKS:

1. P. Subba Rao, *Organizational Behaviour*, Himalaya Publishing House, Mumbai, 2nd Edition, 2023.
2. Aryasri, *Management Science*, Tata McGraw-Hill, 2009.
3. M. Prasad, *Principles and Practice of Management*, 10th Edition, 2022.

Reference Books:

1. Fred Luthans, *Organizational Behaviour*, Tata McGraw-Hill (TMH), New Delhi.
2. Stephen P. Robbins, *Fundamentals of Management*, Pearson Education, India.
3. Philip Kotler and Kevin Lane Keller, *Marketing Management*, 12th Edition, PHI, 2007.
4. Harold Koontz and Heinz Weihrich, *Essentials of Management*, 6th Edition, Tata McGraw-Hill (TMH), 2007.
5. Kanishka Bedi, *Production and Operations Management*, Oxford University Press, 2007.

R23CSM-PE4101.1	Responsible AI	L	T	P	C
		3	0	0	3

Course Objectives:

- The objective of the course is to know about the sponsibility of artificial intelligence (AI) to make AI more useful for society and humanity.
- The course will also teach principles and practices to perform responsibleAI.

Course Outcomes:

Students able to

- State the aspects of responsible AI such as fairness, accountability, bias, privacy etc.
- Assessthe fairness and ethics of AI modules.
- Enforce fairnes sin models and removebias in data.
- Preserve the privacy of individuals while learning from them.
- Develop responsible AI modules for given practical problems and estimate the trade off with accuracy.

Unit-I:(08 Hours)

Artificial Intelligence Fundamentals, Introduction to responsible AI. Need for ethicsin AI.AI for Society and Humanity

Unit-II:(10 hours)

Fairness and Bias - Sources of Biases- Exploratory data analysis, limitation of a dataset- Preprocessing, inprocessing and post processing to removebias- Group fairness and Individual fairness- Counterfactual fairness

Unit-III:(10hours)

Interpretability and explainability- Interpretabiliy through simplification and visualization- Intrinsic interpretable methods- Post Hoc interpretability- Explainability through causality- Model agnostic Interpretation

Unit-IV:(10 hours)

Ethics and Accountability-Auditing AI models, fairness assessment-Principles for ethical practices. **Privacy preservation** - Attack models- Privacy-preserving Learning- Differential privacy- Federated learning.

Unit-V:(10 hours)

Casestudies-Recommendationsystems-Medicaldiagnosis-Hiring/Education-Computer Vision-Natural Language Processing

Text Books:

1. Responsible AI, Csir Qinghua Lu & Liming Zhu, Pearson Education (US)
2. Responsible AI Implementing ethical and Unbiased Algorithms, Saray Agarwal & Shashin Mishra, Springer 2021, first edition.

Reference Books:

1. Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way, Virginia Dignum, Springer Nature, first edition, 2019.
2. Interpretable Machine Learning, Christoph Molnar, Lulu Press, first edition, 2020.

Weblinks

- (i) <https://www.coursera.org/learn/introduction-to-responsible-ai>
- (ii) https://onlinecourses.nptel.ac.in/noc24_cs132/preview

R23CSM-PE4101.2	Quantum Computing	L	T	P	C
		3	0	0	3

Course Educational Objectives:

- Cultivate the fundamental understanding of electromagnetism.
- Deliver the knowledge about Fourier and nonlinear optics.
- Develop elementary problem-solving capability of quantum optics

Course Outcomes:

1. Analyze the behavior of basic quantum algorithms
2. Implement simple quantum algorithms and information channels in the quantum circuit model
3. Simulate a simple quantum error-correcting code
4. Prove basic facts about quantum information channels
5. Know about Quantum Computing Models

UNIT-I:

Introduction: Quantum Measurements Density Matrices, Positive-Operator Valued Measure, Fragility of quantum information: Decoherence, Quantum Superposition and Entanglement, Quantum Gates and Circuits.

UNIT-II:

Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits.

UNIT-III:

Algorithms: Deutsch and Deutsch–Jozsa algorithms, Grover's Search Algorithm, Quantum Fourier Transform, Shor's Factorization Algorithm.

UNIT-IV:

Performance, Security and Scalability: Quantum Error Correction: Fault tolerance; Implementing Quantum Computing: issues of fidelity; Scalability in quantum computing.

UNIT-V:

Quantum Computing Models: NMR Quantum Computing, Spintronics and QED MODEL, Linear Optical MODEL, Nonlinear Optical Approaches; Limits of all the discussed approaches, Future of Quantum computing.

Textbook(s):

1. Eric R. Johnston, Nic Harrigan, Mercedes and Gimeno-Segovia —Programming Quantum Computers: Essential Algorithms And Code Samples, 1st edition, 2019, SHROFF/O'Reilly.
2. Dr. Christine Corbett Moran, Mastering Quantum Computing with IBM QX: Explore the world of quantum computing using the Quantum Composer and Qiskit, Kindle Edition Packt V.K Sahni, Quantum Computing (with CD), 1st edition, 2019, TATA McGraw-Hill.

Reference(s):

1. Introduction to Quantum Computing: Quantum Algorithms and Qiskit
<https://nptel.ac.in/courses/106106232>
2. IBM Experience
<https://www.coursera.org/programs/gitam-open-learning-7qv77/learn/introduction-to-quantum-information?authProvider=gitam>
3. Microsoft Quantum Development Kit <https://www.microsoft.com/en-us/quantum/development-kit>
4. Forest SDK (PyQuil) <https://pyquil.readthedocs.io/en/stable/>

R23CSM-PE4101.3	SOLVE BUSINESS PROBLEMS WITH AI	L	T	P	C
		3	0	0	3

Course Educational Objectives:

- Relate the practical uses of AI in day-to-day businesses.
- Understand the cautions need to be observed while working with AI.
- Apply AI to boost business productivity.

Course Outcomes:

The students will be able to

1. Analyze practical uses of AI in day-to-day businesses.
2. Understand the cautions need to be observed while working with AI
3. Apply AI to boost business productivity.
4. Use various cloud platforms.
5. Understand data privacy.

UNIT-I:

Introduction

AI for businesses, optimizing business processes, Minimizing costs, AI solutions: Deep Q-learning, Action selection policies

UNIT-II:

Apply AI and ML to business problems

Solve Business Problems with AI and Machine Learning Course Introduction, Identify Data-Driven Emerging Technologies Module Introduction, The Data Hierarchy, Big Data, Data Mining, Applied AI and ML in Business, Appropriate Business Problems, Challenges of AI/ML, Machine Learning Model, Machine Learning Workflow, Concept Drift and Transfer Learning, Problem Formulation, Differences Between Traditional Programming and Machine Learning, Differences Between Supervised and Unsupervised Learning, Randomness and Uncertainty, Machine Learning Outcomes

UNIT-III:

How to choose the right tool?

Importance of choosing the right tools, Hardware requirements: Parallel processors, GPUs, GPU platforms; Cloud Platforms: cloud hosting services: Amazon Web Services, Microsoft Azure, Google TPUs; Open-source AI tools, Proprietary AI tools

UNIT-IV:

Data privacy and Ethical Practices

Introduction, Data Protection, Data Privacy Laws, Privacy by Design, Data Privacy Principles at Odds with Machine Learning, Compliance with Data Privacy Laws and Standards, Data Sharing and Privacy, The Big Data Challenge, Preconceived Notions, The Black Box Challenge, Bias, Prejudice, and Discrimination, Ethics in NLP, Use of Data for Unintended Purposes, Intellectual Property, Humanitarian Principles, Asilomar AI Principles

UNIT-V:

Case Studies

Real world case study: Inventory Management with Computer Vision, Fraud Detection with Machine Learning, Personalized Content Recommendations, Predictive Maintenance in Manufacturing, Demand Forecasting and Trend Analysis

Textbook(s):

1. Classical Approach to Artificial Intelligence, M.C. Trivedi, Khanna Book Publishing, 2023
2. Artificial Intelligence in Practice by Bernard Marr, Matt Ward, O'Reilly, 2019.

Reference(s):

1. Artificial Intelligence and Machine Learning for Business: A No-Nonsense Guide to Data-Driven Technologies by Steven Finlay, Relativistic publishers, 2017.
2. <https://www.coursera.org/learn/solve-problems-ai-machine-learning>

R23CSM-PE4101.4	CRYPTOGRAPHY & NETWORK SECURITY	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce classical cryptographic systems and symmetric block ciphers such as DES, AES, and other contemporary symmetric ciphers.
- To provide an understanding of public-key cryptography, including RSA and discrete logarithm-based cryptosystems.
- To familiarize students with algorithms for factoring and discrete logarithms, cryptographic protocols, hash functions, authentication mechanisms, key management, key exchange techniques, and digital signature schemes.
- To provide an overview of e-mail security and web security mechanisms.
- To introduce concepts of viruses, firewalls, and system security for protecting information systems and networks.

Course Outcomes:

1. Understand the basics of cryptography, including its goals, services, and security mechanisms.
2. Analyze symmetric encryption algorithms.
3. Analyze asymmetric cryptographic algorithms.
4. Understand digital signature schemes.
5. Understand e-mail security and system security.

UNIT-I:

Basic Principles of Cryptography: Security goals, cryptographic attacks, security services and mechanisms, and the mathematical foundations of cryptography.

UNIT-II:

Symmetric Encryption Mathematics of Symmetric Key Cryptography, Introduction to Modern Symmetric Key Ciphers, Data Encryption Standard, Advanced Encryption Standard.

UNIT-III:

Asymmetric Encryption: Mathematics of Asymmetric Key Cryptography, Asymmetric Key Cryptography

UNIT-IV:

Data Integrity, Digital Signature Schemes & Key Management Message Integrity and Message Authentication, Cryptographic Hash Functions, Digital Signature, Key Management.

UNIT-V:

Network Security: Security at application layer: PGP and S/MIME, Security at the Transport Layer: SSL and TLS, IPsec, System Security.

Text Books:

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay, *Cryptography and Network Security*, 3rd Edition, McGraw-Hill, 11 February 2007.
2. William Stallings, *Cryptography and Network Security*, 6th Edition, Pearson, April 2014.

Reference Books:

1. Keith M. Martin, *Everyday Cryptography*, Oxford University Press, 2nd Edition, August 2017.
2. Bernard Menezes, *Network Security and Cryptography*, Cengage Learning, 2010.

R23CSM-PE4102.1	AGILE METHODOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce students to various software development methodologies,
- To familiarize students with popular Agile frameworks
- To enable students to apply Agile planning and estimation techniques.
- To train students in modern Agile development practices
- To develop students' ability to analyze Agile project performance using metrics

Course Outcomes

At the end of the course, the student should be able to:

1. Understand various software development methodologies.
2. Explain and compare different Agile frameworks such as Scrum, XP, and Kanban, and identify appropriate practices for different software project scenarios.
3. Apply Agile planning techniques such as release planning, iteration planning, and user story mapping.
4. •Demonstrate Agile development practices including Test-Driven Development (TDD), Behavior-Driven Development (BDD), Continuous Integration/Continuous Deployment (CI/CD), refactoring, and pair programming.
5. Analyze Agile project management metrics and team dynamics.

UNIT-I:

Introduction to Agile Development- Overview of Software Development Methodologies, Traditional vs Agile: Waterfall vs Iterative vs Agile, Agile Manifesto and Principles, Benefits and Challenges of Agile, Agile vs Lean vs DevOps

UNIT-II:

Agile Frameworks and Practices- Scrum: Roles as Scrum Master, Product Owner, Dev Team , Artifacts, Ceremonies, Extreme Programming (XP): Practices and Values, Kanban: Workflow Visualization and WIP Limits, Agile Modelling and Crystal Methods, Choosing the Right Framework

UNIT-III

Agile Project Planning and Estimation- Release Planning, Iteration Planning, User Stories and Story Mapping, Product Backlog and Sprint Backlog, Estimation Techniques: Planning Poker, T-Shirt Sizing, Velocity, Burn-down and Burn-up Charts

UNIT-IV

Agile Design, Development and Testing- Test-Driven Development (TDD), Behaviour Driven Development (BDD), Continuous Integration and Delivery (CI/CD), Refactoring and Pair Programming, Acceptance Testing and Agile Test Automation

UNIT-V

Agile Project Management and Scaling-Agile Metrics and KPIs, Agile Team Dynamics and Roles, Scaling Agile: Safe, Less, Spotify Model, Agile in Distributed Teams, Agile Tools: JIRA, Trello, Azure DevOps.

TEXT BOOKS :

1. Robert C. Martin and Micah Martin, "Agile Software Development: Principles, Patterns, and Practices", Pearson Education, 1st edition, 2002.
2. Andrew Stellman, Jill Alison Hart, Learning Agile, O'Reilly, 1st edition, 2015.

REFERENCE BOOKS:

3. "Essential Scrum: A Practical Guide to the Most Popular Agile Process"
Kenneth S. Rubin
4. "User Stories Applied: For Agile Software Development"
Mike Cohn
5. "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation" Jez Humble & David Farley
6. "Large-Scale Scrum: More with Less" – Bas Vodde & Craig Larman

R23CSM-PE4102.2	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the concepts, characteristics, challenges, and applications of Big Data in various domains.
- To analyze large-scale data using stream processing techniques and real-time analytics concepts.
- To comprehend the architecture and working principles of Hadoop, HDFS, MapReduce, and YARN for Big Data processing.
- To explore Big Data processing frameworks such as Pig, Hive, and HBase for data storage, querying, and analysis.
- To apply predictive analytics and data visualization techniques for extracting meaningful insights and supporting data-driven decision making.

Course Outcomes:

- Explain the characteristics, challenges, and applications of Big Data in domains such as social media, transportation, finance, and healthcare.
- Analyze data streams and real-time analytics techniques for processing continuous data.
- Illustrate the architecture and working of Hadoop, HDFS, MapReduce, and YARN for Big Data processing.
- Apply Pig, Hive, and HBase concepts for storing, querying, and processing Big Data.
- Analyze predictive analytics and visualization techniques for extracting insights from large datasets.

UNIT I: (10 Hours)

Introduction to Big Data: Evolution of data management, characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Big Data platform, challenges of conventional systems, intelligent data analysis, nature of data, analytic processes and tools, analysis versus reporting, applications of Big Data in social media, healthcare, transportation and finance, role of Big Data in AI/ML and IoT, introduction to Data Lakes and Data Warehouses.

UNIT II: (10 Hours)

Mining Data Streams: Introduction to stream concepts, stream data model and architecture, stream computing, sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting ones in a window, decaying window.

Real-Time Analytics: Real-Time Analytics Platform (RTAP), applications of stream processing, case studies on sentiment analysis, stock market prediction and fraud detection.

UNIT III: (10 Hours)

Introduction to Hadoop: History of Hadoop, Hadoop Distributed File System (HDFS), Hadoop ecosystem and components, scaling out, Hadoop streaming.

HDFS Architecture: Design of HDFS, Java interfaces to HDFS basics, data storage and replication.

MapReduce Framework: Developing a MapReduce application, how MapReduce works, anatomy of a MapReduce job run, job scheduling, shuffle and sort, task execution, failures, MapReduce types and formats, MapReduce features, Hadoop environment, introduction to YARN.

UNIT IV: (10 Hours)

Pig: Introduction to Pig, Pig architecture, data model, Pig Latin, data processing operators.

Hive: Hive architecture, Hive services, HiveQL, data definition language, data manipulation language, querying data in Hive.

HBase and ZooKeeper: Fundamentals of HBase, HBase architecture, data model, role of ZooKeeper in distributed coordination.

UNIT V: (08 Hours)

Predictive Analytics: Introduction, regression analysis, simple linear regression, multiple linear regression, interpretation of regression coefficients.

Visualization: Principles of data visualization, visual data analysis techniques, interaction techniques, dashboards and reporting, systems and applications of visualization in Big Data analytics.

Applications: Predictive analytics in business, healthcare, finance and social media.

Text Books

1. Tom White, *Hadoop: The Definitive Guide*, 4th Edition, O'Reilly Media, 2015.
2. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, and Paul Zikopoulos, *Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data*, McGraw-Hill Publishing, 1st Edition, 2011.
3. Anand Rajaraman and Jeffrey David Ullman, *Mining of Massive Datasets*, Cambridge University Press (CUP), 1st Edition, 2011.

References

1. BillFranks, "Taming the BigData Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
2. PaulZikopoulos, DirkdeRoos, KrishnanParasuraman, ThomasDeutsch, JamesGiles, David Corrigan, "Harness the Power of Big Data: The IBM Big Data Platform", Tata McGrawHillPublications, 2012.
3. Arshdeep Bahga and Vijay Madisetti, "BigData Science & Analytics: A Hands On Approach", VPT, 2016.
4. BartBaesens, "Analytics in a BigData World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)", John Wiley & Sons, 2014.

R23CSM-PE4102.3	HIGH PERFORMANCE COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives

- This course covers the design of advanced modern computing systems. In particular, the design of modern microprocessors, characteristics of the memory hierarchy, and issues involved in multi-threading and multi-processing are discussed.

Course Outcomes

1. Understand the concepts and terminology of High-Performance Computing (HPC)
2. Write and analyze the behavior of high-performance parallel programs for distributed memory architectures using MPI.
3. Write and analyze the behavior of high-performance parallel programs for shared memory architectures using Pthreads and OpenMP.
4. Write simple programs for Graphics Processing Units (GPUs).
5. Independently study, learn about, and present various aspects of High-Performance Computing.

UNIT -I:

Introduction to Parallel Hardware and Software: Need for high-performance systems and parallel programming; SISD, SIMD, MISD, and MIMD models; and performance issues.

UNIT-II:

Processors and Pthreads: Thread creation; passing arguments to thread functions; simple matrix multiplication using Pthreads; critical sections; mutexes; semaphores; barriers and conditional variables; locks; thread safety; and simple programming assignments.

UNIT- III:

OpenMP Programming: Introduction to OpenMP; reduction clause; parallel for-loop scheduling; atomic directive; critical sections and locks; private directive; programming assignments; and N-body solvers using OpenMP.

UNIT IV:

Introduction to MPI Programming: MPI primitives such as MPI_Send, MPI_Recv, MPI_Init, MPI_Finalize, etc.; application of MPI to the trapezoidal rule; collective communication primitives in MPI; MPI derived data types; performance evaluation of MPI programs; parallel sorting algorithms; tree search solved using MPI; and programming assignments.

UNIT V:

Introduction to GPU Computing: Graphics pipelines; General-Purpose GPU (GPGPU); data parallelism and CUDA C programming; CUDA thread organization; simple matrix multiplication using CUDA; CUDA memory architecture; benchmarking and tools for high-performance computing environments; and Numerical Linear Algebra Routines (BLAS) for parallel systems evaluation.

Text Books:

1. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill Education, 1st edition, 2003
2. Ananth Grama, An Introduction to Parallel Programming, 2nd Edition, Pearson Education, 2nd edition, 2003

Reference Books:

3. David R. Butenh of, “Programming with POSIX Threads”, Addison-Wesley, 1st edition, 1997.
4. Programming Massively Parallel Processors, Kirk & Hwu, Elsevier, 4th Edition, 2022.
5. Barbara Chapman “Using OpenMP: Portable Shared Memory Parallel Programming”, MIT Press, ,

R23CSM-PE4102.4	AUGMENTED REALITY & VIRTUAL REALITY	L	T	P	C
		3	0	0	3

Course Objectives:

- Augmented Reality focuses on augmenting the physical world with digital artifacts, images, videos, or experiences overlaid with computer-generated images (CGI) and 3D models.
- Virtual Reality aims to create virtual experience with headsets and tracking to place The user in a different world.

Course Outcomes:

1. Describe the concept of virtual reality and Communication Media.
2. Understand current virtual reality hardware and software.
3. Understand various modeling approaches.
4. Illustrate the concepts of Human Factors and Applications of VR.
5. Build a Virtual Reality Application

UNITI:

INTRODUCTION TO VIRTUAL REALITY (VR): Defining Virtual Reality, Key elements of virtual reality experience, Virtual Reality, Telepresence, Augmented Reality and Cyberspace. **Bird's-Eye View:** Hardware, Software, Human Physiology and Perception.

UNITII:

Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces. **Output Devices:** Graphics displays, sound displays & haptic feedback.

UNITIII:

Modeling: Geometric modeling, Kinematics modeling, Physical modeling, Behavior modeling, Model management.

UNITIV:

AugmentedReality (AR): Taxonomy, TechnologyandFeaturesofAugmentedReality,AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems

AR software development: AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit.

UNITV:

Interaction & Audio: Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio-The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.

Text Books

1. Virtual Reality Technology, Second Edition, Gregory C. Burdea & Philippe Coiffet, John Wiley & Sons, Inc, 2003.
2. Virtual Reality, Steven M. LaValle, Cambridge University Press, 1st edition 2016.

References

1. Rajesh K. Maurya, *Computer Graphics with Virtual Reality System*, 3rd Edition, Wiley Publication, 2018.
2. William R. Sherman and Alan B. Craig, *Understanding Virtual Reality Interface, Application, and Design*, 2nd Edition, Morgan Kaufmann Publishers, Elsevier, 2019.
3. Grigore C. Burdea, Philippe Coiffet, *Virtual Reality Technology*, 2nd Edition, Wiley, 2017.
4. K. S. Hale and K. M. Stanney, *Handbook on Virtual Environments*, 2nd Edition, CRC Press, 2015.

Weblinks

- (i) <http://vr.cs.uiuc.edu/vrbook.pdf>
- (ii) <https://nptel.ac.in/courses/106/106/106106138/>

R23CSM-SC4101	PROMPT ENGINEERING	L	T	P	C
		0	1	2	2

Course Objectives:

Equip learners with the skills to design, optimize, and evaluate prompts for diverse tasks using LLMs in real-world applications.

Course Outcomes:

The Students will be able too

- Apply prompting paradigms to design clear, context-aware, and constraint-driven prompts
- Design task-specific prompts for text generation, classification, extraction, question answering, and summarization
- Develop advanced multi-step prompting pipelines leveraging chain-of-thought, step-by-step decomposition
- Evaluate prompts using metrics such as fluency, relevance, and coherence
- Design a complete prompt-based solution to address a real-world problem

Week-1

Introduction to Prompt Engineering

What is a prompt? Types of language models (ChatGPT, Claude, Gemini), Prompting paradigms: zero-shot, few-shot, chain-of-thought.

Activity:

- Exploring ChatGPT or OpenAI Playground
- Basic prompt crafting and analysis

Week-2

Foundations of Prompt Crafting

Role of clarity, context, and constraints, Prompt templates and best practices, Role-playing and persona-based prompting

Activity:

- Rewrite/improve prompts for clarity and output quality
- Use templates for different tasks (e.g., summarize, explain, translate)

Week-3

Task-Specific Prompting

Categories-Text generation (creative writing, marketing), Classification and extraction (e.g., sentiment analysis, data extraction), Question answering and summarization

Activity:

- Design prompts for each category
- Evaluate and iterate based on outputs

Week-4 and 5

Advanced Prompting Techniques

Chain-of-thought reasoning, Step-by-step breakdowns, Self-consistency and verification, System prompts and role instructions

Activity:

- Use multi-step prompts for logical reasoning or math
- Build a guided assistant with structured response flows

Week-6 and 7

Prompt Evaluation & Iteration

Evaluation metrics (fluency, relevance, coherence), A/B testing and prompt tuning, Limitations of LLMs and prompt robustness

Activity:

- Compare prompt variants
- Analyze hallucinations and mitigate errors

Week-8 and 9

APIs and Automation

Using the OpenAI API (or other LLM APIs), Prompt injection defense basics, automating tasks with prompts (scripts, tools)

Activity:

- Build a simple prompt-based app (e.g., email assistant or quiz generator)
- Use prompt chaining via API

Week-10

Capstone Project

Design a prompt-based solution for a real-world problem:

- Examples: résumé optimizer, content generator, legal contract explainer

Textbooks:

1. You Look Like a Thing and I Love You by Janelle Shane – fun intro to how AI interprets prompts, Online Guide, 2019
2. How to Talk to ChatGPT: The Art of Prompting by OpenAI , Online Guide, 2023
3. The Art of Prompt Engineering with ChatGPT by Nathan Hunter, Online Guide, 2023
4. OpenAI Cookbook – Prompt evaluation with GPT-4, Online, 2024

References:

1. Designing Bots: Creating Conversational Experiences by Amir Shevat
2. Building Intelligent Systems: A Guide to Machine Learning Engineering by Geoff Hulten

Web References:

- Prompt Engineering Guide – <https://www.promptingguide.ai>
- OpenAI Cookbook (Introduction to prompting) – <https://github.com/openai/openai-cookbook>
- Article: Anthropic's Claude Prompting Guide – <https://docs.anthropic.com/claude/docs/prompting-bestpractices>
- Notion Prompt Library – <https://www.notion.so/promptlibrary>
- AI Text Generation Handbook (online) – <https://textgeneration.com/>
- OpenAI Cookbook (Prompt examples: summarization, extraction, classification)
- Deep Learning Prompt Engineering Course by Andrew Ng & OpenAI – <https://learn.deeplearning.ai/chatgpt-prompt-eng/>
- OpenAI API Docs – <https://platform.openai.com/docs>
- LangChain Documentation – <https://docs.langchain.com>
- Prompt Injection Guide – <https://promptingguide.ai/risk/prompt-injection>

R23BSH-MC4101	ENTREPRENEURSHIP AND INCUBATION	L	T	P	C
		2	0	0	-

Course Objectives:

- Outline an environment to inculcate entrepreneurial skills.(L2)
- Develop innovative products, services, processes and techniques.(L3)
- Plan to prepare financial proposals and start-ups.(L3)
- Analyse the ideas to collaborate entrepreneur skills in establishment of start-ups.(L3)
- Explain the financial resource existing in government and private sectors.(L2)

Course outcomes:

- Explain the knowledge of Entrepreneurial behavior and skill development.(L2)
- Choose business ideas that have value in the end-market.(L2)
- Identify the validity of idea and its unique selling proposition.(L3)
- Comprehend opportunity and challenges of-startup(L2)
- Analyze various Government and non-Government financial resource.(L3)

Unit-I: Fundamentals of Entrepreneurship

Entrepreneurship- Concept, Importance, Characteristics –Myths of Entrepreneurship -Role of Entrepreneurs in Indian economy–Distinguish between professional entrepreneurs Vs Family entrepreneurs - Social and Ethical Perspectives of Entrepreneurship.

Application: Case lets: Business cases of young entrepreneurs.

Unit-II: Ideation and Evaluation of Business Ideas

Opportunity identification–Ideations process- Sources of business ideas –Role of creativity–Sources of Innovation –Technological Innovation and Entrepreneurship - Product/ Service design – Design Thinking.

Case lets : Business cases of OYO.

Activity: Collection of novel business ideas.

Unit-III: Feasibility Analysis and Business plan

Thrust areas of entrepreneurship- Techno-economic feasibility assessment- Financial feasibility – Market feasibility – Preparation of Business plan – Business canvas & Lean canvas.

Activity:

- Preparation of business plan(draft)
- Analysis on TED program Talks

Unit-IV: Business Incubation and startups

Fundamentals of business incubation-Services of incubators -Start-ups-meaning, significance - start up strategy-Present scenario of startups.

Activity:

- Evaluating new start- ups in India
- Analysis on Shark Tank India program

Unit-V: Financial resources

Sources of finance–Bootstrapping–Government Support–MSMEs–Crowd Funding–Venture Capitalists & Angel Investors - Schemes for women entrepreneurs

Activity: Business plan final version

Contemporary Topics:

1. Green Business
2. Niche Markets
3. New perspectives in rural enterprises

Text Books:

4. T.V Rao, Donald F.Kuratko, Entrepreneurship, A South-Asian Perspective, Cengage Learning, 1st edition, 2012.
5. Datsy Davies, Indian Startups, Amazon Asia- Pacific Holdings Private Limited, 1st Edition, 2016

Reference Books:

1. P.N.Rath,Sarjue Pandita, Entrepreneurship :Startup India & Standup India, Lexicon Publishing House, 2018
2. MadhurimaLall, ShikhaSahai, Entrepreneurship, Excel Books(P)Ltd.2008
3. Rajeev Roy, Entrepreneurship, Oxford Higher Education.2011
4. H.Nandan, Fundamentals of Entrepreneurship, PHIL earning(P)Ltd,2013

B.Tech IV Year - I Semester

Course Code	Course Title	L	T	P	Credits
R23CSM-HN4101	AI in X Honors Course-4(Track-1)	3	0	0	3

Course Objective:

- To enable students to understand and analyze the applications of Artificial Intelligence in healthcare
- To introduce students to the application of Artificial Intelligence in financial services
- To equip students with the knowledge and skills to apply Artificial Intelligence techniques for enhancing business operations and marketing strategies
- To provide students with an understanding of how AI and IoT technologies are revolutionizing agriculture.
- To familiarize students with AI-driven educational technologies that enable personalized learning.

Course Outcomes:

After completion of course, students would be able to:

- Apply AI techniques such as deep learning and natural language processing to solve healthcare challenges
- Apply AI techniques such as pattern recognition and predictive modeling to detect financial fraud.
- Implement AI methods such as clustering, collaborative filtering, and natural language processing to improve customer insights
- Apply AI techniques like computer vision and predictive analytics to solve agricultural challenges
- Apply AI techniques for adaptive learning, intelligent tutoring, and educational analytics to enhance teaching and learning experiences.

Unit-I: (10 Hours)

AI in Healthcare

Medical imaging analysis (X-rays, MRIs using CNNs), Disease prediction and diagnosis (e.g., diabetes, cancer), Drug discovery and development with AI, Virtual health assistants and chatbots, Case Study: IBM Watson for Oncology

Unit-II: (10 Hours)

AI in Finance

Fraud detection using pattern recognition, Credit scoring using alternative data, Algorithmic and high-frequency trading, Robo-advisors for investment planning, Chatbots for banking customer service, Case Study: Zest AI, Kount, JPMorgan's COIN

Unit-III: (10 Hours)

AI in Business & Marketing

Customer segmentation using clustering, Product recommendation systems (collaborative filtering), Sales forecasting and demand prediction, Sentiment analysis of social media and reviews, Automation in CRM and ERP systems, Case Study: Amazon, Netflix, Salesforce Einstein

Unit-IV: (10 Hours)

AI in Agriculture

Precision farming with AI and IoT, Pest and disease detection using computer vision, Crop yield prediction, Weather forecasting and climate adaptation, Drones and robotics in agriculture, Case Study: Plantix, Blue River Technology

Unit-V: (08 Hours)

AI in Education

Adaptive learning platforms and personalization, AI tutors and intelligent learning assistants, Predictive analytics for student performance, AI in grading and assessment, Chatbots for student support, Case Study: Duolingo, Squirrel AI, Coursera ML systems

Contemporary Topics:

- AI in Transportation and Automotive,
- AI in entertainment and media,
- AI in Governance and Law,
- AI in Manufacturing,

Text Book(s)

- “Artificial Intelligence: A Guide for Thinking Humans” by Melanie Mitchell – Good foundational understanding., Farrar, Straus and Giroux, First Edition, 2019.
- “Artificial Intelligence in Healthcare” by Adam Bohr and Kaveh Memarzadeh, Academic Press, First Edition, 2020
- “Artificial Intelligence in Financial Markets” by Christian L. Dunis, Peter W. Middleton, Andreas Karathanasopolous, Springer, First Edition, 2016
- Artificial Intelligence for Marketing” by Jim Sterne, Wiley, First Edition, 2017

- “Artificial Intelligence in Agriculture” edited by J. Rehman and R. Mahmud, CRC Press, First Edition, 2021.
- “Handbook of Artificial Intelligence in Education” by Wayne Holmes, Maya Bialik, Charles Fadel, Center for Curriculum Redesign, First Edition, 2019

Reference Book(s)

- “Deep Medicine” by Eric Topol, Basic books, First Edition, 2019
- “Deep Learning for Medical Image Analysis” by S. Kevin Zhou, Hayit Greenspan, and Dinggang Shen, Academic Press, Second Edition, 2023
- “Machine Learning for Asset Managers” by Marcos López de Prado, Cambridge University Press, First Edition, 2020
- “Data Science for Business” by Foster Provost and Tom Fawcett, O’Reilly Media, First Edition, 2013
- Smart Agriculture: An Approach towards Better Agriculture Management” by Dinesh Peter, Suyel Namasudra, CRC Press, First Edition, 2021

B.Tech IV Year - I Semester

Course Code	Course Title	L	T	P	Credits
R23CSM-HN4102	Scalable Angular and Architecture Patterns Honors Course-4(Track-2)	3	0	0	3

Course Objectives:

- Understand the architectural principles of building scalable Angular applications.
- Apply advanced design patterns and state management techniques.
- Optimize application performance using Angular-specific strategies.
- Develop testable and maintainable enterprise-grade applications.
- Leverage monorepo tools like Nx for large-scale Angular development.

Course Outcomes:

After successful completion, students will be able to:

- Architect and structure Angular applications for scalability and maintainability.
- Implement efficient state management using RxJS, NgRx, or Signals.
- Apply modular and layered architecture using Domain-Driven Design and Clean Architecture.
- Integrate performance and security best practices into Angular projects.
- Manage large codebases using Nx and build CI/CD-ready applications.

Unit 1: Angular Architecture Essentials

Angular Module System: Core, Shared, and Feature Modules, Dependency Injection Hierarchy, Component Design: Smart vs. Dumb Components, Routing Patterns: Lazy Loading, Guards, and Preloading Strategies, Change Detection and Signals API Overview

Unit 2: Scalable Design Patterns and Principles

Component Design Patterns (Presenter, Container), Services and Facade Pattern, SOLID Principles in Angular, Domain-Driven Design (DDD) in Angular, Feature Slicing and Clean Architecture

Unit 3: Advanced State Management

RxJS in Practice: Observables, Subjects, BehaviorSubject, Global State with NgRx / Akita / NGXS, Angular Signals: Reactive Component Design, Data Normalization and Entity Management, State Lifecycle Management

Unit 4: Performance, Testing & Security

Ahead-of-Time Compilation, Lazy Loading, Code Splitting, OnPush Strategy and Change Detection Optimization, XSS, CSRF and API Security in Angular, Unit Testing with Jasmine / Jest, E2E Testing with Cypress / Playwright

Unit 5: Scalable Monorepo Development with Nx

Introduction to Nx Workspace, Modularization with Libraries (Feature, UI, Util, Data), Linting, Formatting, and Project Boundaries, Dependency Graph and Affected Commands, Integration into CI/CD pipelines

TEXT BOOKS:

- “Architecting Angular Applications with Redux, RxJS, and NgRx” – Christoffer Noring, Packt Publishing, 2018.
- “Enterprise Angular Applications” – Manfred Steyer, 3rd Edition, Leanpub, 2020.

REFERENCE BOOKS:

- “Design Patterns: Elements of Reusable Object-Oriented Software” – Erich Gamma et al, Addison-Wesley Professional, 1994
- “Domain-Driven Design: Tackling Complexity in the Heart of Software” – Eric Evans, Addison-Wesley Professional, 2003

WEB REFERENCES:

- Angular.io Documentation: <https://angular.io/docs>
- RxJS Docs: <https://rxjs.dev/>
- NgRx Documentation: <https://ngrx.io/>
- Nx.dev Documentation: <https://nx.dev/>

B.Tech IV Year - I Semester

Course Code	Course Title	L	T	P	Credits
R23CSM-HN4103	Wireless Sensor Networks Honors Course-4(Track-3)	3	0	0	3

Course Objectives

- Define WSN and Dynamic modulation scaling.
- Explore working of the MAC protocols
- Demonstrate Routing and Data gathering protocols
- Illustrate working of Embedded OS.
- Explore a wide range of WSN applications in different sectors

Course Outcomes:

- Understand the basics, characteristics and challenges of Wireless Sensor Network
- Apply the knowledge to identify appropriate physical and MAC layer protocol
- Apply the knowledge to identify the suitable routing algorithm based on the network and user requirement
- Analysis of OS used in Wireless Sensor Networks and build basic modules
- Analyze specific WSN application using a case study approach

Unit-I – CHARACTERISTICS OF WSN (8 Hours)

Characteristic requirements for WSN – Challenges for WSNs – WSN vs Adhoc Networks – Sensor node architecture – Commercially available sensor nodes – Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.

Learning Outcomes:

- Identify and explain the key characteristics
- Differentiate between Wireless Sensor Networks (WSNs) and Ad-hoc Networks
- Understand the role and functionalities of each component within the sensor node.

Unit – II: MEDIUM ACCESS CONTROL PROTOCOLS (10 Hours)

Fundamentals of MAC protocols – Low duty cycle protocols and wakeup concepts – Contention based protocols – Schedule-based protocols – SMAC – BMAC – Traffic adaptive medium access protocol (TRAMA) – The IEEE 802.15.4 MAC protocol.

Learning Outcomes:

- Describe the main challenges of MAC protocols in wireless sensor networks (WSNs)
- Understand the concept of low duty cycle operation and its importance

- Evaluate the performance characteristics of contention-based protocols, including throughput, latency, and energy efficiency

Unit – III: ROUTING AND DATA GATHERING PROTOCOLS (10 Hours)

Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing – Gradient-based routing – Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing – LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP – Data aggregation - data aggregation operations – Aggregate Queries in Sensor Networks – Aggregation Techniques – TAG, Tiny DB.

Learning Outcomes:

- Identify the key routing challenges in WSNs compared to traditional wired networks
- Analyze popular hierarchical routing protocols
- Analyze location-based routing protocols, Real-Time Routing Protocols

Unit – IV: EMBEDDED OPERATING SYSTEMS (10 Hours)

Operating Systems for Wireless Sensor Networks – Introduction – Operating System Design Issues – Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS – OSPM – EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules – Configurations and Wiring – Generic Components – Programming in Tiny OS using NesC, Emulator TOSSIM.

Learning Outcomes:

- Understand the role and importance of operating systems in managing the resources and functionalities of Wireless Sensor Networks.
- Compare and contrast prominent WSN operating systems like TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, and PicOS.
- Understand the strengths and weaknesses of each operating system in terms of features, resource management, and suitability.

Unit – V: APPLICATIONS OF WSN (10 Hours)

WSN Applications – Home Control – Building Automation – Industrial Automation – Medical Applications – Reconfigurable Sensor Networks – Highway Monitoring – Military Applications – Civil and Environmental Engineering Applications – Wildfire Instrumentation – Habitat Monitoring – Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard – Target detection and tracking – Contour/edge detection – Field sampling

Learning Outcomes:

- Identify the key characteristics of Wireless Sensor Networks (WSNs) that make them suitable for various applications.
- Analyze a specific WSN application through a Case Study

[illegible]

B.Tech IV Year - I Semester

Course Code	Course Title	L	T	P	Credits
R23CSM-HN4104	Malware Analysis Honors Course-4(Track-4)	3	0	0	3

Course Objectives:

- * To understand the purpose of computer infection program.
- * To implement the covert channel and mechanisms.
- * To test and exploit various malware in open source environment.
- + To analyze and design the famous virus and worms.
- * Understand the Reverse Engineering (RE) Methodology
- + Disassemble products and specify the interactions between its subsystems and their functionality

Course Outcomes:

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

1. Explain the characteristics of Malware and its effects on Computing systems.
2. Predict the given system scenario using the appropriate tools to Identify the vulnerabilities and to perform Malware analysis.
3. Analyze the given Portable Executable and Non-Portable Executable files using Static and dynamic analysis techniques.
4. Demonstrate the Malware functionalities.
5. Apply anti-reverse engineering in different Applications

UNIT-I:

Malware Basics- General Aspect of Computer infection program. Non Self Reproducing Malware. How does Virus Operate, Virus Nomenclature, Worm Nomenclature, Recent Malware Case Studies.

UNIT- II:

Basic Analysis- Antivirus Scanning. x86 Disassembly. Hashing. Finding Strings. Packed Malware, PE File Format, Linked Libraries & Functions, PE Header File &Section.

UNIT-III:

Advanced Static & Dynamic Analysis-IDA Pro, Recognizing C code constructs. Analyzing malicious windows program. Debugging. OllyDbg. Kernel Debugging with WinDbg. Malware Focused Network Signatures.

UNIT-IV:

Malware Functionalities-Malware Behavior. Covert Malware Launch. Data Encoding. Shell code Analysis.

UNIT-V:

Reverse Engineering Malware (REM): REM Methodology. Resources for Reverse-Engineering Malware (REM) Understanding Malware Threats, Malware indicators, Malware Classification, Examining Clam AV-Signatures.

Text books:

1. Michael Sikorski, Andrew Honig “Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software” publisher Williampollock

Reference Books:

1. ErciFiliol, “Computer Viruses: from theory to applications”, Springer, 1 edition, 2005.

OPEN ELECTIVES

Course code	Course Title	L	T	P	Credits
R23ECE-OE0001	Basics of Communication Systems (Open Elective)	3	0	0	3

Course Objectives:

- Introduce the fundamental principles of analog and digital communication systems.
- Understand the representation and transmission of signals.
- Learn the basics of amplitude, frequency, and phase modulation techniques.
- Study noise performance in communication systems.
- Introduce multiplexing and multiple access techniques.

Course Outcomes:

1. Understand the fundamental elements of communication systems. (L2)
2. Explain various analog and digital modulation techniques. (L2)
3. Analyze the effect of noise on communication signals. (L4)
4. Understand bandwidth and power requirements in modulation schemes. (L2)
5. Describe basic multiplexing techniques and system applications. (L2)

UNIT – I

Introduction to Communication Systems: Basic block diagram of a communication system, types of communication (analog and digital), electromagnetic spectrum, frequency bands, and applications in daily life.

UNIT – II

Amplitude Modulation: Principles of amplitude modulation (AM), modulation index, power and bandwidth of AM, generation and detection of AM signals, DSB-SC and SSB modulation.

UNIT – III

Angle Modulation: Frequency modulation (FM) and phase modulation (PM), modulation index, bandwidth of FM (Carson's Rule), generation and demodulation techniques of FM signals.

UNIT – IV

Noise and Performance Analysis: Types of noise, noise figure, signal-to-noise ratio (SNR), effect of noise on AM and FM systems, pre-emphasis and de-emphasis.

UNIT – V

Multiplexing and Digital Communication Basics: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), basic digital communication concepts (PCM, ASK, FSK, PSK), comparison of analog and digital systems.

Textbooks

1. Simon Haykin, Communication Systems, Wiley.
 2. B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford University Press.
 3. Sanjay Sharma, Communication Systems, S.K. Kataria & Sons. (Indian Author)
-

Course code	Course Title	L	T	P	Credits
R23ECE-OE0002	Micro Processors and Interfacing (Open Elective)	3	0	0	3

Course Objectives: students are provided with

- 8085 8-bit architecture and register organization.
- 8086 architecture, memory segmentation & organization and features of minimum and maximum mode operations.
- Programming of 8086 in assembly language and tools.
- Interfacing memory and various peripheral control devices with 8086.

Course Outcomes: Student is able to

1. Outline the architecture and working diagram of 8085 microprocessors. **(L2)**
2. Interpret the 8086 functioning in minimum mode and maximum mode with its architecture, memory segmentation and organization. **(L2)**
3. Construct Assembly language program for 8086 using assembler directives, addressing modes and instruction set. **(L3)**
4. Develop Interface circuits with various peripheral control ICs for 8086 system. **(L3)**
5. Designing various memory interfacing Circuits with 8086 system. **(L3)**

UNIT 1

Introduction to 8085 Microprocessor: Basic microprocessor system-working, 8085 Microprocessor Architecture, register organization, Pin Diagram, Flag Register, Instruction Cycle, Timing Diagram, Interrupts of 8085.

UNIT 2

8086 Microprocessor: Evolution of Microprocessors, Register Organization of 8086, Architecture, Pin Diagram, Memory segmentation and organization, Stack implementation, Interrupt structure of 8086. minimum and maximum mode microprocessor system, Timing diagram and General Bus operation.

UNIT 3

8086 Programming: Addressing Modes, Instruction Set of 8086, Assembly Language Programming: Assembler Directives, Simple programs, Procedures and Macros Program.

UNIT 4

Data Transfer Schemes and Principle Interfacing: IO Interfacing: Programmable Peripheral Interface 8255 and its applications, Programmable Interrupt Controller 8259 with examples, Programmable Communication Interface 8251 USART, DMA Controller 8257, Programmable Keyboard and Display Interface 8279.

UNIT-5

Memory and IO Interfacing 8086: Address decoding techniques, Interfacing Static RAM and ROM chips, ADC and DAC Interfacing.

Text Books:

1. Microprocessor Architecture Programming and Applications with the 8085, 6th edition, Ramesh S Gaonkar, Penram International Publishing, 2013
2. Advanced Microprocessors and Peripherals, 3e, K M Bhurchandi, A K Ray, McGraw Hill Education, 2017.

References:

1. The Intel Microprocessors: Architecture, Programming and Interfacing, Barry B.Brey, PHI, 6th Edition.
2. Microprocessors and Interfacing, 2e, Douglas.V.Hall, Tata McGrawhill.

Course code	Course Title	L	T	P	Credits
R23ECE-OE0003	Digital System Design using Verilog (Open Elective)	3	0	0	3

Course Objectives:

- To introduce the basics and programming fundamentals of Verilog HDL
- To describe the primitive instances of gates and explain the various modeling constructs of Verilog.
- To familiarize various behavioral modeling constructs of Verilog essential for designing digital circuits.
- To Design and implement various combinational logic circuits in Verilog HDL
- To Design and implement various sequential logic circuits in Verilog HDL.

Course Outcomes:

At the end of the Course, the Student will be able to:

1. Understand the fundamentals of Digital System Design flow using Verilog HDL. (L2)
2. Construct logic circuits with the concept of Gate Level and Dataflow modelling (L3)
3. Construct logic circuits with the concept of Behavioral modelling. (L3)
4. Make use of Verilog programming to design Combinational digital circuits. (L3)
5. Develop synthesizable Verilog codes for sequential digital circuits. (L3)

UNIT-I

Introduction to Verilog HDL: Introduction, Verilog as HDL, Basic elements: Keywords, Identifiers, Comments, Tasks and functions, Numbers, Strings, Logic Values, Data Types, Scalars and Vectors, Parameters, Operands and Operators. Simulation and Synthesis Tools.

UNIT-II

Gate Level Modeling: Introduction, Module Structure, Different Gate Primitives, Array of Instances of Primitives, Illustrative Examples,

Data Flow Modeling: Introduction, Continuous Assignment Structure, Delays, and Assignment to Vectors, Operators and different Examples.

UNIT-III

Behavioral Modeling: Blocking and Non-Blocking Assignments, Simulation Flow : if and if-else constructs, case statement, Assign-De-Assign construct, different loop constructs, Examples

UNIT IV

Design of combinational circuits Elements using HDL models: Logic gates, Half Adders, Full Adders, Subtractors, Decoders, Encoders, Multiplexers, and De-multiplexers & Comparators,

UNIT-V

Design of Sequential circuits Elements using HDL models: RS, D, T, JK Latches & Flip Flops, Registers and Counters.

Text Books

1. T.R Padmanabhan, B.Bala Tripura Sundari Design through Verilog HDL, Wiley India Publications, 2009
2. J.Bhaskar, A Verilog HDL Primer, BS Publications, 3rd Edition.

Reference Books

1. Verilog HDL – Samir Palnitkar, 2nd Edition, Pearson Education, 2009
2. John F.Wakerly , Digital Design, Pearson, 4th Edition.
3. Zainalabdien Navabi, Verilog Digital System Design, TMH, 2nd Edition.

Course code	Course Title	L	T	P	Credits
R23ECE-OE0004	Fundamentals of Digital Image Processing (Open Elective)	3	0	0	3

Course Objectives:

- Introduce the basic concepts and techniques of digital image processing.
- Understand image acquisition, sampling, and quantization processes.
- Study image enhancement and filtering techniques in spatial and frequency domains.
- Explore image segmentation and representation techniques.
- Learn the basics of morphological processing and image compression.

Course Outcomes:

1. Understand image formation, sampling, and quantization techniques. (L2)
2. Apply spatial and frequency domain enhancement methods. (L3)
3. Analyze filtering and edge detection techniques. (L4)
4. Understand image segmentation and morphological operations. (L2)
5. Identify compression techniques and their applications. (L2)

UNIT – I

Introduction and Image Fundamentals: Definition of digital image, image sensing and acquisition, image sampling and quantization, basic relationships between pixels, color image fundamentals, and image file formats.

UNIT – II

Image Enhancement in Spatial Domain: Intensity transformations, histogram processing, spatial filtering, smoothing and sharpening filters, and contrast enhancement techniques.

UNIT – III

Image Enhancement in Frequency Domain: Fourier Transform, frequency domain filtering, low-pass and high-pass filters, homomorphic filtering, and enhancement using Discrete Cosine Transform (DCT).

UNIT – IV

Image Segmentation and Morphology: Edge detection using gradient operators, thresholding techniques, region-based segmentation, morphological operations like dilation, erosion, opening, and closing.

UNIT – V

Image Compression and Representation: Lossless and lossy compression techniques, run-length coding, Huffman coding, JPEG, wavelet-based compression, and basics of image representation and description.

Textbooks:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson.
 2. Anil K. Jain, Fundamentals of Digital Image Processing, PHI Learning. (Indian Author)
 3. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, Digital Image Processing, McGraw-Hill. (Indian Author)
-

Course code	Course Title	L	T	P	Credits
R23ECE-OE0005	Introduction to Internet of Things (Open Elective)	3	0	0	3

Course Objectives:

- To Understand the Architectural Overview of IoT and layers involved in Architecture.
- To Understand Real World Design Constraints of IOT and Various Protocols.
- To familiarize the students to the basics of Internet of things and protocols.
- To expose the students to some of the hardware and Software applications areas where Internet of Things can be applied.

Course Outcomes:

The students should be able to:

1. Understand the architecture of IoT systems, including the components and their roles.(L2)
2. Interface various electronic components, including LEDs, push buttons, buzzers, and LCD displays, with the Arduino board.(L3).
3. Establish remote access to the Raspberry Pi for control and management.(L3)
4. Apply knowledge to develop basic IoT applications using the ESP8266.(L3)

Understand the fundamentals of virtualization and cloud computing architecture.(L2)

UNIT - I

Introduction to IOT: Understanding IoT fundamentals, IOT Architecture and protocols, Various Platforms for IoT, Real time Examples of IoT , Overview of IoT components and IoT Communication Technologies ,Challenges in IOT.

UNIT - II

Arduino Simulation Environment: Arduino Uno Architecture, Setup the IDE, Writing Arduino Software, Arduino Libraries, Basics of Embedded C programming for Arduino, Interfacing LED, push button and buzzer with Arduino, Interfacing Arduino with LCD. Sensor & Actuators with Arduino

UNIT - III

Raspberry Pi Programming: Installing and Configuring the Raspberry Pi, Getting Started with the Raspberry Pi, Using the Pi as a Media Centre, Productivity Machine and Web Server, Remote access to the Raspberry Pi. Preparing Raspberry Pi for IoT Projects.

UNIT - IV

Basic Networking with ESP8266 WiFi module : Basics of Wireless Networking, Introduction to ESP8266 Wi-Fi Module ,Various Wi-Fi library , Web server introduction, installation, configuration ,Posting sensor(s) data to web server .IoT Protocols ,M2M vs. IOT Communication Protocols.

UNIT - V

Cloud Platforms for IOT : Virtualization concepts and Cloud Architecture , Cloud computing, benefits ,Cloud services -- SaaS, PaaS, IaaS , Cloud providers & offerings ,Study of IOT Cloud platforms , ThingSpeak API and MQTT , interfacing ESP8266 with Web services

Text Books:

1. Simon Monk, Programming Arduino: Getting Started with Sketches, Second Edition McGraw- Hill Education
2. Peter Waher, Learning Internet of Things, Packt publishing.
3. Ovidiu Vermesan, Peter Friess, IoT-From Research and Innovation to Market deployment, River Publishers

Reference Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.

Course code	Course Title	L	T	P	Credits
R23ECE-OE0006	Wireless Sensor Networks (Open Elective)	3	0	0	3

Course Objectives:

- Emphasize the basic WSN technology and sensor node architecture with its unique constraints and challenges in design of WSN for different applications.
- Summarize the transceiver design and network technologies used in wireless sensor and networks.
- Explains various key MAC protocols for sensor networks with their merits and demerits.
- Provide knowledge of different routing protocols with their advantages.
- Create awareness on transport layer protocols, security considerations, sensor network platforms and tools with a brief study of different WSN applications.

Course Outcomes:

1. Illustrate the wireless sensor node architectures.
2. Outline the physical layer design.
3. Inspect MAC protocols of wireless sensor and networks.
4. Infer various network layer routing protocols of wireless sensors.
5. Summarize the network security requirements.

UNIT-I

Overview of Wireless Sensor Networks: Key definitions of sensor networks, advantages of sensor networks, unique constraints and challenges, driving application, enabling technologies for wireless sensor networks.

Architectures:

Single-node architecture - hardware components, energy consumption of sensor nodes, operating system and execution environments, network architecture- sensor network scenarios, optimization goals and figures of merit, gateway concepts.

UNIT - II

Networking Technologies: Physical layer and transceiver design consideration, personal area networks (PANs), hidden node and exposed node problem, topologies of PANs, MANETs, and WANETs.

UNIT - III

MAC Protocols for Wireless Sensor Networks: issues in designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention -Based Protocols, contention - based protocols with reservation mechanism, contention - based MAC protocols with scheduling Mechanisms, MAC protocols that use directional antennas, others MAC protocols.

UNIT - IV

Routing Protocols: introduction, issues in designing a routing protocols for Ad Hoc Wireless Networks, classification of routing protocols, table- driven routing protocols, On-Demand routing protocols, Hybrid routing protocols, routing protocols with efficient flooding mechanisms, hierarchical routing protocols, power- aware routing protocols, proactive routing.

UNIT-V

Transport Layer and Security Protocols: Introduction, issues in designing a transport layer protocol for Ad Hoc wireless networks, design goals of a transport layer protocol for Ad Hoc wireless networks, Security in Ad Hoc wireless networks, network security requirements, issues and challenges in security provisioning, network security attacks, key management, secure routing in Ad Hoc wireless Networks.

Sensor Network Platforms and Tools:

Sensor node hardware - Berkeley motes, programming challenges, node- level software platforms, node-level simulators, state - centric programming.

Textbooks

1. Ad Hoc wireless networks: Architectures and protocols - C.Siva Ram Murthy and B.S.Manoj, 2004, PHI.
2. Wireless Ad - Hoc and Sensor Networks: Protocols, Performance and Control - Jagannathan Sarangapani, CRC Press.
3. Holger Karl & Andreas Willig, Protocol and Architectures for Wireless Sensor Networks, John Wiley, 2005.

References

1. Kazem Sohraby, Daniel Minoli, & Taieb Zanti, "Wireless Sensor Networks - Technology, Protocols and Applications", John Wiley, 2007.
 2. Feng Zhao & Leonidas J.Guibas, "Wireless Sensor Networks - An Information Processing Approach", Elsevier, 2007.
 3. Ad Hoc Mobile Wireless Networks: Protocols & Systems, C.K.Toh, 1ed, Pearson Education.
 4. Wireless Sensor Networks - C.S.Raghavendra, Krishna M.Sivalingam, 2004, Springer.
 5. Wireless Sensor Networks - S Anandamurugan, Lakshmi Publications
-

Course code	Course Title	L	T	P	Credits
R23ECE-OE0007	Satellite Communication (Open Elective)	3	0	0	3

Course Objectives:

- Introduce the basic concepts and architecture of satellite communication systems.
- Understand satellite orbits, launch methods, and positioning techniques.
- Study satellite subsystems including transponders and antennas.
- Learn about satellite link design and signal propagation.
- Explore multiple access techniques and satellite applications.

Course Outcomes:

1. Understand satellite system architecture and functions. (L2)
2. Analyze orbital mechanics and satellite positioning. (L4)
3. Understand the design and working of satellite subsystems. (L2)
4. Analyze satellite link budgets and signal propagation. (L4)
5. Understand access techniques and applications in communication systems. (L2)

UNIT – I

Overview of Satellite Communications: Introduction to satellite communication, advantages and limitations, types of satellites, satellite applications in communication, broadcasting, navigation, and remote sensing.

UNIT – II

Orbital Mechanics and Launchin: Kepler's laws, orbital elements, types of satellite orbits (LEO, MEO, GEO), look angle determination, eclipse effects, and satellite launching methods.

UNIT – III

Satellite Subsystems: Space segment and ground segment, transponders, antenna systems, telemetry, tracking and command (TT&C), and power systems.

UNIT – IV

Satellite Link Design and Propagation: Link power budget, system noise temperature, C/N ratio, G/T ratio, propagation effects such as rain attenuation, free-space loss, and ionospheric effects.

UNIT – V

Access Techniques and Applications: FDMA, TDMA, CDMA in satellite communication, VSAT systems, satellite mobile communication, GPS, and DTH systems.

Textbooks:

1. Dennis Roddy, Satellite Communications, McGraw-Hill.
2. Timothy Pratt et al., Satellite Communications, Wiley India.
3. T. K. Bandopadhyay, Satellite Communication, PHI Learning. (Indian Author)

Course code	Course Title	L	T	P	Credits
R23ECE-OE0008	Fundamentals of Embedded Systems (Open Elective)	3	0	0	3

Course Objectives

- Basic fundamentals and components of a typical embedded system.
- Embedded system development as a hardware design and firmware design methodologies, tools and integration.
- Understand the need and development of hardware software codesign.
- Aware of the interrupt service mechanism and device driver programming.
- Understand the working of real time operating systems.

Course Outcomes

1. Illustrate the working of various components of a typical embedded system. (L2)
2. Develop hardware and firmware design methodologies, tools and integration for a embedded system. (L3)
3. Discuss the importance and development using hardware software codesign. (L2)
4. Summarize the interrupt service mechanism and device driver programming. (L2)
5. Outline the real time operating system functions and study of a deployed RTOS. (L2)

UNIT-I

Introduction to Embedded System: Embedded System, Embedded System Vs General Computing System, History of Embedded Systems, Classification of Embedded System, major Application Areas, Purpose of Embedded system, Core of Embedded System, Memory, Sensors and Actuators, Communication Interface, other System components, PCB and passive components, Characteristics of Embedded System, Quality Attributes of Embedded System, application and domain specific embedded systems.

UNIT-II

Embedded system Development: Analog and Digital Electronic components, VLSI and IC Design, EDA tools, PCB Fabrication, Embedded Firmware Design approaches, embedded firmware development languages, Integration of Hardware and Firmware, Board Bring up, Embedded System Development Environment – IDE, Types of File Generated on Cross Compilation- Disassembler/ Decompiler, Simulator, Emulator and Debugging, Target hardware Debugging, Boundary Scan,

UNIT-III

Hardware Software Co-design and program modelling: Fundamental Issues in Hardware and Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modelling Language (UML), hardware Software Trade-offs, embedded product development life cycle- objectives, different phases, approaches of EDLC.

UNIT-IV

Device Drivers and Interrupt service mechanism: Programmed I/o, busy-wait approach without interrupt service mechanism, ISR concepts, interrupt sources, interrupt service handling mechanism, multiple interrupts, context and periods for context switching, interrupt latency and deadline. Classification of processors interrupt service mechanism from context saving, direct memory access, device driver programming.

UNIT-V

Real time operating system: operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling, threads, processes and scheduling, task communication, task synchronization, how to choose an RTOS, case study of ucos-II and vxworks.

Textbooks:

1. Introduction to Embedded System, Shibu K.V, Tata McGraw-Hill, 2014.

References:

1. Embedded Systems- Architecture, programming and Design, 2e, Raj kamal, McGraw Hill Education (India) Private Limited.
2. Embedded System Design- Frank vahid, Tony Givargis, Wiley publications, 2002.

Course code	Course Title	L	T	P	Credits
R23EEE-OE0001	Renewable Energy Sources (Open Elective)	3	0	0	3

Course Objectives:

- To study the solar radiation data, extraterrestrial radiation, radiation on earth's surface.
- To study solar thermal collectors.
- To study maximum power point techniques in solar Photovoltaic Systems
- To study wind energy conversion systems, Betz coefficient, tip speed ratio and geothermal systems.
- To study basic principle and working of tidal, biomass and fuel cell

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

1. Understand the basic concepts of solar radiation, its data on earth's surface(L2)
2. Explain the different types of solar thermal energy collectors(L2)
3. Develop the maximum power point techniques in solar Photovoltaic Systems(L3)
4. Understand the Wind energy conversion systems and the various geothermal resources(L2)
5. Explain the methods of generation of electricity from tidal and chemical resources(L2)

UNIT-I

Fundamentals of Energy Systems and Solar energy: Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation: Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry – Radiation on flat and tilted surfaces – Numerical problems.

UNIT-II

Solar Thermal Systems: Liquid flat plate collectors: Performance analysis –Transmissivity– Absorptivity product collector efficiency factor – Collector heat removal factor – Numerical problems. Introduction to solar air heaters – Concentrating collectors, solar pond and solar still – solar thermal plants.

UNIT-III

Solar Photovoltaic Systems: Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Cell I-V characteristics and P-V characteristics. Applications and systems – Balance of system components – System design: storage sizing – PV system sizing – Maximum power point techniques: Perturb and observe (P&O) technique – Hill climbing technique.

UNIT-IV

Wind Energy and Geothermal Energy: Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip-speed ratio – Efficiency – Power output of wind turbine – Selection of generator (synchronous, induction) – Maximum power point tracking – wind farms. Geothermal: Classification – Dry rock and hot aquifer – Energy analysis – Geothermal based electric power generation

UNIT-V

Tidal Power, Biomass and Fuel Cells: Tidal power – Basics – Kinetic energy equation – Turbines for tidal power – Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices.

Biomass Energy: Fuel classification – Pyrolysis – Direct combustion of heat – Different digesters and sizing.

Fuel cell: Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics

Text Books:

1. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
2. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis - second edition, 2013.

Reference Books:

1. Energy Science: Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press.
2. Renewable Energy- Edited by Godfrey Boyle-oxford university.press,3rd edition,2013.
3. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
4. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
5. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
6. Non-conventional energy source –B.H.khan- TMH-2nd edition.

Weblinks:

1. <https://nptel.ac.in/courses/103103206>
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Course code	Course Title	L	T	P	Credits
R23EEE-OE0002	Energy Conservation and Management (Open Elective)	3	0	0	3

Course objectives:

- To make the students aware of global energy scenario
- To apply good engineering practices in energy conservation activities
- To summarize the salient features of energy conservation Act 2001.
- To study about energy management and methods of improving energy efficiency in different electrical systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Course Outcomes: At the end of the Course the student shall be able to

1. Understand the classification of Energy and global energy scenario(L3)
2. Understand the importance of Energy Conservation. (L2)
3. Understand the schemes of energy conservation act 2001 (L3)
4. Analyze the performance of electrical utilities and their efficient improvement approaches (L3)
5. Analyze the life cycle costing and return on investment of energy efficient technologies(L2)

UNIT – I

ENERGY SCENARIO: Classification of Energy – Primary and Secondary Energy, Commercial Energy and Non-commercial Energy and Renewable & Non-renewable energy; commercial energy production, final energy consumption, energy needs of growing economy, energy intensity on purchasing power parity (PPP), energy consumption in various sectors, long term energy scenario, Indian energy scenario, energy pricing.

UNIT - II

ENERGY CONSERVATION: Energy conservation and its importance – need of energy conservation, energy strategy for the future, energy efficiency and its benefits. Energy security – definition, purpose of implementing national energy security policy. Energy conservation systems- short, medium, long term energy conservation. Energy conservation equipments - Automatic power factor controller (APFC) - Intelligent power factor controller(IPFC).

UNIT - III

ENERGY CONSERVATION ACT – 2001: Energy conservation act – 2001 and its features, power and function of bureau, responsibilities and duties of state designated agencies, schemes of BEE under energy conservation act 2001 – Energy conservation building codes – standards and labelling – demand side management – Bachat lamp yojana(BLY) – promoting energy efficiency in small and medium enterprises – designated consumers – certification of energy auditors and managers (introduction only).

UNIT - IV

ENERGY MANAGEMENT: Energy management – energy management program, function of energy manager, principles of energy management and quality of energy manger, Energy management techniques in transformers and motors - Transformer losses& Energy efficient transformers. - Distribution losses in industrial systems. Assessment of transmission and distribution losses in power systems. - Economics of energy efficient motors and systems. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT - V

ECONOMIC ASPECTS AND ANALYSIS: Electricity billing, electrical load management and maximum demand control, Benefits of demand side management- Harmonics-causes-effects-overcoming - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis.

Text books:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995.
4. Amlan Chakrabarti, “Energy Engineering and management”, PHI Publication.

Reference books:

1. Energy management by W.R.Murphy & G.Mckay Butterworth, Elsevier publications. 2012
2. S.C.Tripathy, “Utilization of Electrical Energy and Conservation”, McGraw Hill, 1991.
3. Doty, Steven; Turner, Wayne C, Energy Management Hand book (8th Edition), Fairmont Press, Inc., 978-0-88173-707-3

Web Links:

1. www.energy.gov/energy_saver/blower-door-tests.
2. https://beeindia.gov.in/content/energy_auditor.
3. www.pcra.org/pages/display180-energy-audit
4. <https://www.myscheme.gov.in/schemes/peacedea>

Course code	Course Title	L	T	P	Credits
R23EEE-OE0003	Electrical Safety & Standards (Open Elective)	3	0	0	3

Course Objectives:

- To Explain the importance of electrical safety and security measures.
- To Demonstrate the principles of safe electrical wiring and fitting practices.
- To Demonstrate the importance of issuing safety clearance notices before energizing equipment.
- To Classify hazardous zones and the associated risks in electrical environments.
- To Explain regulations regarding physical clearances in electrical installations.

Course Outcomes: At the end of this course, students will be able to

1. Explain the principles and scope of electrical safety, including its relevance across residential, commercial, and industrial sector. (L2)
2. Understand the Indian power sector organization and Electricity rules, electrical safety in residential, commercial, agriculture, hazardous areas. (L2)
3. Outline the electrical safety during installation, testing and commissioning procedure. (L2)
4. Make use of specification of electrical plants and classification of safety equipment for various hazardous locations. (L2)
5. Understand Safety Management & Standards in Electrical Systems. (L2)

UNIT-I

Introduction to Electrical Safety, Shocks and its Prevention: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shop.

UNIT-II

Electrical Safety in Residential, Commercial and Agricultural Installations: Wiring and fitting –Domestic appliances –water tap giving shock –shock from wet wall –fan firing shock – multi-storied building –Temporary installations – Agricultural pump installation –Do's and Don'ts for safety in the use of domestic appliances.

UNIT-III

Electrical Safety during Installation, Testing and Commissioning: Preliminary preparations –safe sequence –risk of plant and equipment –safety documentation –field quality and safety –personal protective equipment –safety clearance notice –safety precautions –safeguards for operators –safety.

UNIT-IV

Electrical Safety in Hazardous Areas: Hazardous zones –class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment's for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT-V

Safety Management of Electrical Systems and Standards: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees. Review of IE Rules and Acts, their Significance: Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and firefighting facility. The Electricity Act, 2003,

Textbooks

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept

Publishing company, New Delhi, 1997

Reference Books

1. Cooper.W.F, “Electrical safety Engineering”, Newnes-Butterworth Company, 1978.
2. John Codick, “Electrical safety hand book”, McGraw Hill Inc., New Delhi, 2000.
3. Nagrath, I.J. and Kothari, D.P., “Power System Engineering”, Tata McGraw Hill, 1998.
4. Wadhwa, C.L., “Electric Power Systems”, New Age International, 2004.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_mg43
 2. https://onlinecourses.swayam2.ac.in/nou20_cs08/preview
 3. <https://www.udemy.com/course/electrical-safety>
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Course code	Course Title	L	T	P	Credits
R23EEE-OE0004	Utilization of Electrical Energy (Open Elective)	3	0	0	3

Course Objectives:

- To study the laws of illumination and their applications for various lighting schemes.
- To explain the various methods of Electric heating.
- To explain the various electric traction systems and its equipment
- To identify the speed-time curves of different services and energy consumption levels at various modes of operation.
- To analyze the economic aspects of utilization of electrical energy.

Course Outcomes: At the end of this course, students will be able to

1. Apply the concepts of illumination to Calculate the illumination levels required for various lighting schemes (L3).
2. Explain the appropriate heating techniques for different applications (L2).
3. Apply the concepts of D.C and A.C traction systems (L3).
4. Apply speed-time curves and the energy consumption of different services under various operating conditions (L3).
5. Analyze the economic aspects of utilization of electrical energy (L4).

UNIT-I

Illumination: Basic definitions of Illumination, Laws of Illumination, Polar Curves, Calculation of MHCP and MSCP, Lamps: Incandescent Lamp, Sodium Vapour Lamp, Fluorescent Lamp, CFL and LED. Requirement of Good Lighting Scheme, Types, Design and Calculation of Illumination, Numerical Problems.

UNIT-II

Electric Heating: Electrical Heating: Advantages, Modes of heat transfer, Design of heating Element, Methods of Electric Heating – Resistance, Arc heating, Induction and Dielectric Heating, Applications of electric heating, Numerical Problems.

UNIT-III

Electric Traction – I: Introduction, Systems of Electric Traction, Comparison Between A. C. and D. C Traction, Special Features of Traction Motors, The Locomotive, Wheel arrangement and Riding Qualities, Transmission of Drive, and Motor Coaches for Track Electrification, DC Equipment, AC Equipment, Overhead Equipment, Numerical Problems.

UNIT-IV

Electric Traction – II: Introduction to Speed-Time Curves of Different Services, Calculations of Tractive Effort Mechanics of Train Movement, Adhesive Weight and Dead Weight, and Coefficient of Adhesion, Numerical Problems.

UNIT-V

Economic Aspects of Utilizing Electrical Energy: Power Factor Improvement, Load Factor improvement, Off Peak Loads, Use of Exhaust Steam, Waste Heat recovery, Pit Head Generation, Diesel Plant, General Comparison of Private Generating Plant and Public Supply- Initial Cost and Efficiency, Capitalization of Losses.

Textbooks:

1. E. Openshaw Taylor, Utilisation of Electric Energy, Universities Press, Penram International Publishers, 2010
2. N.V. Suryanarayana, Utilisation of Electrical power including Electric drives and Electric Traction, New Age Publishers, 2017.

Reference Books:

1. H. Partab, Art & Science of Utilization of Electric Energy, Dhanpat Rai & Sons, 1998.
 2. J. B Gupta, Utilization of Electric Power & Electric Traction S.K. Kataria & Sons, Reprint 2020, 10th Edition.
 3. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited.
 4. Electrical Power Systems, S. L. Uppal, Khanna publishers.
-

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ee94/preview
 2. <https://archive.nptel.ac.in/courses/108/105/108105060/>
 3. <https://archive.nptel.ac.in/courses/112/103/112103263/>
 4. <https://archive.nptel.ac.in/courses/112/107/112107090/>
 5. https://onlinecourses.nptel.ac.in/noc23_ag06/preview
-

Course code	Course Title	L	T	P	Credits
R23MEC-OE0001	Operations Research (Open Elective)	3	0	0	3

Course Objectives:

The objectives of the course are to

- Explore advanced methodologies in Operations Research to model and optimize decision-making processes in complex systems.
- Comprehend the theoretical foundations and practical applications of Linear Programming to address challenges in industrial and operational domains.
- Develop effective solutions for Transportation and Assignment Problems by applying optimization techniques to enhance productivity in manufacturing and efficiency in logistics.
- Impart knowledge of strategic tools in Game Theory and Network Analysis to evaluate and improve competitive scenarios and project management systems.
- Evaluate Queuing models and Simulation models to address uncertainty and improve the system performance.

Course Outcomes

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

1. **construct** mathematical models for allocation problems to find the optimal solutions. (L3)
2. **determine** optimal solutions for transportation and assignment problems and **test** for optimality to obtain the optimal solutions. (L4)
3. **design** simulation models for discrete systems under uncertainties to obtain the solutions for decision making. (L4)
4. **apply** the concepts of PERT and CPM for scheduling the projects. (L3)
5. **determine** strategic solutions for competitive scenarios in two-person zero-sum games (L4)

UNIT I

Introduction to Operations Research (OR): OR definition - Classification of Models, **Linear Programming (LP):** Problem Formulation, Graphical Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Simplex Method, Big- M simplex Method, application of L.P.P. in manufacturing firms. Software solutions

Applications: Determination of Production quantities of different products in manufacturing industries

UNIT II

Transportation and Assignment Problems: Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem. application of Transportation and Assignment Problems in manufacturing firms. Software solutions.

Applications: Optimizing transportation costs in distribution of goods

UNIT III

Queuing Theory: Introduction – Basic queuing process, basic structure of queuing models terminology: arrival Pattern, service channel, population, departure pattern, queue discipline, Kendall's notation.

Single Channel model with poisson arrivals, exponential service times with infinite queue length

Simulation: Basic concept of simulation, discrete event simulation, applications of simulation, merits and demerits of simulation, Monte Carlo simulation, simulation of Inventory system, simulation of Queuing system. Simulation languages

Applications: Decision making in uncertainty situations

UNIT IV

Network Analysis: Network Representation, rules for drawing network, Fulkerson's Rule, Determination of Earlier Starting Time and Earliest Finishing Time in the Forward Pass – Latest Starting Time and Latest Finishing Time in Backward Pass, determination of critical path, total float calculation, Time estimates in PERT, Probability of completing the project, project cost, project crashing, Optimum project duration, Project management.

Applications: Project planning control in manufacturing and maintenance

UNIT V

Game Theory: Optimal solution of two-person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. algebraic method, Reduction by principles of dominance, graphical method for $[2 \times n]$ and $[m \times 2]$ game problems, Linear programming model

Applications: Determination of optimal strategies in competition between industries

Text books:

1. Sharma S.D., Operations Research: Theory, Methods and Applications, Kedar Nath Ram Nath.
2. Prem kumar Gupta and Hira, Operations Research, S Chand Company Ltd., New Delhi.

Reference books:

1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, Tata McGraw Hill.
2. Sharma J.K., Operations Research: Theory and Applications, Laxmi Publications.
3. Taha H.A., Operations Research, Prentice Hall of India, New Delhi.
4. Pannerselvam R., Operations Research, Pentice Hall of India, New Delhi.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications.

Web Source References:

1. https://onlinecourses.nptel.ac.in/noc22_mg15
 2. https://onlinecourses.nptel.ac.in/noc22_ma48
 3. https://onlinecourses.nptel.ac.in/noc24_mg30
 4. <https://www.britannica.com/topic/operations-research>
 5. <https://www.theorsociety.com/about-or>
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Course code	Course Title	L	T	P	Credits
R23MEC-OE0002	3D Printing Technology (Open Elective)	3	0	0	3

Course Objectives:

The objectives of the course are

- To exploit technology used in 3D printing.
- To understand importance of 3D printing in advance manufacturing process.
- To acquire knowledge, techniques and skills to select relevant 3D Printing process.
- To explore the potential of 3D Printing in different industrial sectors.

Course Outcomes

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

1. **Know** the importance of 3D printing in Manufacturing (L1)
2. **Understand** the liquid-based 3D printing system(L2)
3. **Illustrate** the solid-based 3D printing system (L2)
4. **Explain** the powder-based 3D printing system (L2)
5. **Elucidate** the application 3D printing in medical field (L2)

UNIT-I

Introduction: 3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.

UNIT-II

LIQUID-BASED 3D PRINTING SYSTEM: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages.

UNIT-III

SOLID-BASED 3D PRINTING SYSTEMS: Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT-IV

POWDER BASED 3D PRINTING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages, disadvantages and case studies.

UNIT-V

MEDICAL APPLICATIONS & FUTURE DIRECTION FOR 3D PRINTING - Use of 3D Printing to Support Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications. Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Blended Multiple Material Processes, Commercial Applications Using Multiple Materials, Business Opportunities and Future Directions

Text Books

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, LeongKah Fai, World Scientific.

References

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer.
 2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer.
 3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons.
-

4. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC PressTaylor & Francis Group.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGraw Hill.

Web resources

1. <https://www.nist.gov/additive-manufacturing>
 2. <https://www.metal-am.com/>
 3. <http://additivemanufacturing.com/basics/>
 4. <https://www.3dprintingindustry.com/>
 5. <https://www.thingiverse.com/>
 6. <https://reprap.org/wiki/RepRap>
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Course code	Course Title	L	T	P	Credits
R23MEC-OE0003	Statistical quality control (Open Elective)	3	0	0	3

Course Objectives:

The Objectives of this course are to

- Explore the techniques for identifying customer needs, gathering customer feedback, and using that information to drive quality improvements.
- develop skills in analyzing quality control data and making data-driven decisions to maintain or improve product quality
- Design and apply TQM tools and techniques such as control charts, process capability analysis, and Kaizen for continuous process improvement.
- Comprehend Six Sigma methodologies and acceptance sampling plans for quality excellence and reduce operational costs.
- foster a culture of quality and support quality management initiatives to ensure compliance, sustainability, and competitive advantage.

Course outcomes:

Upon completion of this course students will be able to

1. **apply** the concept of Quality function deployment to meet the customer quality requirements in product development (**L3**)
2. **apply** tools and techniques of Quality Management to identify the assignable causes for process variations to control the manufacturing process (**L3**)
3. **construct** control charts for variables and attributes for controlling manufacturing process (**L3**)
4. **develop** acceptance sampling plan to minimize producer risk and consumer risk. (**L4**)
5. **comprehend** Six Sigma methodologies and ISO quality systems to achieve quality excellence (**L2**)

UNIT –I

Introduction: Introduction to quality – Definition of Quality, Dimensions of Quality, Quality Planning, Total quality management – history – stages of evolution– objectives –Inspection and quality control, Quality Management versus TQM, Reliability engineering –reliability as a parameter of quality for sustainability -bathtub curve, MTBF, System reliability calculations, Quality Loss Function, Quality function deployment (QFD). applications, real life examples

Application:

Quality control concepts used to meet customer requirements in manufacturing industries

UNIT II

Tools and Techniques of TQM: Process capability, Natural Tolerance limits, Process capability index. Check Sheets, Histograms, Scatter Diagrams, Cause and Effect Diagrams, Pareto Chart, control charts, TPM, Kaizen, JIT, Quality Circles, Seven wastes elimination in manufacturing industries for sustainable development, Five S principle

Application: Perform Process capability studies in machine tool industries

UNIT III

Statistical Process Control: Control charts: Statistical basis of the Control Charts-principles, Control limits for X and R-Charts, analysis of pattern on control charts, Type I and Type II errors, p chart, c chart construction. Simple Numerical Problems, revised control limits

Application:

Identify the assignable causes Quality control in manufacturing to control the processes

UNIT- IV

ACCEPTANCE SAMPLING: Fundamental concept in acceptance sampling, Need of acceptance sampling, operating characteristics curve. Producer risk and consumer risk in sampling plans. Acceptance plans, single sampling plan, double sampling plan –exercises.

Application: Selection of sampling plan to minimize risk in purchasing parts, components from the suppliers

UNIT- V

Quality Systems: The Concept of Six Sigma, Objectives of Six Sigma, The Frame-Work of Six Sigma Programme, Six Sigma Problem Solving Approach, The DMAIC Model: Cost of Poor Quality, Benefits and Costs of Six Sigma.

Need for ISO 9000 and Other Quality Systems, ISO 9000: 2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Case Studies of TQM projects and Six Sigma projects.

Application: Systems followed in manufacturing units for quality excellence

Text books:

1. Subburaj Ramaswamy, Total Quality Management, Tata Mcgraw Hill Publishing Company Ltd.
2. Statistical Quality Control, M.Mahajan, Dhanpat Rai Publishing Co Pvt Ltd

Reference Books:

1. Introduction to statistical quality control: By D.C. Montgomery, John Wiley & Sons Inc.
2. Forrest W. Breyfogle, Implementing Six Sigma, John Wiley & Sons, Inc.
3. Statistical Quality Control – R.C. Gupta– Khanna Publishers, Delhi
4. Grant, E.L. and LavenWorth, R.S.: Statistical Quality Control, McGraw Hill.
5. Evans, J R and W M Lindsay, An Introduction to Six Sigma and Process Improvement, Cengage Learning.

Web Source References:

1. <https://nptel.ac.in/courses/112/107/112107259/>- Inspection and Quality control manufacturing.
 2. <https://nptel.ac.in/courses/110105039>
 3. <https://www.youtube.com/watch?v=qb3mvJ1gb9g>
 4. <https://nptel.ac.in/courses/110104085>
 5. https://onlinecourses.nptel.ac.in/noc20_mg19
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Course code	Course Title	L	T	P	Credits
R23MEC-OE0004	Hybrid Vehicle Technologies (Open Elective)	3	0	0	3

Course Objectives:

The course is intended to

- Familiarize the fundamentals of conventional and hybrid electric vehicle components.
- Understand the configurations and working of hybrid and electric drive-trains.
- Understand the architecture, operation and energy management of PHEVs
- Study and understand different power converters used in hybrid and electrical vehicles.
- Familiarize with different batteries and other energy storage systems.

Course outcomes:

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

1. *Understand* the fundamentals of conventional and hybrid electric vehicle components.
2. *Describe* hybridization of power sources in hybrid electric vehicles.
3. *Apply* the principles of power management and fuel economy to optimize the PHEV performance
4. *Explain* the working principle of power electronics in hybrid vehicles.
5. *Describe* the different battery technologies and other energy storage systems.

UNIT-I:

Introduction: Fundamentals of vehicle, components of conventional vehicle and propulsion load, drive cycles and drive terrain; concept of electric vehicle and hybrid electric vehicle; history of hybrid vehicles, advantages and applications of electric and hybrid electric vehicles, different motors suitable for electric and hybrid electric vehicles.

UNIT-II:

Architectures of Hybrid, Plug-in Hybrid, Fuel Cell and Electric Vehicles

Hybrid Electric Drive-trains: Architectures of HEVs, Series and parallel HEVs complex HEVs. Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV- Fuel Cell vehicles and its constituents.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.

UNIT-III:

Plug-in Hybrid Electric Vehicle: PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology(V2G), PHEV battery charging.

Applications:

- Optimizing fuel economy by managing the switch between electric and combustion power in PHEVs.
- Using PHEV batteries to support the grid during peak demand through Vehicle-to-Grid (V2G) technology.

UNIT-IV:

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples, Buck converter used in HEVs, non- isolated bidirectional DC-DC converter, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT-V:

Battery and Storage Systems: Energy storage parameters; lead acid, li-ion and Ni-MH batteries, ultracapacitors, flywheels- superconducting magnetic storage system; pumped hydroelectric energy storage; compressed Air energy storage-storage heat; energy storage as an economic resource.

Applications:

- Battery selection in EVs: Selecting Li-ion or Ni-MH batteries for EVs based on battery cost and performance.

- Supporting the power grid with pumped hydro or compressed air energy storage systems.

Text Books:

1. Ali Emadi, Advanced Electric Drive Vehicles, 1st Edition, CRC Press.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd Edition, CRC Press, 2010.

Reference Books:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2009.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H.Partab: Modern Electric Traction-DhanpatRai &Co,2007.

Web link:

1. <https://archive.nptel.ac.in/courses/108/103/108103009/>

Course code	Course Title	L	T	P	Credits
R23MEC-OE0005	Industrial Robotics (Open Elective)	3	0	0	3

Course Objectives:

The objectives of the course are

- To understand the Geometrical Configuration and Components of Industrial Robots (Anatomy)
- To analyze the factors influencing gripper selection and design.
- To grasp the concept of rotation matrices and their significance in robotics.
- To understand forward and inverse kinematics of robot manipulator
- To familiarize the students with the fundamentals of sensors and various drive systems.
- To develop Program Robot for applications in various fields.

Course Outcomes:

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

1. Understand the anatomy of robots including the components and structure. (L2)
2. Design the grippers considering grasping force, Engelberger-g-factors, and actuation mechanisms (L2)
3. Apply basic transformation and rotation matrices in robot kinematics (L3)
4. Explain the function of feedback components such as position sensors (potentiometers, resolvers, encoders) and velocity sensors. (L2)
5. Understand the use of robots in manufacturing, inspection and quality control applications. (L2)

Unit- I

Robotics: Introduction, classification with respect to geometrical configuration (Anatomy), Controlled system & chain type, Serial manipulator & Parallel Manipulator. Components of Industrial robotics, precession of movement, resolution, accuracy & repeatability,

Dynamic characteristics: speed of motion, load carrying capacity & speed of response, Sensors, Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force and Torque sensors.

Unit-II

Grippers & End effectors: Mechanical Gripper, Grasping force, Engelberger-g-factors, mechanisms for actuation, Magnetic gripper, vacuum cup gripper, considerations in gripper selection & design, specifications. Selection of gripper based on Application.

Applications:

1. Wall climbing robot
2. Vacuum cups

Unit- III

Motion Analysis:

Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation.

Manipulator Kinematics- Assignment of frames, D-H Transformation Matrix, joint coordinates and world Coordinates, Forward and inverse kinematics.

Applications:

1. Robot trajectory generation by forward kinematics.
2. Welding robots by inverse kinematics by root multiplicity.

Unit-IV

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors, potentiometers, resolvers, encoders, Velocity sensors, Tactile and Range sensors, Force and Torque sensors, End Effectors and Tools.

Applications:

1. Automated Assembly Lines in Automotive Manufacturing
2. Surgical Robotics (e.g., Da Vinci System)

Unit-V

Robot Programming & Applications: Material Transfer - Material handling, loading and unloading- Processing spot and continuous arc welding & spray-painting Assembly and Inspection. Robotic Programming Methods - Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

Applications:

1. Automated Car Body Assembly
2. Electronics Manufacturing (e.g., PCB Assembly)

Text Books

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John j.Craig / Pearson

References

1. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson
2. Robot Dynamics and controls / Spony and Vidyasagar / John Wiley

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_me143/preview
 2. https://www.youtube.com/results?search_query=1.%09Robotics+Programming+in+Just+30+Days!+%7C+Industrial+Robotics+Programming+in+Bangalore+%7C+RVM+CAD
 3. <https://www.youtube.com/watch?v=QiFbrmJTib4&t=11s>
 4. https://www.youtube.com/watch?v=hL_GKapQd1k
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Course code	Course Title	L	T	P	Credits
R23MEC-OE0006	Nano Materials (Open Elective)	3	0	0	3

Course objectives:

The objectives of the course are

- To understand the nano-structured materials and their applications.
- To learn about the nano-crystalline materials, their properties and defects.
- To understand various techniques of nanofabrication.
- To identify the tools to characterize nano materials.
- To analyze the applications of nano materials.

Course Outcomes:

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

1. **Explain** nano-structured materials and their applications (L2)
2. **Apply** knowledge about the nano-crystalline materials, their properties and defects (L3)
3. **Demonstrate** various techniques of nanofabrication (L2)
4. **Apply** the tools to characterize nano materials (L3)
5. **Analyze** the applications of nano materials (L4)

UNIT-I

Introduction to Nanomaterials: History and Scope, Classification of Nano structured Materials, Distinction between nanomaterials and bulk materials, Classification of nanomaterials: 0D, 1D, 2D, 3D, Fascinating Nanostructures, and applications of nanomaterials, challenges and future prospects.

Learning outcomes:

At the end of this unit students will be able to:

1. **Understand** the fundamental concepts of nanomaterials and how they differ from bulk materials (L2)
2. **Identify** and describe various nanostructures (0D, 1D, 2D, 3D) and their unique properties at the nanoscale (L2)

Application:

Semiconductors , Nano sensors, Memory storage devices, Hydrogen fuel cells.

UNIT-II

Properties Of Nano Materials: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and declinations. Effect of Nano-dimensions on Materials Behaviour: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

Application: high-density data storage and magnetic sensors

UNIT-III

Manufacturing Methods: Bottom-up approaches: Physical Vapour Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapour Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top-down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing, Cold isostatic pressing, Spark plasma sintering.

Application:

Bulk nanostructured alloys for aerospace and automotive applications

UNIT-IV

Characterization of Nanomaterials: X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FIM), Three-dimensional Atom Probe, Nano indentation.

Application:

Measures the hardness and elastic modulus of individual nanoparticles

UNIT-V

Applications of Nano Materials: Nano-electronics, Micro- and Nano electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology.

Application:

Solar cells, Batteries and water purification systems

Textbooks

1. Charles. P. Poole Jr & Frank J. Owens, Introduction to Nanotechnology, Wiley-Inter science.
2. A.K. Bandyopadhyay, Nano Materials, New Age International Pvt Ltd Publishers.
3. T. Pradeep, Nano: The Essentials, McGraw Hill Education.

References

1. S.O. Pillai, Solid State Physics, New Age International Private Limited.
2. Charles Kittel, Introduction to solid state physics, Wiley & Sons (Asia) Pvt Ltd.

Web Sources References:

1. <https://www.youtube.com/watch?v=oN1I09LpygE&list=PLMlC7Vx5awsenMs5y02xcW6i5NmdEIRGx&index=2>
 2. <https://www.youtube.com/watch?v=jryDvx7VNxw&list=PLyqSpQzTE6M8682dGkNTN8936vSY4CbqZ&index=15>
 3. https://www.youtube.com/watch?v=mva_njonj2Y&list=PLbMVogVj5nJTdeiLvuGSB_AE8hloTAHWJ&index=3
 4. <https://www.youtube.com/watch?v=JffF6AqWCHE>
-

Course code	Course Title	L	T	P	Credits
R23MEC-OE0007	AI and ML In Manufacturing (Open Elective)	3	0	0	3

Course Objectives:

The main objectives of this course are to:

- Introduce the fundamentals of Artificial Intelligence (AI) and its relevance to modern manufacturing systems.
- Enable students to understand and apply AI techniques like Machine Learning, Expert Systems, and Fuzzy Logic in industrial scenarios.
- Familiarize students with AI applications in predictive maintenance, quality control, process optimization, and robotics.
- Develop the ability to analyze manufacturing data using AI-based decision-making tools.
- Encourage innovation in smart manufacturing by integrating AI with Industry 4.0 technologies.

Course Outcomes:

After completing this course, the students will be able to:

1. Explain the role and benefits of Artificial Intelligence in modern manufacturing and Industry 4.0. (L2)
2. Apply machine learning algorithms to real-world problems like fault detection and predictive maintenance in manufacturing. (L3)
3. Develop expert systems to support manufacturing decision-making and diagnostics. (L6)
4. Analyze and implement fuzzy logic and neural network models for manufacturing process control. (L4)
5. Evaluate advanced AI applications in smart robotics, digital twins, and AI-driven production systems. (L5)

UNIT I:

Introduction to AI in Manufacturing: Definition and scope of AI in engineering, Evolution of AI and its relationship with automation, Traditional automation vs. AI-based decision-making, Role of AI in Industry 4.0 and Smart Factories, Cyber-Physical Systems (CPS) and AI, Benefits and limitations of AI in manufacturing, Case studies: AI in production lines, real-time process control

UNIT II:

Machine Learning for Manufacturing Systems: Overview of ML algorithms and relevance to manufacturing, Supervised, unsupervised, and reinforcement learning, Classification (SVM, Decision Trees, k-NN) and Regression models, Clustering techniques (K-means, Hierarchical) for pattern detection, Feature engineering and preprocessing of sensor data, Predictive maintenance using historical data, Intro to deep learning: CNN and RNN applications in fault detection, Tools: Python, Scikit-learn, TensorFlow, MATLAB

UNIT III:

Expert Systems and Knowledge Representation: Components of an expert system: knowledge base, inference engine, user interface, Rule-based reasoning and IF-THEN rule chaining, Certainty factors and decision trees, Knowledge acquisition methods: interviews, machine learning, simulations, Semantic networks, ontologies, and frames, AI-based troubleshooting and fault diagnostic systems, Case study: Expert systems in CNC, PLCs, and maintenance management

UNIT IV:

Fuzzy Logic and Neural Networks in Manufacturing : Fundamentals of fuzzy logic and fuzzy inference systems, Designing fuzzy rule-based controllers, Integration of fuzzy logic with PLCs and SCADA, Neural networks: architecture, activation functions, training algorithms, Backpropagation and real-time adaptation, Process optimization using neural networks and fuzzy hybrid models, Applications: welding control, casting defect prediction, tool wear monitoring

UNIT V:

AI Applications in Smart Manufacturing: Intelligent robotics and AI-based path planning, Machine vision systems and defect detection, Digital twins and virtual commissioning, AI in production planning and real-time scheduling, Role of AI in quality assurance and adaptive control, AI in smart inventory management and logistics, Ethical implications and challenges in AI implementation, Case studies: AI in aerospace, automotive, and healthcare manufacturing

Textbooks:

1. **Russell, Stuart J., and Peter Norvig**, *Artificial Intelligence: A Modern Approach*, Pearson Education, 3rd Edition, 2019.
2. **Dan W. Patterson**, *Introduction to Artificial Intelligence and Expert Systems*, PHI Learning, 2009.
3. **M. Gopal**, *Applied Machine Learning*, McGraw-Hill Education, 2018.
4. **Ramesh Babu**, *Artificial Intelligence in Mechanical and Industrial Engineering*, SciTech Publications, 2022 (Indian Author)

Reference Books:

1. **V.S. Janakiraman, K. Sarukesi, P. Gopalakrishnan**, *Foundations of AI and Expert Systems*, Macmillan India, 2019 (Indian Author)
2. **David Forsyth**, *Applied Machine Learning*, Springer, 2019.
3. **Donald A. Waterman**, *A Guide to Expert Systems*, Pearson, 2018.
4. **S. N. Sivanandam**, *Principles of Soft Computing*, Wiley India, 2nd Edition, 2011 (covers fuzzy logic and neural networks)

Online Resources:

Coursera – AI for Everyone (by Andrew Ng)

<https://www.coursera.org/learn/ai-for-everyone>

edX – Artificial Intelligence in Manufacturing (by RWTH Aachen University)

<https://www.edx.org>

MIT OpenCourseWare – Artificial Intelligence

<https://ocw.mit.edu>

Google AI – Research and Tools

<https://ai.google>

YouTube – AI in Industry by Analytics Vidhya / Siemens

<https://www.youtube.com>

Course code	Course Title	L	T	P	Credits
R23MEC-OE0008	Automation in Manufacturing (Open Elective)	3	0	0	3

Course Objectives:

The main objectives of this course are to:

- Understand the concept of automation and process control systems.
- Classify the automated flow lines and analyze automated flow lines
- Able to balance the operations on assembly line.
- Design automated material handling systems.
- Understand the level of automation in continuous and discrete manufacturing systems.

Course Outcomes:

1. **Understand** the characteristics of Automated Systems. (L2)
2. **Illustrate** operational aspects of flow lines.(L2)
3. **apply** the methods to balance the assembly line(L3)
4. **Compare** conventional and automated material transport, storage system.(L2)
5. **Explain** the level of automation in continuous and discrete manufacturing industries.(L2)

Unit-I

Introduction To Automation: Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies, levels of automation, Basic elements of an automated system, Types of production, pneumatic and hydraulic components, circuits, automation in foundry industries, automation in machine tools, mechanical feeding and tool changing and machine tool control. Economical and technological factors for automation. Barriers of automation in manufacturing industries.

Applications:

- Automated Material Handling System in Manufacturing
- Automation in Machine Tools for Precision Manufacturing

Unit-II

Automated Flow Lines: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

Applications:

- Automated Conveyor Systems in Assembly Lines
- Buffer Storage in Automotive Manufacturing

Unit-III

Assembly Line Balancing: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

FMS: Types of FMS, components of FMS, Types of flexibility, types of FMS layouts, applications, scope for FMS in manufacturing today, group technology, hierarchy of computer control in FMS, economic justification of FMS planning, scheduling and control of FMS

Applications:

- Optimized Assembly Line Balancing in Electronics Manufacturing
- Flexible Manufacturing Systems (FMS) in Automotive Production

Unit-IV

Material Handling Systems: Introduction to Material Handling, Basic Principles, Material Transport equipment, analysis of material transport systems, Automated Guided Vehicle Systems, Generalized Theories Governing the Mechanical Design Parameters of Handling Systems storage systems–storage system performance and location strategies, Conventional storage methods and equipment, Automated Storage and Retrieval System (ASRS) and Its Types, Applications of ASRS,Engineering analysis of storage systems. ASRS and Industry 4.0

Automatic Identification Methods: Overview of Identification Methods, Barcode technology, Radio frequency identification, other AIDC technologies, benefits of AIDC.

Applications:

- Automated Storage and Retrieval System (ASRS) in Warehousing
- Radio Frequency Identification (RFID) in Supply Chain Management

Unit-V

Industrial Control Systems: Process industries Vs Discrete manufacturing industries, levels of automation in the two industries, variables and parameters in the two industries. Continuous Vs Discrete control –continuous control system, discrete control system.

Automated Inspection And Assembly: Fundamentals, inspection principles, types of inspection methods and equipment, Quality function deployment, Coordinate Measuring Machines, Machine Vision, Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems, Multi- Station Assembly Machines, Single Station Assembly Machines.

Applications:

- Industrial Control Systems in Chemical Processing Plants
- Machine Vision-Based Automated Inspection in Automotive Manufacturing

Text Books:

1. M.P. Groover, Automation, Production systems and Computer Integrated Manufacturing, 3/e, PHI
2. Learning.
3. Geoffrey Boothroyd, Assembly Automation and Product design, Taylor and Francis Publishers.

Reference Books:

1. Krishna Kant, Computer based industrial control, Prentice Hall of India.
 2. Tiess Chiu chang and A. W. Richard, An introduction to automated process planning systems, Tata Mc Graw Hill.
 3. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel, Nicholas, G. Odrey, Industrial Robotics, McGraw Hill.
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Course Code	Subject Name	L	T	P	C
R23CSE-OE0001	PYTHON PROGRAMMING	3	0	0	3

Course Objectives:

- Understand the structure and data types of Python script.
- Implement iterations and functions in Python.
- Implement modules and understand packages.
- Implement data structures using mutable & immutable objects.
- Understand object-oriented concepts and Exception handling.

Course Outcomes:

- Implement Basic Python programming Fundamentals for Computation of Expression [L3]
- Apply Iterators and functions in data processing.[L3]
- Understand modules and packages to leverage powerful libraries for data science tasks.[L2]
- Implement sequences and data structures for data organization.[L3]
- Implement object-oriented principles in Python, handling run-time errors.[L3]

Unit I:

Hours:10

Introduction: History of Python, Features of Python, Applications, Python Using the REPL (Shell), Running Python Scripts, Variables, Assignment forms, Keywords, Input-Output, Indentation.

Operators and Type Conversion: Data Types: Numeric, Booleans, Sequence, Strings, Type Conversions, Operators, Operator Precedence, Evaluation of Expressions.

Learning Outcomes: After completing this chapter, students will be able to

- Understand the environment of Python. (L2)
- Write and run simple scripts in Python. (L3)
- Implement Type conversion techniques. (L3)

Unit II:

Hours:10

Control Flow: Conditional statements (if, else, elif), Looping structures (for, while, for-else, while-else) Transfer Control Statements: break, continue, pass.

Functions: Defining Functions, Calling Functions, Types of Arguments: Keyword Arguments, Default Arguments, Variable-length arguments, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables, Anonymous Functions, Lambda, map, reduce and filter.

Learning Outcomes: After completing this chapter, students will be able to

- Understand the iterations using looping structures.(L2)
- Implement Python functions.(L3)

Unit III:**Hours:9**

Modules: Creating modules, import statement, from import statement, namespace, built-in modules- OS, random, Math, JSON, request, date, RegEx, itertools

Packages: Introduction to PIP, Installing packages using PIP.

Exploring Data Science Libraries: NumPy, Pandas, Data visualization: Matplotlib

Learning Outcomes: After completing this chapter, student will be able to

- Understand modules (L2)
- Understand data science libraries.(L2)

Unit IV:**Hours:10**

Strings & Data Structures: String, String Formatting, List, String and List Slicing, Tuple, Sets, Frozen Sets, Dictionaries, Comprehensions, Built-in methods of all sequences, File Handling: Reading and writing files, File modes and file objects

Learning Outcomes: After completing this chapter, student will be able to

- Implement different data structures in Python.(L3)
- Understand different file handling Operations.(L2)

Unit V:**Hours:09**

Object Oriented Programming OOP in Python: Classes, 'self- variable', Methods, Constructor, Inheritance, Polymorphism, and Data Abstraction.

Errors and Exceptions: Syntax Errors, Exceptions, Exception Handlers, Raising Exceptions, User-defined Exceptions.

Learning Outcomes: After completing this chapter, student will be able to

- Understand Object oriented concepts with real world scenarios.(L2)
- Implement exceptions in Python.(L3)

TEXT BOOKS:

1. Let Us Python by Yashavant Kanetkar ,Aditya Kanetkar ,6th edition, BPB Publication
2. Python Programming: Using Problem Solving Approach by Reema Theraja, 2nd edition, Oxford publications.

REFERENCE BOOKS:

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
2. Learning Python, Mark Lutz, Orielly.
3. Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2nd Edition, Pearson, 2024

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH:3; MEDIUM:2; LOW:1):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	3	2	2	2	3				3			1	2	3	3
	3	3	2	2	3				3			1	2	3	3
	3	3	2	2	3				3			1	2	3	3
	3	3	3	2	3				3			1	2	3	3
	3	3	3	3	3				3			1	2	2	3
	3	3	3	2	3				3			1	2	3	3

* For Entire Course, PO & PSO Mapping

Course Code	Subject Name	L	T	P	C
R23CSE-OE0002	DATA STRUCTURES USING C	3	0	0	3

Course Objectives:

1. To teach efficient storage mechanisms of data for an easy access.
2. To develop application using data structures.
3. To improve the logical ability

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

1. Compare the performances of various Searching and Sorting techniques in terms of time and space complexities.
2. Illustrate the applications of Stacks.
3. Implement various types of Queues and their efficient operations.
4. Demonstrate the advantages of dynamic memory allocation via linked lists.
5. Implement the basic operations, search and traversals on Trees.

UNIT-I

Time and space complexity, Data Structures – Introduction to Data Structures, abstract data types, Searching and Sorting – Sorting- selection sort, bubble sort, insertion sort, quick sort, merge sort, shell sort, radix sort, Searching-linear and binary search methods, comparison of sorting and searching methods.

UNIT –II

Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, circular linked list implementation, Double linked list implementation, insertion, deletion and searching operations. Applications of linked lists.

UNIT-III

Stacks-Operations, array and linked representations of stacks, stack applications -infix to postfix conversion, postfix expression evaluation, recursion implementation.

UNIT-IV

Queues-operations, array, and linked representations. Circular Queue operations, Dequeues, applications of queues.

UNIT-V

Trees – Definitions, tree representation, properties of trees, Binary tree, Binary tree representation, binary tree properties, binary tree traversals, binary tree implementation, applications of trees.

Text Books:

1. Fundamentals of Data structures in C, 2nd Edition, E.Horowitz, S.Sahniand Susan Anderson-Freed, Universities Press, 2008.
2. Data structures A Programming Approach with C, 2nd Edition D.S.Kushwaha and A.K.Misra, PHI, 2007.

References:

1. Data structures: A Pseudocode Approach with C, 2nd edition, R.F.GilbergAndB.A.Forouzan, CengageLearning.
2. Data structures and Algorithm Analysis in C, 2nd edition, M.A.Weiss, Pearson.
3. Data Structures using C& C ++,2nd Edition A.M.Tanenbaum,Y. Langsam, M.J.Augenstein, Pearson.
4. Data structures and Program Design in C, 2nd edition, R.Kruse, C.L.TondoandB.Leung,Pearson

Course Code	Subject Name	L	T	P	C
R23CSE-OE0003	OPERATING SYSTEM CONCEPTS	3	0	0	3

Course Objectives

1. Provide knowledge about the services rendered by operating systems.
2. Present detail discussion on processes, threads and scheduling algorithms.
3. Discuss various file-system implementation issues and memory management techniques.

Course Outcomes:

1. Understand the importance of operating systems and different types of system calls.
2. Analyze the communication between processes and various process scheduling algorithms.
3. Understand the process synchronization, different ways for deadlocks handling.
4. Analyze various memory mapping techniques and different page replacement methods.
5. Evaluate various file allocation and disk scheduling algorithms.

UNIT-I: Operating Systems Overview:

Introduction: what is an operating system, Types of operating systems, operating systems concepts, operating systems services, Introduction to System call, System call types, Operating System Generation.

UNIT-II: Process Management:

Process concept: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication.

Multithreaded Programming: Overview, Multithreading models, Threading Issues.

Process scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

UNIT-III: Synchronization:

Process Synchronization: The Critical-Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization examples.

Principles of deadlock – System Model, Deadlock Characterization, Deadlock Prevention, Detection and Avoidance, Recovery from Deadlock.

UNIT-IV: Memory Management:

Memory Management strategies: Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table.

Virtual Memory Management: Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing.

UNIT-V: File system Interface- The concept of a file, Access Methods, Directory and Disk structure, File system mounting.

File System implementation: File system structure, allocation methods, free-space management.

Mass-storage structure: Overview of Mass-storage structure, Disk scheduling, Device drivers.

Text Books:

1. Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 10th edition, Wiley, 2013.
2. Tanenbaum A S, Modern Operating Systems, 4th edition, Pearson Education, 2008.
(for Interprocess Communication and File systems).

References:

- i. Tanenbaum A S, Woodhull A S, Operating Systems Design and Implementation, 3rd edition, PHI, 2006.
- ii. Dhamdhare D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw-Hill, 2012.
- iii. Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009.
- iv. Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004.

Course Code	Subject Name	L	T	P	C
R23CSE-OE0004	INTRODUCTION TO JAVA PROGRAMMING	3	0	0	3

Course Objectives

1. Understand the structure and environment of Java.
2. Implement the relationship between objects.
3. Understand the Strings and Organize data using different data
4. Implement text processes and error handling.
5. Understand to create multi threading applications and GUI applications.

Course Outcomes:

1. Understand the environment of JRE and Control Statements. (L2)
2. Implement real world objects using class Hierarchy (L3)
3. Implement generic data structures for iterating distinct objects (L3)
4. Implement error handling through exceptions and file handling through streams. (L3)
5. Design thread-safe GUI applications for data communication between objects (L4)

Unit I: Java Environment and Program Structure (10 Hours)

History of Java, Features, Applications, Java Installation - JDK and JRE, JVM Architecture, OOPS Principles, Class and Object, Naming Convention, Data Types, Type Casting, Type Conversion, Wrapper classes, Operators, instance of operator, Command Line Arguments, Decision making, Arrays, and Looping statements.

Learning Outcomes: Student will be able to

1. Understand architecture of Java Virtual Machine. (L2)
2. Understand the structure of java program and its environment. (L2)

Unit II: Class Hierarchy & Data Hiding (10 Hours)

Property, Method, Constructor, Inheritance (IS-A) , Aggregation and Composition (HAS-A), this and super, static and initialize blocks, Method overloading and overriding, static and final keywords, Types of Inheritance, Compile time and Runtime Polymorphism, Access Specifiers and scope, packages and access modifiers, Abstract class, Interface, Interface Inheritance, Achieving Multiple Inheritance, Class casting, Object Cloning, Inner Classes.

Learning Outcomes: Student will be able to

1. Understand the class hierarchy and their scope. (L2)
2. Implement relationship between objects. (L3)
3. Understand data hiding and nested classes. (L2)
4. Implement data type casting and cloning of objects. (L3)

Unit III: Strings and Collections (10 Hours)

String: Methods, StringBuffer and StringBuilder, StringTokenizer

Collections: Exploring java.util.*, Scanner, Iterable, Collection Hierarchy, Set, List, Queue and Map, Comparable and Comparator, Iterators: foreach, Enumeration, Iterator and ListIterator.

Learning Outcomes: Student will be able to

1. Understand the usage of String and its properties and methods.(L2)
2. Understand data structures and Iterators. (L2)
3. Create the data structures and implement different utility classes. (L3)

Unit IV: IO and Error Handling (10 Hours)

IO Streams: Exploring java.io.*, Character and Byte Streams, Reading and Writing, Serialization and De-serialization, Error Handling: Error vs Exception, Exception hierarchy, Types of Exception, Exception handlers, User defined exception, Exception propagation.

Learning Outcomes: Student will be able to

1. Understand character and byte streams. (L2)
2. Understand the hierarchy of errors and exceptions. (L2)
3. Implement data streams and exception handlers. (L3)

Unit V: Threads and GUI (8 Hours)

Multi-Threading: Process vs Thread, Thread Life Cycle, Thread class and Runnable Interface, Thread synchronization and communication.

GUI: Component, Container, Applet, Applet Life Cycle, Event delegation model, Layouts, Menu, MenuBar, MenuItem.

Learning Outcomes: Student will be able to

1. Understand the Thread Life Cycle and its scheduling.(L2)
2. Implement the synchronization of threads. (L2)

TEXT BOOKS:

1. The complete Reference Java, 8th edition, Herbert Schildt, TMH.
2. Programming in JAVA, Sachin Malhotra, SaurabhChoudary, Oxford.
3. Introduction to java programming, 7th edition by Y Daniel Liang, Pearson.
4. Java: How to Program, 9th Edition (Deitel) 9th Edition.
5. Core Java: An Integrated Approach, Java 8 by R. Nageswara Rao.

REFERENCE BOOKS:

1. Swing: Introduction, JFrame, JApplet, JPanel, Componets in Swings, Layout Managers
2. Swings, JList and JScrollPane, Split Pane, JTabbedPane, JTree, JTable, Dialog Box.

Weblinks:

1. <https://www.javapoint.com/>
2. <https://www.sitesbay.com/java/index>
3. <https://www.tutorialspoint.com/java/index.htm>
4. <https://www.w3schools.com/java/>
5. <https://www.programiz.com/java-programming>

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

SNO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	1	2				1			1	3	1	2
CO2	3	3	2	2	2				2			1	3	1	2
CO3	3	3	2	1	2				2			1	3	1	2
CO4	3	3	2	1	2				2			1	3	1	2
CO5	3	3	2	1	2				2			1	3	1	2

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0005	DATA BASE MANAGEMENT SYSTEMS CONCEPTS	3	0	0	3

Course Objectives:

1. Train in the fundamental concepts of database management systems, database modeling and design, SQL, PL/SQL, and System implementation techniques.
2. Enable students to model ER diagram for any customized applications.
3. To learn the principles of systematically designing and using large scale Database Management Systems for various applications.

Course Outcomes:

1. Understand the usage of Key Constraints on Database.
2. Describe ER model and normalization for database design.
3. Create, maintain, and manipulate a relational database using SQL.
4. Understand efficient data storage and retrieval mechanism, recovery techniques.
5. Design and build database system for a given real world problem.

UNIT-I:

An Overview of Database Management: Introduction- Importance of Database System, Data Independence- Relation Systems and Others- Summary, Database system architecture, Introduction- The Three Levels of Architecture-The External Level- the Conceptual Level- the Internal Level- Mapping- the Database Administrator-The Database Management Systems- Client/Server Architecture.

UNIT-II:

The E/R Models: The Relational Model, Relational Calculus, Introduction to Database Design, Database Design and ER Diagrams-Entities Attributes, Entity Sets-Relationship and Relationship Sets-Conceptual Design with the ER Models.

The Relational Model: Integrity Constraints Over Relations- Key Constraints –Foreign Key Constraints-General Constraints, Relational Algebra and Calculus, Relational Algebra- Selection and Projection- Set Operation, Renaming – Joins- Division- More Examples of Queries, Relational Calculus - Tuple Relational Calculus, Domain Relational Calculus.

UNIT-III:

Queries, Constraints, Triggers: The Form of Basic SQL Query, Union, Intersect, and Except, Nested Queries, Aggregate Operators, Null Values, Complex Integrity Constraints in SQL, Triggers and ActiveDatabase.

Schema Refinement (Normalization) : Purpose of Normalization or Schema Refinement, Concept of Functional Dependency, Normal Forms Based on Functional Dependency(1NF, 2NF and 3 NF), Concept of Surrogate Key, Boyce-Codd Normal Form(BCNF), Lossless Join and Dependency Preserving Decomposition, Fourth Normal Form(4NF).

UNIT-IV:

Transaction Management and Concurrency Control:

Transaction, Properties of Transactions, Transaction Log, Transaction Management with SQL using Commit Rollback and Save Point, Concurrency Control for Lost Updates, Uncommitted Data, Inconsistent Retrievals, and the Scheduler.

Concurrency Control with Locking Methods: Lock Granularity, Lock Types, Two Phase Locking For Ensuring Serializability, Deadlocks, Concurrency Control with Time Stamp Ordering: Wait/Die and Wound/Wait Schemes, Database Recovery Management : Transaction Recovery.

UNIT-V:

Overview of Storages and Indexing: Data on External Storage- File Organization and Indexing – Clustered Indexing – Primary and Secondary Indexes, Index Data Structures, Hash-Based Indexing – Tree- Based Indexing, Comparison of File Organization.

Text Books:

1. Introduction to Database Systems, 8th Edition CJ Date, Pearson, 2004.
2. Data base Management Systems, Raghurama Krishnan, Johannes Gehrke, TATAMcGraw Hill 3rd Edition.

References Books:

1. Data base Systems design, Implementation, and Management, Peter Rob & Carlos Coronel 13th Edition.
2. Fundamentals of Database Systems, 7th Edition Elmasri Navrate Pearson Education.
3. Database Systems - The Complete Book, 2nd edition H G Molina, J D Ullman, J Widom Pearson.
4. Data base System Concepts, 7th edition, Silberschatz, Korth, McGraw Hill (TMH).

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0006	UNIX and Shell Programming	3	0	0	3

Course Objectives:

- To provide an overview of the history, development, and significance of UNIX/Linux in computing.
- To provide skills in diagnosing common problems, log analysis, and troubleshooting techniques in a UNIX/Linux environment.
- To provide an overview of system administration tasks such as user management, backup and restore, system monitoring, and software installation.
- To explain file systems, mounting, disk usage, file permissions (chmod), and file attributes (chown).

Course Outcomes:

- Understand the architecture and features of UNIX. (L2)
- Apply the commands for implementation of the File System. (L3)
- Understand the Streams, Pipes and Filters. (L2)
- Apply the pattern reorganization commands and scripting concepts. (L3)
- Implementation of system calls for file system. (L3)

Unit 1 (10 Hours)

Introduction to Unix:

Introduction to Unix-Brief History-What is Unix-Unix Components-Using Unix-Commands in Unix-Some Basic Commands-Command Substitution-Giving MultipleCommands.

Learning Outcomes: Student will be able to

- Understand the origins and development of Unix. (L2)
- Learn the key milestones in the evolution of Unix (L3)
- Learn how to use command substitution to streamline tasks. (L3)

Unit 2 (8 Hours)

Unix Utilities:

Introduction to Unix file system, vi editor, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands, unlink, du, df, mount, unmount, find, unmask, ulimit, ps, w, finger, Arp, ftp, telnet, rlogin. Text processing utilities and backup utilities , detailed commands to be covered are tail, head , sort, nl, uniq, grep, egrep, fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio

Learning Outcomes: Student will be able to

1. Learn the organization and layout of the Unix directory hierarchy. (L2)

2. File Attributes and Permissions: Understand the various file attributes and how permissions work. (L2)

Unit 3 (10 Hours)

Introduction to Shells:

Using the Shell-Command Line Structure-Met characters- Creating New Commands-Command Arguments and Parameters-Program Output as Arguments-Shell Variables- -More on I/O Redirection- Looping in Shell Programs.

Filters:

Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count characters, Words or Lines, Comparing Files.

Learning Outcomes: Student will be able to

1. Understand the role and management of variables in the Unix shell. (L2)
2. Gain advanced knowledge of input/output redirection in Unix. (L3)
3. Learn how to implement loops in shell scripts. (L3)

Unit 4 (12 Hours)

Grep: Operation, grep Family, Searching for File Content.

Sed:Scripts, Operation, Addresses, commands, Applications, grep and sed.

Shell Programming:

Basic Script concepts, Expressions, Decisions: Making Selections, Repetition, special Parameters and Variables, changing Positional Parameters, Argument Validation, Debugging Scripts, Script Examples.

Learning Outcomes: Student will be able to

1. Understand the basics of awk for pattern scanning and text processing (L2)
2. Learn best practices for creating and using effective filters and well-structured files in Unix. (L3)

Unit 5 (8 Hours)

File Management:

File Structures, System Calls for File Management – create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir, closedir, mkdir, rmdir, umask.

Learning Outcomes: Student will be able to

1. Learn how to change file ownership using the chown command.(L2)
2. Understand how to change the group ownership of a file using the chgrp command.(L2)

TEXT BOOKS:

1. Unix and shell Programming Behrouz A. Forouzan, Richard F. Gilberg.Thomson
2. Your Unix the ultimate guide, Sumitabha Das, TMH. 2nd Edition.

REFERENCE BOOKS:

- Unix for programmers and users, 3rd edition, Graham Glass, King Ables, Pearson Education.
- Unix programming environment, Kernighan and Pike, PHI. / Pearson Education.
- The CompleteReference Unix, Rosen, Host, Klee, Farber, Rosinski, Second Edition, TMH.

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

Cos	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	3				1		1	1	2	3	3
CO2	3	2	2	1	3				1		1	1	2	3	3
CO3	3	3	3	2	3				1		1	2	3	3	3
CO4	3	3	3	2	3				2		1	2	3	3	3
CO5	2	2	2	2	2				2		1	1	2	2	2

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0007	SOFTWARE ENGINEERING	3	0	0	3

Course Objectives:

1. Explain the phases of Software Development.
2. Teach the customer requirement gathering techniques.
3. Teach Software Design techniques
4. Demonstrate coding standards
5. Apply the testing techniques on software

Course Outcomes:

Students will be able to:

1. Understand the need of Software Life Cycle Models (L1)
2. Demonstrate the Requirements of the Software Systems process (L2)
3. Summarize the system models of software engineering (L2)
4. Choose appropriate software architecture style for real-time software projects (L3)
5. Analyze various testing techniques, Risk management and Software quality of the software products(L4)

UNIT-1

Introduction: Introduction to Software Engineering, Evolving role of Software, Software Crisis, Changing Nature of Software, Software myths, Process Models for Software Development, Waterfall, prototyping Evolutionary models: Incremental model, Spiral model, Agile developmental process.

Learning Outcomes:

At the end of the module, students will be able to:

1. List the steps involved in software development. (L1)
2. Explain myths of software. (L2)
3. Apply various software process models (L3)

UNIT-2

Software Requirements Engineering: Functional & Non-functional requirements, Feasibility studies, Requirements Elicitation and Analysis, requirements validation, Software Requirements Specification, Process and System Models, context models, behavioural model, Data model.

Learning Outcomes:

At the end of the module, students will be able to:

1. Explain software development model (L2)
2. Define functional and non-functional requirements for software development (L1)
3. Analyse user requirements for a software(L4)

UNIT-3

Design Engineering: Design concepts, data design, software architecture, Architectural styles and patterns, User interface design - Golden rules, User interface analysis and design, Effective Modular Design.

Learning Outcomes:

At the end of the module, students will be able to:

1. List the software architecture style for the given problem. (L1)
2. Build Golden rules for the given problem (L3)
3. User Interface Analysis and Design (L5)

UNIT-4

Coding&Testing: Coding standards, code review and verification, Testing levels: Unit testing, integration testing, system testing . alpha and beta testing, black box and white box testing, debugging.

Learning Outcomes:

At the end of the module, students will be able to:

1. Implementation of coding standards(L6)
2. Apply different Testing concepts (L3)

UNIT-5

Risk Management: Risk types, strategies, Estimation and Planning. Software Quality .McCall Quality factors, Six Sigma for Software Quality, Quality Assurance and its techniques.

Applications: analyze the risks in any software project

Learning Outcomes:

At the end of the module, students will be able to:

1. Evaluate different Risk management techniques. (L5)

Text books:

1. Roger S. Pressman, Software Engineering, A practitioner.s Approach, 7thEdition, McGraw-Hill International Edition, 2009
2. Rajib Mal, Fundamentals of software Engineering, 3rdEdition, Eastern Economy Edition, 2009

Reference books:

1. Sommerville, Software Engineering, 7thEdition, Pearson education, 2004
2. K KAggarwal and Yogeshsingh, Software engineering,3rd Edition,New age International publication,2008

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0008	Introduction to Data Mining	3	0	0	3

COURSE OBJECTIVES:

- Students will be enabled to understand and implement classical models and algorithms in data warehousing and data mining.
- They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.
- They will further be able to assess the strengths and weaknesses of various methods and algorithms and to analyze their behavior.

COURSE OUTCOMES:

- Understand the process of knowledge discovery from data.
- Analyze the Data Pre-processing techniques.
- Apply classification techniques to various data sets.
- Apply the association rule mining to real time applications
- Apply the clustering algorithms to various data sets.

UNIT –I:

Introduction: Why Data Mining? What Is Data Mining? What Kinds of Data Can Be Mined? What Kinds of Patterns Can Be Mined? Which Technologies Are Used? Which Kinds of Applications Are Targeted? Major Issues in Data Mining. Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity

Learning Outcomes: Student should be able to

1. Summarize the process of Data mining.(L2)
2. Classify various kinds of Data Mining techniques.(L2)
3. Memorize different visualization techniques.(L1)
4. Differentiate a data warehouse with data mining(L4)

UNIT –II:

Data Pre-processing: Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

Learning Outcomes: Student should be able to

1. Recognize various steps in Data Preprocessing.(L1)
2. Identify the process of handling noisy data.(L1)

UNIT –III:

Classification: Basic Concepts, General Approach to solving a classification problem, Decision Tree Induction: Working of Decision Tree, building a decision tree, methods for expressing an attribute test conditions, measures for selecting the best split, Algorithm for decision tree induction.

Classification: Alternative Techniques, Bayesian Classifier: Bayes theorem, using bayes theorem for classification, Native Bayes Classifier: Bayes error rate, Bayesian Belief Networks: Model representation, model building (Tan)

Learning Outcomes: Student should be able to

1. Summarize the process of classification.(L2)
2. Apply the process of classification on sample data.(L3)
3. Construct a decision tree for any sample data.(L3)
4. Calculate Bayes probability for any given data(L3)
5. Calculate Naïve Bayes probability.(L3)

UNIT –IV:

Association Analysis: Basic Concepts and Algorithms: Problem definition, Frequent Item Set generation, Rule generation, compact representation of frequent item sets, FP-Growth Algorithm. **(Tan & Vipin)**

Learning Outcomes: Student should be able to

1. Apply the Apriori algorithm on any sample data.(L3)
2. Construct an FP tree for any sample data. (L3)

UNIT –V

Cluster Analysis: Basic Concepts and Algorithms: Overview: What Is Cluster Analysis? Different Types of Clustering, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Bisecting K-means, Strengths and Weaknesses; Agglomerative Hierarchical Clustering: Basic Agglomerative Hierarchical Clustering Algorithm DBSCAN: Traditional Density Center-Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. **(Tan & Vipin)**

Learning Outcomes: Student should be able to

1. Identify the data objects and partition them into different clusters.(L2)
2. Apply the different clustering techniques on sample data.(L3)
3. Acquire the knowledge of The strength and weakness of clustering algorithms.(L2)

TEXT BOOKS:

1. Introduction to Data Mining: Pang-Ning Tan & Michael Steinbach, Vipin Kumar, Pearson.
2. Data Mining concepts and Techniques, 3/e, Jiawei Han, Michel Kamber, Elsevier.

REFERENCE BOOKS:

1. Data Mining Techniques and Applications: An Introduction, Hongbo Du, Cengage Learning.
2. Data Mining : VikramPudi and P. Radha Krishna, Oxford.
3. Data Mining and Analysis - Fundamental Concepts and Algorithms; Mohammed J. Zaki, Wagner Meira, Jr, Oxford
4. Data Warehousing Data Mining & OLAP, Alex Berson, Stephen Smith, TMH.

MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

COs	P O 1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	P O1 0	P O1 1	P O1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2				1			2	2	1	2
CO2	2	3	2	1	2				1			2	2	1	1
CO3	3	2	2	1	2				1			2	2	1	1
CO4	3	3	2	2	2				1			2	2	1	3
CO5	3	2	3	1	2				1			2	2	1	2

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0009	FUNDAMENTALS OF WEB TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES:

1. Creating Web User Interfaces
2. Creating dynamic Web pages
3. Implementing the usage of Scripts in Web Pages
4. Analyzing real world objects into Web Pages as Scripts Handlers
5. Analyzing look and feel kind of applications which are useful for real world
6. Web framework implementation using Model View Controller
7. Writing background scripts to run the virtual machines and servers

COURSE OUTCOMES:

1. Demonstrate knowledge on web page design elements.
2. Design web pages with dynamic content
3. Create Responsive layout with customized forms
4. Implement simple client-side scripts using AJAX
5. Build web applications using PHP

UNIT-I:

HTML: Introduction: Fundamentals of HTML, Working with text, Organizing text in HTML, Working with links and URLs, Creating tables, Working with images, Canvas, Forms, Frames and Multimedia.

HTML5: Introduction, HTML5 document structure, Creating editable content, Checking spelling mistakes.

Learning Outcomes:

After completion of this unit, student will be able to

- Identify basic steps that are followed to develop web applications [L2]
- Understand the functions of different HTML5 tags and how to use them [L2]
- Design and develop basic web pages using HTML5[L3]

UNIT-II:

CSS AND JAVASCRIPT: CSS: Introduction, CSS selectors, Inserting CSS in an HTML document, Backgrounds, Fonts and Text styles, Creating boxes, Displaying, Positioning and floating elements, Features of CSS3,Media queries. JavaScript: Overview of JavaScript, JavaScript functions, Events, Image maps and animations, JavaScript objects, working with browser and document objects.

Learning Outcomes:

After completion of this unit, student will be able to

- Learn the basic syntax of the CSS Style rule[L2]
- Get an idea about different CSS Selectors[L2]
- Use style rules to apply styles to different elements[L3]
- Understand HTML5 DOM object hierarchy[L2]
- Understand java script event handling mechanism[L2]

UNIT -III:

JQUERY and BOOTSTRAP: JQuery: Introduction, JQuery selectors, Events, Methods to access HTML elements and attribute. Bootstrap: Getting started with Bootstrap, Creating responsive layouts using Bootstrap CSS - Basic HTML structure for Bootstrap, Responsive classes, Rendering images, the grid system, Constructing data entry forms.

Learning Outcomes:

After completion of this unit, student will be able to

- Understanding the Bootstrap file structure[L2]
- Learning the basics of responsive design[L2]
- Understanding the all-important grid system in Bootstrap[L2]
- Introduce Bootstrap as a responsive design framework[L2]

UNIT –IV:

XML: Document type Definition, XML schemas, Document object model, XSLT, DOM and SAX Approaches, AJAX A New Approach: Introduction to AJAX, Integrating PHP and AJAX.

Learning Outcomes:

After completion of this unit, student will be able to

- Learn the basic building blocks of XML Documents [L1]
- Understand how name clashes are avoided using namespaces [L2]
- Learn how to create forms dynamically [L2]
- Learn how to generate dynamic tables[L2]
- Write interactive web applications using AJAX [L3]

UNIT-V:

INTRODUCTION TO PHP: Introduction, Data types, Variables, Constants, Expressions, String interpolation, Control structures, Functions, Arrays, Embedding PHP code in web pages, Object Oriented PHP.PHP Web forms: PHP and web forms, Sending form data to a server, Working with cookies and session handlers PHP with MySQL: Interacting with the database, Prepared statement, Database transactions.

Learning Outcomes:

After completion of this unit, student will be able to

- Examine the relationship between PHP and MySQL L2]
- Plan a PHP Web application [L4]
- Create and use a Logon Window [L6]
- Manage User sessions using cookies and sessions [L3]

Text Books:

1. Kogent Learning Solutions Inc, HTML 5 Black Book: Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP and JQuery, Dreamtech Press, Second Edition, 2016.
2. W. Jason Gilmore, Beginning PHP and MySQL, APress, Fourth Edition, 2011.

Reference Books:

1. Snig Bahumik, Bootstrap Essentials, PACKT Publishing, 2015 (e-book).
2. Thomas A. Powell, The Complete Reference: HTML and CSS, Tata McGraw Hill, Fifth Edition, 2010
3. Andrea Tarr, PHP and MySQL, Willy India, 2012.
4. Ruby on Rails Up and Running, Lightning fast Web development, Bruce Tate, Curt Hibbs, Oreilly (2006)

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

COs	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	P O 10	P O 11	P O 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2				1			2	2	1	2
CO2	2	3	2	1	2				1			2	2	1	1
CO3	3	2	2	1	2				1			2	2	1	1
CO4	3	3	2	2	2				1			2	2	1	3
CO5	3	2	3	1	2				1			2	2	1	2

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0010	FUNDAMENTALS OF COMPUTER NETWORKS	3	0	0	3

Course Objectives:

1. To introduce the fundamental various types of computer networks.
2. To understand state-of-the-art in network protocols, architectures, and applications.
3. To explore the various layers of OSI Model.

Course Outcomes:

The students can

1. Understand OSI and TCP/IP reference models with an emphasis to Physical Layer, Data Link Layer and Network Layer.
2. Analyze the issues related to data link, medium access and transport layers by using channel allocation and connection management schemes. Analyze MAC layer protocols and LAN technologies.
3. Solve problems related to Flow control, Error control, Congestion control and Network Routing.
4. Design and compute subnet masks and addresses for networking requirements.
5. Understand how internet works

UNIT-I:

Introduction: Network Hardware and software Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models, Examples of Networks: Novell Networks, Arpanet, Internet, Network Topologies WAN, LAN, MAN.

Physical Layer: Guided Transmission Media, Digital Modulation and Multiplexing: frequency division multiplexing, wavelength division multiplexing, synchronous time division multiplexing, statistical time division multiplexing.

UNIT-II:

The Data Link Layer - Design Issues, Services Provided to the Network Layer – Framing – Error Control – Flow Control, Error Detection and Correction – Error-Correcting Codes – Error Detecting Codes, Elementary Data Link Protocols, Sliding Window Protocols.

Channel allocation methods: TDM, FDM, ALOHA, Carrier sense Multiple access protocols, Collision Free protocols – IEEE standard 802 for LANS – Ethernet, Token Bus, Token ring, Bridges and IEEE 802.11 and 802.16. Data link layer switching, virtual LANs.

UNIT-III:

Network layer Routing Algorithms: Design Issues, Routing Algorithms-Shortest path, Flooding,

Flow based Distance vector, Link state, Hierarchical, Broadcast routing, Congestion Control algorithms-General principles of congestion control, Congestion prevention policies, Choke packets, Load shedding, and Jitter Control.

Internet Working: Tunnelling, internetworking, Fragmentation, Network layer in the internet– IP protocols, IP address, Subnets, Internet control protocols, OSPF, BGP, Internet multicasting, Mobile IP, IPV6.

UNIT IV:

The Transport Layer: Elements of transport protocols – addressing, establishing a connection, releasing connection, flow control and buffering and crash recovery, End to end protocols: UDP, Real Time Transport Protocol.

The Internet Transport Protocol: TCP- reliable Byte Stream (TCP) end to end format, segment format, connection establishment and termination, sliding window revisited, adaptive retransmission, TCP extension, Remote Procedure Call.

UNIT – V:

Application Layer: WWW and HTTP: Architecture- Client (Browser), Server, Uniform Resource Locator HTTP: HTTP Transaction, HTTP Operational Model and Client/Server Communication, HTTP Generic Message Format, HTTP Request Message Format, HTTP Response Message Format.

The Domain Name System: The DNS Name Space, Resource Records, Name Servers, Electronic Mail: Architecture and Services, The User Agent, Message Formats, Message Transfer, Final Delivery.

Text Books:

1. Data Communications and Networks – Behrouz A. Forouzan, Third Edition ,TMH.
2. Computer Networks, 5ed, David Patterson,Elsevier
3. Computer Networks: Andrew S Tanenbaum, 5th Edition. PearsonEducation/PHI
4. Computer Networks, Mayank Dave, CENGAGE

References:

1. Tanenbaum and David J Wetherall, Computer Networks, 5th Edition, Pearson Edu, 2010
2. Computer Networks: A Top Down Approach, Behrouz A. Forouzan, FirouzMosharraf, McGraw Hill Education
3. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, PearsonEducation.
4. Understanding communications and Networks, 3rd Edition, W.A. Shay, ThomsonThe TCP/IP Guide, by Charles M. Kozierok, Free online Resource,<http://www.tcpipguide.com/free/index.htm>.

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0011	BASICS OF CLOUD COMPUTING	3	0	0	3

Course Objective :

1. To provide students with the fundamentals and essentials of Cloud Computing.
2. To provide students a sound foundation of the Cloud Computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios.
3. To enable students exploring some important cloud computing driven commercial systems and applications.

Course Outcomes :

Upon completion of the course, it is expected that student will be able to:

1. Understand and analyze different computing paradigms
2. Understand the basics of cloud computing and different cloud deployment models.
3. Understand different cloud implementation and management strategies.
4. Understand and evaluate different cloud service models.
5. Identify, analyze and use different cloud services /applications/tools available from key cloud providers.

UNIT-I:

Computing Paradigms: High-Performance Computing, Parallel Computing, Distributed Computing, Cluster Computing, Grid Computing, Cloud Computing, Bio computing, Mobile Computing, Quantum Computing, Optical Computing, Nano computing..

UNIT-II:

Cloud Computing Fundamentals: Motivation for Cloud Computing, The Need for Cloud Computing, Defining Cloud Computing, Definition of Cloud Computing, Cloud Computing is a Service, Cloud Computing is a Platform, Principles of Cloud computing, Five Essential Characteristics, Four Cloud Deployment Models

UNIT-III:

Cloud Computing Architecture and Management: Cloud architecture, Layer, Anatomy of the Cloud, Network Connectivity in Cloud Computing, Applications on the Cloud, Managing the Cloud, Managing the Cloud Infrastructure, Managing the Cloud Application, Migrating Application to Cloud, Phases of Cloud Migration Approaches for Cloud Migration.

UNIT-IV:

Cloud Service Models: Infrastructure as a Service, Characteristics of IaaS. Suitability of IaaS, Pros and Cons of IaaS, Summary of IaaS Providers, Platform as a Service, Characteristics of PaaS, Suitability of PaaS, Pros and Cons of PaaS, Summary of PaaS Providers, Software as a Service, Characteristics of SaaS, Suitability of SaaS, Pros and Cons of SaaS, Summary of SaaS Providers, Other Cloud Service Models.

UNIT-V:

Cloud Providers and Applications : EMC, EMC IT, Captiva Cloud Toolkit, Google Cloud Platform, Cloud Storage, Google Cloud Connect, Google Cloud Print, Google App Engine, Amazon Web Services, Amazon Elastic Compute Cloud, Amazon Simple Storage Service, Amazon Simple Queue service, Microsoft, Windows Azure, Microsoft Assessment and Planning Toolkit, SharePoint, IBM, Cloud Models, IBM Smart Cloud, SAP Labs, SAP HANA Cloud Platform, Virtualization Services Provided by SAP, Sales force, Sales Cloud, Service Cloud: Knowledge as a Service, Rack space, VMware, Manjra soft, Aneka Platform.

Text Book:

- i. Essentials of Cloud Computing, K. Chandra sekhran, CRC press.

Reference Books:

- i. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley.
- ii. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier.
- iii. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumara swamy, Shahed Latif, O'Reilly.

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0012	INTRODUCTION TO MACHINE LEARNING	3	0	0	3

Course Objectives:

- To familiarize with a set of well-known Machine Learning (ML) algorithms.
- The ability to implement machine learning algorithms.
- To understand how machine learning algorithms are evaluated.
- To formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms with their pros and cons.

Course Outcomes:

- Illustrate the characteristics of machine learning algorithms.
- Summarize the process of classification using decision tree approach.
- Apply Bayesian classifier to label data points an ML approach.
- Understand computational and instance-based learning.
- Understand advanced computational and types of learning.

UNIT I: (10 Hours)

Introduction: Well- posed learning problems, designing a learning system, perspectives, and issues in machine learning. Applications of machine learning. **Concept Learning:** Concept learning and the general to specific ordering. Concept learning task, Concept learning as search, Find-s: finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, Remarks on version spaces and candidate elimination, Inductive bias.

Learning Outcomes: Student will be able to

- Summarize the process of machine learning.
- Recognize various machine learning Applications.
- Understand various candidate elimination algorithms

UNIT II: (09 Hours)

Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, the basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning

Learning Outcomes: Student will be able to

- Summarize the process of classification.
- Construct a decision tree for any sample data.

UNIT III: (11 Hours)

Bayesian learning: Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses for predicting probabilities, Bayes optimal classifier, An example learning to classify text, Bayesian belief networks

Learning Outcomes: Student will be able to

- Calculate Bayes probability for any given data.
- Calculate Naïve Bayes probability.
- Distinguish the process of Bayes and Naïve Bayes probability calculation.

UNIT IV: (09 Hours)

Computational learning theory – 1: Probability learning an approximately correct hypothesis, Sample complexity for infinite Hypothesis spaces, The mistake bound model of learning- Instance- Based learning- Introduction.

Learning Outcomes: Student will be able to

- Understand Probability learning and Instance- Based learning.

UNIT V: (09 Hours)

Computational learning theory – 2: K- Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning

Learning Outcomes: Student will be able to

- Understand the concept of classification.
- Distinguish lazy Lazy and Eager Learning.

Contemporary Problems:

Explore Modern Tools- Altair Rapid Miner Tools- Scalability Issues- Regularity Complex-Black Box Problem

Text Books

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Raschka, Sebastian and Mirjalili, Vahid, Python Machine Learning, 3rd Edition, Packt Publishing., 2019
3. Stephen Marsland- Machine Learning – An Algorithmic Perspective – Second Edition – Chapman & Hall CRC Press, 2015

References

1. Ethem Alpaydin, Introduction to machine learning, 2nd edition, PHI.
2. Kevin P. Murphy, "Machine Learning," A Probabilistic Perspective, MIT Press, 2012

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

CO	PO1	PO2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O 2	PS O 3
CO1	3	3	1	2	2			1	2	1		2	1	2	1
CO2	3	3	1	2	2			1	2	1		2	1	2	1
CO3	3	3	3	3	3			1	2	1		2	1	2	1
CO4	3	3	1	2	2			1	2	1		2	1	2	1
CO5	3	3	1	2	2			1	2	1		2	1	2	1

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0013	ESSENTIALS OF CYBER SECURITY	3	0	0	3

Course Objectives:

1. Understand the fundamental concepts and principles of cyber security.
2. Understand Security architecture, risk management, attacks, incidents, and emerging IT and IS technologies.
3. To Provide the importance of Cyber Security and the integral role of Cyber Security professionals.
4. Recognize the importance of cybersecurity in protecting digital assets and information.
5. Analyze real-world cyber-attack scenarios and case studies.

Course Outcomes:

1. Understand Cyber Security architecture principles
2. Analyze the System and application security threats and vulnerabilities
3. Estimate operational cyber security strategies and policies.
4. Apply security model to handle mobile, wireless devices and related security issues.
5. Analyze the functionality of Security Technologies and Controls in Cybersecurity

UNIT - I: (8 Hours)

Introduction to Cyber Security: Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security, scope of Cyber security, Importance of Cyber security in the modern world, Evolution of cyber threats, Importance of Cybersecurity in the digital age.

Foundations of Cyber Security: Cyber Security principles, threat models, and cyber laws. Confidentiality, integrity, and availability (CIA) Triad– Cyber security Framework, Security principles and concepts, Risk management. to better understand the dynamics of Cyber Security.

Learning Outcomes: student will be able to

- Outline the Importance of Cyber security. (L2)
- Understand the Security architecture principles and concepts. (L2)
- Understand the Design of Cyber security Framework. (L2)

UNIT-II: (10 Hours)

Common Threats and Attack Vectors: Introduction, Proxy Servers and Anonymizers, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks, Social Engineering attacks: Introduction, Phishing, spear phishing, pretexting, Identity Theft (ID Theft).

Learning Outcomes: student will be able to

- Understand about the Cyber security Threats and Attacks. (L2)
- Summarize the various types of application security vulnerabilities (L2)
- Analyze the System and application security threats and vulnerabilities (L4)

UNIT-III: (12 Hours)

Introduction to Cyber Crime, law and Investigation: Introduction to Cybercrime, Definition and scope of cybercrime, Categories of cybercrimes, Impact of cybercrime, Cybercrime and Information Security, classifications of cybercrimes, Cybercrime: The Legal Perspectives, cybercrime and the Indian IT Act 2000, a Global perspective on Cybercrimes.

Cyber laws: Introduction to Cyber Laws, Need for Cyber laws The Indian Context, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Consequences of Not Addressing the Weakness in Information Technology Act, Digital Signatures and the Indian IT Act, Information Security Planning and Governance, Information Security Policy Standards.

Learning Outcomes: student will be able to

- Extend The Categories of cybercrimes and Impact of cybercrime(L2)
- Understand about the Need for Cyber laws and Cybercrime Scenario in India(L2)
- Estimate operational cyber security strategies and policies(L5)
- Develop an understanding of cybercrimes and various legal perspectives involved(L3)

UNIT-IV: (10 Hours)

Cybercrime-Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Authentication Service Security, Attacks on Mobile/Cell Phones.

Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Learning Outcomes: student will be able to

- Understand Various devices and related security issues (L2)
- Develop a security model to handle Policies and Measures in Computing era(L3)
- Develop a security model to handle mobile, wireless devices and related security issues of an organization (L3)

UNIT-V: (8 Hours)

Security Technologies and Controls in Cyber security: Access control mechanisms, Encryption, Firewalls, intrusion detection systems (IDS), intrusion prevention systems (IPS), Network Security, Security Information and Event Management (SIEM), functionality of cyber security tools.

Legal and Ethical Aspects of Cyber Security: Laws and regulations governing cyber security, Ethical considerations in cyber security practices, Privacy issues.

Learning Outcomes: student will be able to

- Analyze the functionality of Security Technologies and Controls in Cyber security(L4)
- Outline the Ethical considerations in cyber security practices(L2)
- Understand the functionality of cyber security tools(L2)

Text Books:

1. Computer Security: Principles and Practice, Third Edition, William Stallings, Lawrie Brown, Pearson Education, 2014.
2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole, SunitBelapure, 1st Edition Publication Wiley, 2011.
3. William Stallings, Effective Cyber security: A Guide to Using Best Practices and Standards, 1st edition, 2019.
4. Mark Rhodes, Ousley, Information Security, 1st Edition, MGH, 2013.

Reference Books:

1. Principles of Information Security, Michael E. Whitman and Herbert J. Mattord, Cengage Learning.
2. Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018.
3. Yuri Diogenes, Erdal Ozkaya, Cyber security - Attack and Defense Strategies, Packt Publishers,

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH:3; MEDIUM:2; LOW:1):

CNO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	3	2	1	-	-	-	-	-	-	-	-	1	-	-	1
	3	3	2	2	-	-	-	-	-	-	-	1	2	-	1
	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
	3	2	1	1	2	-	-	-	-	1	-	1	-	-	1
	3	2	2	2	2	-	-	-	-	1	-	1	1	2	-
	3	2	2	2	2	-	-	-	-	1	-	1	2	2	1

** For Entire Course, PO & PSO Mapping*

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0014	INTRODUCTION TO REACT JS	3	0	0	3

Course Objectives:

- To learn essential React JS skills for front-end development.
- To explore client-side JavaScript application development and the React library.
- To implement React components, hooks, and state management for building interactive UIs.
- To gain experience with React.js, JSX, HTML, CSS, and JavaScript.
- To create a functional front-end web application using React.

Course Outcomes:

1. Understand the anatomy of React Java Script. (L2)
2. Understand the life cycle methods of React JS. (L2)
3. Implement React components for building applications. (L3)
4. Apply React hooks for component reusability and monitoring. (L3)
5. Implement React rendering for interactive applications. (L3)

Unit 1 (10 Hours)

React JS: Introduction to React JS, React vs Angular, React Version History, Architecture of the React Application, Installation, Creating and Running React App, Anatomy of React Project.

Templating using JSX: Expressions, Operators, Attributes, Fragments.

Learning Outcomes: Student will be able to

- Understand react framework for building applications. (L2)
- Understand the installations of react packages. (L2)
- Implement templates in react applications. (L3)

Unit 2 (8 Hours)

React Core: Props, State, Event Handling, Lists and Keys, Styling, Pagination, React Life Cycle, Life Cycle Methods, State Management, Mounting Life Cycle.

Learning Outcomes: Student will be able to

- Understand event handling in React. (L2).
- Implement life cycle methods in react. (L3).
- Implement props and states in building react apps. (L3)

Unit 3 (10 Hours)

React Components: Pure Components, memo, Refs, Portals, Higher Order Components (HOC), Context, HTTP requests (POST & GET).

Learning Outcomes: Student will be able to

- Understand http request methods in handling end points. (L2)
- Implement components to handle react requests. (L3)
- Implement higher order components and refs in react. (L3)

Unit 4 (12 Hours)

React Hooks: Introduction to Hooks, useState, useEffect, Run Effects, Fetching Data, useContext, useReducer, useCallback, useMemo, useRef, Custom Hooks

Learning Outcomes: Student will be able to

- Understand react hooks. (L2)
- Apply hooks and custom methods for handling components. (L3)
- Implement context and callback methods in hooks. (L3)

Unit 5 (8 Hours)

React Render: Introduction to Rendering, useState, useReducer, State Immutability, Parent & Child, Memo, Context, useCallback.

Learning Outcomes: Student will be able to

- Understand the working react rendering. (L2)
- Implement userReducer and context for rendering react apps. (L3)

TEXT BOOKS:

1. React.js Book: Learning React JavaScript Library From Scratch by Greg Sidelnikov, Learning Curve.
2. React: Quickstart Step-By-Step Guide To Learning React Javascript Library (React.js, Reactjs, Learning React JS, React Javascript, React Programming) by Lionel Lopez

REFERENCE BOOKS:

- Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js, 2nd Edition by Shama Hoque, Packt

Course Code	Subject Name	L	T	P	C
R23CSE-OE0015	Deep Learning	3	0	0	3

Course Objectives

1. Understand the fundamentals of machine learning algorithms and their challenges.
2. Learn the architecture and training of deep feedforward networks.
3. Master regularization techniques to improve deep learning model performance.
4. Explore optimization methods for training deep neural networks.
5. Gain comprehensive knowledge of convolutional neural networks and their applications.

Course Outcomes: Upon successful completion of course , students will be able to

1. Apply machine learning algorithms to solve practical problems, demonstrating understanding of overfitting and underfitting (Application).
2. Analyse and design deep feedforward networks using gradient-based learning techniques (Analysis).
3. Evaluate the effectiveness of various regularization techniques to enhance model performance and robustness (Evaluation).
4. Analyse advanced optimization strategies to efficiently train deep neural networks (Synthesis).
5. Understand the convolutional neural networks, explaining their significance in the context of deep learning history and neuroscientific principles.

Unit-I – Machine Learning Basics (8 Hours)

Learning Algorithms-Capacity,OverfittingandUnderfitting-HyperparametersandValidationSets-
Estimators,BiasandVariance -SupervisedLearningAlgorithms -UnsupervisedLearningAlgorithms -
ChallengesMotivatingDeepLearning.

Learning Outcomes: Student will be able to understand the fundamentals of machine learning.

Application:ML Algorithms can use in health care, NLP and computer vision applications.

Unit – II: DeepNetworks (8 Hours)

Deep Feed forward Networks: Example: Learning XOR - Gradient-Based Learning - Hidden Units - Architecture Design – BackPropagation and Other Differentiation Algorithms.

Learning Outcomes:Student will be able to analyse the fundamentals of deep learning.

Application:Deep Networks can use in NLP and finance applications for solving complex problems.

Unit – III: Regularization for Deep Learning (8 Hours)

Parameter Norm Penalties – Norm Penaltiesas Constrained Optimization- Regularization and Under Constrained Problems – DatasetAugmentation-NoiseRobustness- SemiSupervisedLearning- MultiTaskLearning- EarlyStopping - ParameterTyingandParameterSharing – SparseRepresentations -BaggingandOtherEnsembleMethods -Dropout.

Learning Outcomes: Student will be able to evaluate the regularization importance in deep neural networks.

Application: Regularization is used for improve the performance of network in various applications like computer vision and NLP etc.

Unit – IV: Optimization for Training Deep Models (8 Hours)

How Learning Differs from Pure Optimization- Challenges in Neural Network Optimization- Basic Algorithms – Parameter Initialization Strategies – Algorithms with Adaptive Learning Rates- Approximate Second Order Methods- Optimization Strategies and Meta-Algorithms.

Learning Outcomes: Student will be able to analyse the fundamentals of optimization techniques in deep learning.

Application: Optimization techniques are using in many applications like NLP, computer vision and finance sector.

Unit – V: Convolutional Networks (8 Hours)

The Convolution Operation- Motivation- Pooling – Convolution and Pooling as an Infinitely Strong Prior – Variants of the Basic Convolution Function- The Neuro scientific Basis for Convolutional Networks – Convolutional Networks and the History of Deep Learning.

Learning Outcomes: Student will be able to understand the purpose of CNN and its importance in deep learning.

Application: CNN used in the area of computer vision applications and many more like NLP, finance and manufacturing sectors.

Text Books: Ian Goodfellow and Yoshua Bengio and Aaron Courville,” Deep Learning” MIT Press, 2017.

References Books:

1. Shai Shalev-Shwartz, Shai Ben-David “Understanding Machine Learning: From Theory to Algorithms” , Cambridge Press
2. Peter Harington “ Machine Learning in Action”, , 2012, Cengage.

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	2	1	1	1							1			1
C02	3	2	1	1	1							1			1
C03	3	2	1	1	1							1			1
C04	3	2	1	1	1							1			1
C05	3	2	1	1	1							1			1

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0016	DevOps	3	0	0	3

Course Objectives:

DevOps improves collaboration and productivity by automating infrastructure and workflows and continuously measuring applications performance.

(Need to write at least 5 objects for this course)

Course Outcomes:

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

1. Enumerate the principles of continuous development and deployment, automation of configuration management, inter-team collaboration, and IT service agility
2. Understand different actions performed through Version control tools like Git.
3. Illustrate the types of version control systems, continuous integration tools, continuous monitoring tools, and cloud models
4. Ability to Perform Automated Continuous Deployment
5. Understand to leverage Cloud-based DevOps tools using Azure DevOps

Need to write what is the skill gained by student at the end of each unit and mention the blooms taxonomy levels in parenthesis for each course outcome

UNIT –I:

Introduction to Software Engineering: Phases of Software Development life cycle. Models ,Values and principles of agile software development.

Learning outcomes:

- Identify and describe the phases of the Software Development Life Cycle (SDLC) (Knowledge, Understanding). (L1 & L2)
- Compare and contrast different software development models (e.g., Waterfall, Agile) and their applications (L3)
- Apply the values and principles of agile software development in real-world scenarios (L3)

UNIT -II: Introduction To DevOps -Devops Essentials – Introduction To AWS, GCP, Azure – Version control systems: Git and Github.

Learning outcomes:

- Understand the essentials of DevOps and its importance in modern software development (L2)
- Demonstrate the use of version control systems(L3)
- Compare cloud platforms and their relevance to DevOps practices (L3)

UNIT –III:

DevOps adoption in projects: Technology aspects, Agiling capabilities, Tool stack implementation, People aspect, processes.

Learning outcomes:

- Analyze the technology aspects required for successful DevOps adoption (L4)
- Analyze the agile capabilities and tool stack implementation for DevOps in various projects (L4)
- Analyze the people and process aspects necessary for DevOps adoption and their impact on project success (L4)

UNIT -IV:

CONTINUOUS INTEGRATION USING JENKINS: Install & Configure Jenkins, Jenkins Architecture Overview, Creating a Jenkins Job, Configuring a Jenkins job, Introduction to Plugins, Adding Plugins to Jenkins, Commonly used plugins (Git Plugin, Parameter Plugin, HTML Publisher, Copy Artifact and Extended choice parameters). Configuring Jenkins to work with java, Git and Maven, Creating a Jenkins Build and Jenkins workspace.

Learning outcomes:

- Install and configure Jenkins for continuous integration (L3)
- implement Jenkins jobs and pipelines, including configuring jobs and adding plugins (L3)
- Understand Jenkins in continuous integration by creating and managing builds (L2)

UNIT-V: BUILDING DEVOPS PIPELINES USING AZURE :
Create Github Account, Create Repository, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file

Learning outcomes:

- Create and manage repositories on GitHub and integrate them with Azure DevOps (Application). (L3)
- Implement new pipeline in Azure DevOps and build sample code using azure-pipelines.yaml file(L3)
- Analyze the Modification and optimization Azure DevOps pipelines for continuous deployment (L4)

Text Books:

- Roberto Vormittag, “A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises”, Second Edition, Kindle Edition, 2016.
- Jason Cannon, “Linux for Beginners: An Introduction to the Linux Operating System and Command Line”, Kindle Edition, 2014

Reference Books:

- Hands-On Azure Devops: Cidc Implementation For Mobile, Hybrid, And Web Applications Using Azure Devops And Microsoft Azure: CICD Implementation for ... DevOps and Microsoft Azure (English Edition) Paperback – 1 January 2020 by Mitesh Soni
- Jeff Geerling, “Ansible for DevOps: Server and configuration management for humans”, First Edition, 2015.
- David Johnson, “Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps”, Second Edition, 2016.
- MariotTsitoara, “Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer”, Second Edition, 2019.

Web References :

- <https://www.jenkins.io/user-handbook.pdf>
- <https://maven.apache.org/guides/getting-started/>

**COURSE OUTCOMES VS POs MAPPING (DETAILED: HIGH: 3,
MEDIUM: 2, LOW: 1)**

Cours e	CNO	PO 1	P O2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	P O 9	P O 10	P O 11	PO 12	PS O1	PS O2	PS O3
DevOps		3	3	2	2					2			1	3	1	2
		3	3	2	2					2			1	3	1	2
		3	3	2		2				2			1	3	1	2
		3	3	2		2				2			1	3	1	2
		3	3	2		2				2			1	3	1	2
		3	3	2	2	2				2			1	3	1	2

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0017	Mobile Computing	3	0	0	3

Course Objective:

1. Understand the fundamental concepts, architecture, and paradigms of mobile computing and GSM.
2. Comprehend the motivation for specialized MAC techniques in wireless communications, addressing issues such as hidden and exposed terminals, near and far terminals and IEEE 802.11.
3. Analyze the IP and Mobile IP network layers, focusing on packet delivery, handover management, location management, registration, tunneling, encapsulation and DHCP.
4. Understand conventional TCP/IP protocols and specialized protocols like Indirect TCP, Snooping TCP, and Mobile TCP for mobile networks and database issues in mobile computing.
5. Introduce the concept, applications, and challenges of Mobile Ad hoc Networks (MANETs), and to explore various routing algorithms such as DSR, AODV, and DSDV.

Course Outcomes: Upon Successful completion of Course, the students will be able to

1. Understand the fundamental concepts, architecture, and paradigms of mobile computing and GSM.
2. Understand the need for specialized MAC techniques in wireless communications, addressing challenges like hidden and exposed terminals, near and far terminals and IEEE 802.11.
3. Understand the concept of the IP and Mobile IP network layers, focusing on packet delivery, handover management, location management, registration, tunnelling, encapsulation, route optimization, and DHCP.
4. Understand proficient in conventional TCP/IP protocols as well as specialized protocols like Indirect TCP, Snooping TCP, and Mobile TCP.
5. Understand the concept, applications, and challenges of Mobile Ad hoc Networks (MANETs).

UNIT I

Introduction: Mobile Communications, Mobile Computing – Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Handheld Devices, Limitations of Mobile and Handheld Devices.

GSM – Services, System Architecture, Radio Interfaces, Protocols, Localization and Calling, Handover, Security, New Data Services, GPRS.

Learning Outcome:

- 1) Student able to understand the basic concepts of mobile communications and GSM.

UNIT –II

(Wireless) Medium Access Control (MAC): Motivation for a specialized MAC (Hidden and exposed Terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA.

Learning Outcome:

- 1) Student able to differentiate the SDMA, FDMA, TDMA and CDMA.

UNIT –III

Mobile Network Layer: IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunnelling and Encapsulation, Route Optimization, DHCP.

Learning Outcome:

- 1) Student able to explain the Mobile IP in mobile networks.

UNIT –IV

Mobile Transport Layer: Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, Other Transport Layer Protocols for Mobile Networks.

Learning Outcome:

- 1) Student able to understand the issues of databases and Mobile TCP/IP in mobile networks.

UNIT V

Mobile Ad hoc Networks (MANETs): Introduction, Applications & Challenges of a MANET, Routing, Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, etc., Mobile Agents, Service Discovery. **Protocols and Platforms for Mobile Computing:** WAP, Bluetooth, XML, J2ME, Java Card, PalmOS, Windows CE, SymbianOS, Linux for Mobile Devices, Android.

Learning Outcomes:

- 1) Student able to identify the best routing protocol for mobile networks for data transmission.

Text Books:

1. Jochen Schiller, “Mobile Communications”, Addison-Wesley, Second Edition, 2009.
2. Raj Kamal, “Mobile Computing”, Oxford University Press, 2007, ISBN: 0195686772

Reference Book:

1. ASOKE K TALUKDER, HASAN AHMED, ROOPA R YAVAGAL, “Mobile Computing, Technology Applications and Service Creation” Second Edition, Mc Graw Hill.
2. UWE Hansmann, Lothar Merk, Martin S. Nocklous, Thomas Stober, “Principles of Mobile Computing,” Second Edition, Springer.

Course Code	Subject Name	L	T	P	C
R23CSE-OE0018	Java Full-Stack Development (Open Elective)	0	1	2	2

Course Objectives:

1. Understand the basics of full-stack web development and the software development life cycle.
2. Design simple and responsive web pages using HTML, CSS, and JavaScript.
3. Develop basic backend applications using Java Servlets, JSP, and connect to databases.
4. Learn how to use SQL for database management.
5. Build and deploy a simple full-stack project using basic tools.

Course Outcomes: After completing this course, students will be able to:

1. Understand the structure of a full-stack web application.
2. Design interactive and responsive web pages.
3. Write basic backend logic and connect to a database.
4. Apply simple SQL queries to manage data effectively.
5. Build and deploy a simple full-stack project.

Unit 1: Frontend Development

Introduction to Full-Stack Development

- What is Full-Stack Development?
- Frontend, Backend, and Databases overview

HTML & CSS Basics

- HTML5: Elements, Forms, Tables
- CSS3: Selectors, Flexbox, Grid
- Responsive design with media queries

JavaScript Basics

- Variables, Loops, Functions
- Simple DOM Manipulation and Event Handling

Unit 2: Backend Development

Java Servlets & JSP

- Servlet lifecycle
- Handling HTTP requests and responses
- Basic JSP: Scripting and Expressions

Introduction to Hibernate

- What is Hibernate?
- Basic setup and configuration
- Mapping simple Java classes to database tables

Unit 3: Database Development

SQL Basics

- SELECT, INSERT, UPDATE, DELETE
- Simple JOINS
- Basic database normalization

Hibernate Basics

- Using annotations for mapping
- Simple one-to-many relationships
- Basic queries with HQL

Unit 4: Introduction to Frameworks

Spring & Spring Boot

- What is Spring? IoC and Dependency Injection
- Introduction to Spring Boot: Starter packs, auto-configuration
- Simple Spring Boot application connecting to a database

Unit 5: REST APIs & Deployment

RESTful APIs

- Basic REST concepts: GET, POST, PUT, DELETE
- Building a simple REST API with Spring Boot

Deployment Basics

- Using Git/GitHub for version control
- Testing APIs with Postman
- Simple project deployment (local server)

Project & Capstone

Mini Projects:

- Online Book Store
- Student Portal or basic E-Commerce App

Tools:

- Git/GitHub for version control
- Maven/Gradle for builds
- Postman for testing

Project & Deployment Tools

- Git & GitHub – Version Control
- Maven/Gradle – Build Tools
- Postman – API Testing

Full-Stack Capstone Project

- Online Book Store / Student Portal
- E-Commerce App with Payment Gateway.

CONTEMPORARY TOPICS:

1. Micro services Architecture using Spring Boot and Spring Cloud
2. JWT-Based Authentication and Authorization in Web Applications
3. Containerization and Deployment using Docker and Kubernetes
4. Integration of No SQL Databases like MongoDB with Java Applications

APPLICATIONS:

1. Online Book Store

- Features: User registration/login, book catalog, shopping cart, order management, admin panel
- Tech Stack: Java Spring Boot , React/HTML-CSS-JS , MySQL

2. Student Information Portal

- Features: Student profiles, course registration, grade tracking, admin dashboard
- Tech Stack: Java Servlets + Hibernate, Bootstrap + JavaScript , PostgreSQL

3. Job Placement Management System

- Features: Company registration, student applications, interview tracking, placement stats
- Tech Stack: Spring Boot + JSP , HTML/CSS + JavaScript , MySQL

TEXT BOOKS:

1. "Learning Web Design" by Jennifer Niederst Robbins, 5th Edition, O'Reilly Media
2. "Beginning Hibernate: For Hibernate 5" by Joseph B. Ottinger, Jeff Linwood, Dave Minter, 4th Edition, Apress

REFERENCE BOOKS:

1. "Web Programming and Internet Technologies" by Uttam K. Roy, Published 2010, Oxford University Press.
2. "Java: The Complete Reference" By Herbert Schildt, Published 2023, McGraw Hill Education

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
117.1	3	2	2	1	3				1		1	1	2	3	3
117.2	3	2	2	1	3				1		1	1	2	3	3
117.3	3	3	3	2	3				1		1	2	3	3	3
117.4	3	3	3	2	3				1		1	2	3	3	3
117.5	2	2	2	2	2				1		1	1	2	2	2
117*	3	2	2	2	3				1		1	1	2	3	3

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0019	Human Computer Interface	3	0	0	3

Course Objectives:

1. Demonstrate an understanding of guidelines, principles, and theories influencing human Computer interaction.
2. Recognize how a computer system may be modified to include human diversity.
3. Select an effective style for a specific application.
4. Design mock ups and carry out user and expert evaluation of interfaces.
5. Carry out the steps of experimental design, usability and experimental testing, and evaluation of human computer interaction systems.
6. Use the information sources available, and be aware of the methodologies and technologies supporting advances in HCI.

Course Outcomes:

UNIT-I:

The User Interface: Introduction, Importance of the User Interface, Importance and benefits of Good Design History of Human Computer Interface. Characteristics of Graphical and Web User Interface: Graphical User Interface, popularity of graphics, concepts of Direct Manipulation, Graphical System advantage and disadvantage, Characteristics of GUI. Web User Interface, popularity of web, Characteristics of Web Interface, Merging of Graphical Business systems& the Web, Principles of User Interface Design.

UNIT-II:

The User Interface Design Process: Obstacles and Pitfall in the development Process, Usability, The Design Team, Human Interaction with Computers, Important Human Characteristics in Design, Human Consideration in Design, Human Interaction Speeds, Performance versus Preference, Methods for Gaining and Understanding of Users

UNIT-III:

Understanding Business Functions: Business Definitions & Requirement analysis, Determining Business Functions, Design standards or Style Guides, System Training and Documentation

UNIT-IV:

Principles of Good Screen Design: Human considerations in screen Design, interface design goals, test for a good design, screen meaning and purpose, Technological considerations in Interface Design System Menus and Navigation Schemes: Structure, Functions, Context, Formatting, Phrasing and Selecting, Navigating of Menus, Kinds of Graphical Menus Windows Interface: Windows characteristic, Components of Window, Windows Presentation Styles, Types of Windows, Window Management, Web systems.

UNIT-V:

Device and Screen-Based Control: Device based controls, Operable Controls, Text entry/read-Only Controls, Section Controls, Combining Entry/Selection Controls, Other Operable Controls and Presentation Controls, Selecting proper controls

Text Books:

1. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley India Edition
2. Prece, Rogers, "Sharps Interaction Design", Wiley India.
3. Ben Shneidermann, "Designing the user interfaces". 3rd Edition, Pearson Education Asia.

References Books:

1. Soren Lauesen, "User Interface Design", Pearson Education
2. Alan Cooper, Robert Riemann, David Cronin, "Essentials of Interaction Design", Wiley
3. Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell, Bealg, "HumanComputer Interaction", Pearson Education

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0020	Cryptography and network security	3	0	0	3

Course Objectives:

- Understand the fundamentals of Information Security
- Acquire knowledge on Security Needs to provide confidentiality, integrity and authenticity.
- Understand the various key cryptography concepts
- Design security applications using security policies
- Understand the Security Issues in TCP/IP

Course Outcomes:

1. Analyze the vulnerabilities in any computing system and hence be able to design a security solution
2. Identify the security needs in the network
3. Explain the basic objectives of symmetric & Asymmetric key cryptography technique to secure the communication over the internet
4. Identify the security policies to provide strong authentication
5. Understand basic ecommerce security protocols.

Unit 1: Introduction.

The History of Information Security, Balancing Information Security and Access, Introduction and Security Trends, General Security Concepts and introduction to what is an “info sphere”, Operational Security and People’s Role in Information Security.

Learning outcomes: Student should be able to

1. Understand various types of Information Security concepts (L2)
2. Analyze the role of information security.(L4)

Unit 2: Security Needs.

The Need for Security, Business Needs, Needs to protect against Threats and Attacks, Security in Emails. Secure Software Development.

Learning outcomes: Student should be able to

1. Understand the need of security to deal with the threats and attacks.(L2)

Unit 3: Cryptography Concepts.

Concepts of Data encryption, Introduction, Plaintext & Cipher text, Substitution Techniques, Transposition Techniques, Encryption & Decryption, Symmetric& Asymmetric key Cryptography. Public Key Infrastructure (PKI), Different attacks on Cryptosystems

Network Security & Web Security.

Security Issues in TCP/IP – TCP, DNS, Routing (Topics such as basic problems of security in TCP/IP, IPsec, BGP Security, DNS Cache poisoning etc), Network Defense tools – Firewalls, Intrusion Detection, Filtering, DNSSec, NSec3, Distributed Firewalls

Learning outcomes: Student should be able to

1. Understand various Cryptography Concepts (L2)
2. Analyze the impact of Symmetric& Asymmetric key Cryptography in real time applications (L4)
3. Understand Security Issues in TCP/IP. (L2)
4. Identify the tools to provide the web and network security. (L2)

What is security policy, high and low level policy, user issues? Protocol problems, assumptions, Shared secret protocols, public key protocols, mutual authentication, reflection attacks, use of timestamps, nonce and sequence numbers, session keys, one-and two-way public key based authentication.

1. Understand various Security Policies for authentication (L2)
2. Identity various Security Handshake (L2)

Electronic mail security, IP security, Network management security. Security for electronic commerce: E-commerce security analysis, protocol, SSL, SET

Intruders and Viruses, Firewalls, Intrusion Detection.

1. Apply the concepts of the cryptography and security in case studies. (L4)

1. Michael E Whitman and Herbert J Mattord, “Principles of Information Security”, Vikas Publishing House, New Delhi.
- 2 Micki Krause, Harold F. Tipton, “ Handbook of Information Security Management”, CRC Press LLC
3. AtulKahate, Cryptography and Network Security, McGraw Hill
- 4 Kaufman, c., Perlman, R., and Speciner, M., Network Security, Private Communication in a public world, 2nd ed., Prentice Hall PTR., 2002
5. Stallings, W.,Cryptography and Network Security: Principles and Practice, 3rd ed., Prentice Hall PTR.,2003
6. Stallings, W. Network security Essentials: Applications and standards, Prentice Hall, 2000

[illegible]

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0021	QUANTUM COMPUTING	3	0	0	3

Course Objectives:

1. To understand the components of computing in a Quantum world
2. To gain knowledge on mathematical representation of quantum physics and operations.
3. To write computations in the real world (standard) in a Quantum computer and simulator.

Course Outcomes:

By the end of this course, the student is able to

1. Analyze the behavior of basic quantum algorithms
2. Implement simple quantum algorithms and information channels in the quantum circuit model
3. Simulate a simple quantum error-correcting code
4. Prove basic facts about quantum information channels
5. Know about Quantum Computing Models

UNIT –I:

Introduction: Quantum Measurements Density Matrices, Positive-Operator Valued Measure, Fragility of quantum information: Decoherence, Quantum Superposition and Entanglement, Quantum Gates and Circuits.

UNIT –II:

Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits.

UNIT -III:

Algorithms: Deutsch and Deutsch–Jozsa algorithms, Grover's Search Algorithm, Quantum Fourier Transform, Shore's Factorization Algorithm.

UNIT –IV:

Performance, Security and Scalability: Quantum Error Correction: Fault tolerance; Quantum Cryptography, Implementing Quantum Computing: issues of fidelity; Scalability in quantum computing.

UNIT -V:

Quantum Computing Models: NMR Quantum Computing, Spintronics and QED MODEL, Linear Optical MODEL, Nonlinear Optical Approaches; Limits of all the discussed approaches, Future of Quantum computing.

Text Books:

1. Eric R. Johnston, Nic Harrigan, Mercedes and Gimeno-Segovia “Programming Quantum Computers: Essential Algorithms And Code Samples, SHROFF/O’Reilly.
2. Dr. Christine Corbett Moran, Mastering Quantum Computing with IBM QX: Explore the world of quantum computing using the Quantum Composer and Qiskit, Kindle Edition Packt

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0022	BIG DATA ANALYTICS	3	0	0	3

Course Objectives:

- Optimize business decisions and create a competitive advantage with Big Data analytics
- Introducing Hadoop concepts for developing solutions.
- Derive business benefits from unstructured data
- Imparting the architectural concepts of Hadoop and introducing map- reduce paradigm
- To introduce programming tools PIG & HIVE in the Hadoop ecosystem.

Course Outcomes:

1. Understands the basic concepts and challenges of handling Big Data.
2. Applying data modelling techniques of Big Data.
3. Analyze Hadoop components & its applications.
4. Analyze spark for optimized query execution and memory caching.
5. Understand the Big data frame work and its applications.

UNIT-I

Introduction: Introduction to Big data, Characteristics & Classification of Data, Challenges of conventional systems(storage), Intelligent data analysis, The Life cycle of Big Data Analytics, Types of Big Data Analytics, Analytic processes, and tools, Big Data Industry Applications, Analysis vs. Reporting.

Learning Outcomes: Students will be able to

- Understands the Basic concept of Big Data.
- Understands their challenges in the industry

UNIT-II

Working with Big Data: Google File System, Hadoop Distributed File System (HDFS) –Building blocks of Hadoop (Name node, Datanode, Secondary Name node, Job Tracker, Task Tracker), What is NoSQL, Why NoSQL, Use of No SQL in Industry, Comparison of SQL, No SQL, and New SQL, No SQL Business Drivers, No SQL Case Studies,

Learning Outcomes: Students will be able to

- Understand HDFS and its basic building blocks
- Understand No SQL for working with Data sets.

UNIT-III

Introduction to Hadoop: why Hadoop, RDBMS versus Hadoop, History of Hadoop, Components of Hadoop, Hadoop Distributed File System (HDFS), Processing Data with Hadoop, How Map Reduce Works, Anatomy of a Map Reduce Job run, Map Reduce Features Hadoop environment. Interacting with Hadoop Ecosystem.

Learning Outcomes: Students will be able to

- Understand and implement Hadoop Components.
- Understand the Concept of Interacting with the Hadoop Ecosystem.

UNIT-IV

SPARK: SPARK BASICS, Using the Spark Shell, RDD Data Types and RDD Creation, RDDs (Resilient Distributed Datasets) in Spark, General RDD Operations: Transformations & Actions, RDD Lineage, RDD Persistence, Overview, Distributed Persistence

Learning Outcomes: Student will be able to

- Understand Hadoop Architecture,
- Explain about Hadoop Ecosystem components.

UNIT-V

Frameworks and Applications: HIVE : Hive Shell, Hive Services, Hive Meta store, Comparison with Traditional Databases **Learning,** Frameworks: Applications on Big Data Using Pig and Hive, Data processing operators in Pig, Hive Architecture of Hive, Hive services, HiveQL, Querying Data in Hive, fundamentals of H Base and Zoo keeper.

Outcomes: Students will be able to

- Work with PIG and Hive Tech.
- Understand programming tools of HIVE in the Hadoop ecosystem.
- Applying a complete business data analytics solution.

Text Books :

1. Big Data Analytics 2nd Edition, Seema Acharya, Subhashini Chellappan, Wiley India Pvt. Ltd, Second Edition, 1 Jan 2019.
2. Min Chen, Shiwen Mao, Yin Zhang, Victor C.M. Leung, "Big Data: Related Technologies, Challenges and Future Prospects", Springer; 2014.
3. Big Java 4th Edition, Cay Horstman, Wiley John Wiley & Sons, INC, by Wiley India Pvt. Ltd, 2008.
4. Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'Reilly, 12 June 2012.
5. Tom White, "Hadoop- The Definitive Guide", O'reilly, 4th Edition, April 2015.

Reference Books :

1. Hadoop in Practice by Alex Holmes, MANNING Publ, Second Edition, 5 Feb 2015.
2. Hadoop MapReduce Cookbook, Srinath Perera, Thilina Gunarathne, Ingram short title, 1 Jan 2013.
3. Hadoop for Dummies by Dirk deRoos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss, by For Dummies, First Edition, 7 May 2014.
4. Eric Sammer, "Hadoop Operations", O'Reilly, 2nd Edition., October 2012.

Software Links :

1. Hadoop: <http://hadoop.apache.org/>+
2. Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
3. Pig latin: <http://pig.apache.org/docs/r0.7.0/tutorial.html>
4. http://www.jbonneau.com/doc/2012-04-27-big_data_lecture_1.pdf
5. https://www.ibm.com/developerworks/community/blogs/SusanVisser/entry/flash_book_understanding_big_data_analytics_for_enterprise_class_hadoop_and_streaming_data?lang=en

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
x.1	1	2	2	3	1	2	1	1	1	-	2	1	1	2	1
x.2	2	1	3	3	3	-	-	-	1	-	-	1	2	3	1
x.3	1	2	1	3	3	3	-	-	1	-	1	1	3	3	1
x.4	2	2	3	3	3	1	1	-	-	-	1	1	3	3	3
x.5	2	2	3	3	3	1	1	-	-	-	1	1	3	3	3

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0023	BLOCK CHAIN TECHNOLOGIES	3	0	0	3

Course Objective:

1. To provide conceptual understanding of the function of Blockchain as a method of securing distributed ledgers.
2. To understand the structure of a Blockchain and why/when it is better than a simple distributed database
3. To make students understand the technological underpinnings of Blockchain operations as distributed data structures and decision making systems.

Course Outcomes:

Upon completion of the course, it is expected that student will be able to:

1. Define and explain the fundamentals of Blockchain.
2. Understand decentralization and the role of Blockchain in it.
3. Understand and analyze Bitcoin in Cryptocurrency and underlying Blockchain network.
4. Understand Ethereum currency and platform, and develop applications using Solidity.
5. Understand Hyper ledger project and its components; critically analyze the challenges and future opportunities in Block chain technology.

UNIT-I:

Introduction: History and basics, Types of Blockchain, Consensus, CAP Theorem.

Cryptographic Hash Functions: Properties of hash functions, Secure Hash Algorithm, Merkle trees, Patricia trees.

UNIT-II:

Decentralization: Decentralization using Blockchain, Methods of decentralization, decentralization framework, Blockchain and full ecosystem decentralization, Smart contracts, Decentralized Organizations, Platforms for decentralization.

UNIT-III:

Bitcoin: Introduction to Bitcoin, Digital keys and addresses, Transactions, Blockchain, The Bitcoin network, Bitcoin payments, Bitcoin Clients and APIs, Alternatives to Proof of Work, Bitcoin limitations.

UNIT-IV:

Ethereum: Smart Contracts, Introduction to Ethereum, The Ethereum network, Components of the Ethereum ecosystem, Blocks and Blockchain, Fee schedule, Ethereum Development Environment, Solidity.

UNIT-V:

Hyperledger: Introduction, Hyperledger Projects, Protocol, Architecture, Hyperledger Fabric, Sawtooth Lake, Corda.

Challenges and Opportunities: Scalability, Privacy, Blockchain for IoT, Emerging trends

Text Book:

1. Mastering Block chain, Imran Bashir, Second Edition, PacktPublishing.

References:

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 3rd Edition Andreas Antonopoulos,O'Reilly.
2. Blockchain Blueprint for a New Economy, Melanie Swan,O'Reilly.
3. Mastering Bitcoin: Programming the Open Blockchain, Antonopoulos, Andreas M. O'Reilly.
4. Blockchain Technology: Cryptocurrency and Applications, S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, Oxford University Press

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0024	MULTIMEDIA APPLICATION DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES: To learn

1. To understand the definition of multimedia
2. To understand and differentiate text, image, video & audio.
3. To describe the ways in which multimedia information is captured, processed, and rendered
4. Introduce multimedia quality of service (QoS) and to compare subjective and objective methods of assessing user satisfaction and multicast protocols to provide QoS guarantees
5. Discuss privacy and copyright issues in the context of multimedia

COURSE OUTCOMES: Upon successful completion of the course, the student is able to

1. Describe different realizations of multimedia tools and the way in which they are used
2. Analyze the structure of the tools in the light of low-level constraints imposed by the adoption of various QoS schemes (i.e. bottom up approach)
3. Analyze the effects of scale and use on both presentation and lower-level requirements (i.e. top down approach)
4. State the properties of different media streams;
5. Compare and contrast different network protocols and to describe mechanisms for providing QoS guarantees in the network.

UNIT – I Classes: 12

Introduction: Definitions - Brief history of Multimedia; its market; content and copyright –public Domain, establishment of Copyright, fair use, multimedia copyright issues; resources for multimedia developers – Uses of multimedia - Making multimedia : Stages of a project

UNIT – II Classes: 14

Hardware Macintosh Versus Windows Platform – Connections – SCSI – IDE – EIDE – ULTRA – IDE – ATA – ULTRA - ATA - Memory and Storage Devices - Input Devices - Output Hardware – Communication Devices Basic Software Tools :Text Editing - Word Processing - OCR Software - Painting and Drawing Tools - 3D Modeling and Animation Tools - Image Editing - Sound Editing – Animation – Video - Digital Movie tools - Movie Editors - Compressing Movie Files MLR Institute of Technology B.Tech-IT Academic Regulations & Syllabi – MLR18

UNIT – III Classes: 14

Text : Fonts – Designing – Choosing -Menus for Navigation - Buttons for Interaction – Fields for Readings - HTML Documents - Symbols and Icons – Animating - Fonts Foundries – Managing Fonts - Character sets and Alphabets - Mapping Text – Fontographer - Hypermedia Structures – Hypertext tools Sound : Power of sound - Multimedia System Sound - MIDI Versus Digital Audio - Preparing Digital Audio Files - Making MIDI Audio - Audio File Formats - Sound for the World Wide Web – Adding Sound to Your Multimedia Project - Toward Professional Sound - The Red Book Standard – Space Considerations - Production Tips - Audio Recording -

Keeping Track of Your Sounds - Testing and Evaluation

UNIT – IV Classes: 12

Introduction: The Bandwidth Bottleneck - Internet Services - MIME-Types - World Wide Web and HTML – Dynamic Web Pages and XML - Multimedia on the Web. Tools for the World Wide Web: Web Servers - Web Browsers - Web Page Makers and Site Builders - Plug ins and Delivery Vehicles - Text – Images –Sound - Animation, Video and Presentation - Beyond HTML - 3D Worlds, designing for the World Wide Web..

UNIT – V Classes: 08

Multimedia File Handling: Compression & De compression - Data & file formats standards - Digital voice, Audio, video – Video image and Animation - Full motion video - storage and retrieval Technologies

Text Books:

1. Multimedia making it work Tay Vaughan Tata McGrawHill, Delhi
2. Multimedia – Technology and applications David Hillman Galgotia Publications, Delhi

Subject Code	Subject Name	L	T	P	C
R23CSE-OE0025	MOBILE AD-HOC NETWORKS	3	0	0	3

Course Objectives:

- To understand the concepts of Ad Hoc Wireless Networks
- To understand the Data Transmission in MANETS
- To understand the MAC protocols for ad-hoc networks
- To understand and analyze the various routing protocols and model link cost
- Understanding cross layer design in Adhoc Networks

Course Outcomes:

1. Evaluate the principles and characteristics of mobile ad hoc networks (MANETs) and what distinguishes them from infrastructure-based networks
2. Discuss the challenges in designing MAC, routing, and transport protocols for wireless ad-hoc sensor networks
- 3.. Understand the MAC Protocols for Ad Hoc Wireless Networks
4. Illustrate the various Routing Protocols And Transport Layer In Ad Hoc Wireless
5. Demonstrate the issues and challenges in security provisioning and also familiar with the mechanisms for implementing security and trust mechanisms in MANETs and WSNs

UNIT - 1

INTRODUCTION: Introduction to ad-hoc networks – definition, characteristics features, applications. Characteristics of wireless channel, ad-hoc mobility models: indoor and outdoor models.

UNIT - 2

MEDIUM ACCESS PROTOCOLS: MAC Protocols: Design issues, goals and classification. Contention based protocols – with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

UNIT - 3

NETWORK PROTOCOLS: Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, energy aware routing algorithm, hierarchical routing, QoS aware routing.

UNIT - 4

END – END DELIVERY AND SECURITY: Transport Layer: Issues in designing – Transport layer classification, adhoc transport protocols.

Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols.

UNIT – 5

CROSS LAYER DESIGN:

Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, cross layer cautionary perspective. Integration of adhoc with Mobile IP networks.

TEXT BOOKS:

1. C. Siva Ram Murthy and B. S. Manoj, Ad hoc Wireless Networks Architecture and Protocols, 2nd edition, Pearson Edition, 2007.
2. Charles E. Perkins, Ad hoc Networking, Addison – Wesley, 2000.

REFERENCES:

1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, Mobile ad-hoc networking, Wiley-IEEE press, 2004.
2. Mohammad Ilyas, The handbook of ad-hoc wireless networks, CRC press, 2002.
3. T. Camp, J. Boleng, and V. Davies “ A Survey of Mobility Models for Ad-hoc Network”
4. Research, “Wireless Commun, and Mobile Comp.. Special Issue on Mobile Ad-hoc Networking Research, Trends and Applications, Vol. 2, no. 5, 2002, pp. 483 – 502.
5. A survey of integrating IP mobility protocols and Mobile Ad-hoc networks, Fekri M.bduljalil and Shrikant K. Bodhe, IEEE communication Survey and tutorials, no: 12007.

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

[illegible]

Subject Code	Subject Name	L	T	P	C
R23CSS-OE0001	Operating Systems	3	0	0	3

Course Objectives:

- Provide knowledge about the services rendered by operating systems.
- Present detail discussion on processes, threads and scheduling algorithms.
- Expose the student with different techniques of handling deadlocks.
- Discuss various file-system implementation issues and memory management techniques.
- Learn the basics of Linux system and Android Software Platform.

Course Outcomes:

1. Understand the importance of operating systems and different types of system calls
2. Analyze process scheduling algorithms and various IPC mechanisms.
3. Understand the process synchronization, different ways for dead locks handling.
4. Analyze different page replacement methods, various File management techniques
5. Understand Linux and Android environment and behavior

Unit: 1: Operating Systems Overview: Introduction: What Operating systems Do, Types of Operating systems, Computer system Architecture, Computer system organization, Operating system functions, Operating systems operations, Protection and Security.

Virtualization: Types of Virtualizations, Benefits, and Challenges.

System structure: Operating System Services, User and Operating - System Interface, System calls, Types of System Calls, Operating system debugging, System Boot.

Learning Outcomes: Student will be able to

- Understand operating system structure and functions.
- Understand operating system services and system calls
- Comprehend the basics of virtualization

Unit: 2: Process Management: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication.

Multithreaded Programming: Overview, Multithreading models, Threading Issues.

Process scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

Learning Outcomes: Student will be able to

- Identify various message sharing mechanisms used in IPC.
- Understand how to handling multiple threads.
- Differentiate between preemptive, non-preemptive and real time CPU scheduling

Unit: 3: Synchronization: Process Synchronization, The Critical-Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization examples Principles of deadlock – System Model, Deadlock Characterization, Deadlock Prevention, Detection and Avoidance, Recovery form Deadlock, Concurrency in Distributed Systems, Consistency, and Replication.

Learning Outcomes: Student will be able to

- Analyze various solutions for process synchronization.
- Analyze the reasons for deadlocks and proposed solutions to detect, avoid, recovery from deadlocks.
- Understand concurrency issues in distributed systems

Unit: 4: Memory Management:

Memory Management strategies: Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table.

Virtual Memory Management: Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing.

File system Interface and Introduction to Network Programming: - the concept of a file, Access Methods, OSI model, Unix standards, TCP and UDP & TCP connection establishment and Format, Buffer sizes and limitation, standard internet services, Protocol usage by common internet application.

Learning Outcomes: Student will be able to

- Demonstrate the ability to implement various memory management techniques
- Illustrate various demand paging techniques.
- Identify various file management and optimization techniques.

Unit: 5: Network Programming and OS Security:

Sockets: Address structures, value – result arguments, Byte ordering and manipulation function and related functions.

Elementary TCP sockets – Socket, connect, bind, listen, accept, fork and exec function, concurrent servers. Close function and related function.

Elementary UDP sockets: Introduction UDP Echo server function, lost datagram, summary of UDP example, Lack of flow control with UDP, determining outgoing interface with UDP.

OS Security - Security Policies, Intrusion Detection, and Prevention.

Learning Outcomes: Student will be able to

- Understand socket programming.
- Understand basics of UDP (L2), Comprehend OS security concepts

Text Books:

1. Silberschatz A, Galvin PB, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2013
2. Tanenbaum AS, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (for Inter process Communication and File systems).

References:

1. Tanenbaum AS, Woodhull AS, Operating Systems Design and Implementation, 3rd edition, PHI, 2006.
2. Dhamdhere D M, Operating Systems A Concept Based Approach, 3rd edition, Tata Mc Graw-Hill, 2012.
3. Stallings W, Operating Systems –Internals and Design Principles, 6th edition, Pearson Education, 2009
4. Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004.

Subject Code	Subject Name	L	T	P	C
R23CSS-OE0002	Red Hat Linux	3	0	0	3

Course Objectives:

- Master essential command-line tools for file manipulation, system access, and documentation in a RHEL environment.
- Implement core system administration tasks, including booting, process control, service control (systemd), and managing user/group accounts.
- Configure and manage local storage using partitions, filesystems (XFS/Ext4), and Logical Volume Management (LVM).
- Secure the system by configuring the firewall (firewalld), managing file permissions, and enforcing SELinux policies.
- Perform network configuration, package management, and write basic Bash shell scripts for task automation.

Course Outcomes:

1. Navigate and operate a Red Hat Enterprise Linux system entirely from the command line.
2. Manage local security policies, including users, groups, and file permissions.
3. Diagnose and troubleshoot boot process failures and service issues.
4. Apply proper file system management techniques, including creating and extending LVM.
5. Automate routine administrative tasks using shell scripting and scheduled utilities.

Unit 1: Essentials and System Access

Introduction to RHEL: Command Line Interface (CLI), Shell basics, using grep and regular expressions.

Getting Help: Utilizing man pages and system documentation.

File Management: Standard commands (ls, cp, mv), hard and soft links.

Text Editing and Remote Access: Using vim/nano for configuration; Secure Shell (ssh) usage.

Unit 2: Running Systems and Management

System Boot and Processes: Boot procedure, run levels, interrupting boot for recovery.

Process Control: Identifying, managing, and adjusting process priority (top, kill, nice).

Service Control: Managing system services and daemons using systemctl (systemd).

Package Management: Installing, updating, and removing software using dnf / yum (RPM).

User and Group Administration: Creating, modifying, and managing local users, groups, and password policies.

Unit 3: Storage Administration

Disk Partitioning: Understanding MBR/GPT and creating partitions.

Filesystems: Creating, mounting and managing XFS/Ext4 filesystems, and configuring /etc/fstab.

Logical Volume Management (LVM): PVs, VGs, LVs, creating, resizing, and extending logical volumes.

Network Storage: Basics of mounting NFS and SMB/CIFS shares.

Unit 4: Networking and Security

Basic Networking Configuration: Configuring IPv4/IPv6 addresses and network interfaces.

Firewall Management: Configuring network access restrictions using firewalld.

Security Contexts: Managing Access Control Lists (ACLs) for granular permissions.

SELinux: Introduction to SELinux modes, contexts, and troubleshooting access issues.

System Logging: Locating and interpreting system logs using journalctl.

Unit 5: Automation and Advanced Topics

Archiving and Scheduling: Using tar and compression utilities; scheduling tasks with cron and at.

Bash Shell Scripting: Introduction, variables, conditional execution (if), loops, and processing script inputs/outputs.

Kernel and Updates: Managing kernel modules and performing system maintenance/updates.

Virtualization / Containers: Overview of enterprise virtualization and container concepts (e.g., Podman).

Text Books:

1. Red Hat RHCSA [RHEL Version] Cert Guide (Exam EX200), Sander van Vugt
2. UNIX and Linux System Administration Handbook, Evi Nemeth, Garth Snyder

Subject Code	Subject Name	L	T	P	C
R23CSS-OE0003	Cloud Computing	3	0	0	3

Course Objectives:

- To implement Virtualization
- To implement Task Scheduling algorithms
- Apply Map-Reduce concept to applications
- To build Private Cloud
- Broadly educate to know the impact of engineering on legal and societal issues involved

Course Outcomes: At the end of the course, student will be able to

1. Interpret the key dimensions of the challenge of Cloud Computing
2. Examine the economics, financial, and technological implications for selecting cloud computing for own organization
3. Assessing the financial, technological, and organizational capacity of employers for actively initiating and installing cloud-based applications
4. Evaluate own organizations. needs for capacity building and training in cloud computing-related IT areas
5. Illustrate Virtualization for Data-Center Automation

UNIT I

Introduction: Network centric computing, Network centric content, peer-to .peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing. Parallel and Distributed Systems: introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency, and model concurrency with Petri Nets.

UNIT II

Cloud Infrastructure: At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Inter cloud, energy use and ecological impact, responsibility sharing, user experience, Software licensing, Cloud Computing : Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, HPC on cloud.

UNIT III

Cloud Resource virtualization: Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization- full and para, performance and security isolation, hardware support for virtualization, Case Study: Xen, vBlades, Cloud Resource Management and Scheduling: Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, scheduling algorithms, fair queuing, start time fair queuing, cloud scheduling subject to deadlines, Scheduling Map Reduce applications, Resource management and dynamic application scaling.

UNIT IV

Storage Systems: Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Apache Hadoop, Big Table, Megastore (text book 1), Amazon Simple Storage Service(S3) (Text book 2), Cloud Security: Cloud security risks, security . a top concern for cloud users, privacy and

privacy impact assessment, trust, OS security, Virtual machine security, Security risks.

UNIT V

Cloud Application Development: Amazon Web Services : EC2 – instances, connecting clients, security rules, launching, usage of S3 in Java, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming (Text Book 1), Google: Google App Engine, Google Web Toolkit (Text Book 2), Microsoft: Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM (Text Book 2)

Text Books:

1. Cloud Computing, Theory and Practice, 1st Edition, Dan C Marinescu, MK Elsevier publisher ,2013
2. Cloud Computing, A Practical Approach, 1st Edition, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH,2017

Reference Books:

1. Mastering Cloud Computing, Foundations and Application Programming, 1st Edition, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, TMH,2013
2. Essential of Cloud Computing, 1st Edition, K Chandrasekharan, CRC Press, 2014.
3. Cloud Computing, A Hands on Approach, ArshdeepBahga, Vijay Madisetti, Universities Press, 2014.

Subject Code	Subject Name	L	T	P	C
R23CSS-OE0004	Distributed Operating Systems	3	0	0	3

Course Objectives:

- To study the concepts and design principles of Distributed Operating Systems,
- To understand clock synchronization protocols and distributed file system implementation,
- To gain knowledge on communication, synchronization, and consistency models in distributed systems.

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

- Explain the architecture and components of distributed systems,
- Understand various synchronization and coordination mechanisms,
- Analyze consistency and fault tolerance issues,
- Describe distributed file systems and object-based distributed environments,
- Apply concepts of distributed systems in real-time applications.

Detailed Syllabus:

Unit I – Fundamentals of Distributed Systems

Introduction to distributed systems, Goals of distributed systems, Hardware and software concepts, Design issues, Network operating systems, Comparison between time-sharing, multiprocessor, and true distributed systems, System architectures for distributed systems.

Unit II – Communication in Distributed Systems

Basics of communication systems, Layered protocols, ATM models, Client–Server model, Blocking and non-blocking primitives, Buffered and unbuffered communication, Reliable and unreliable primitives, Message passing, Remote Procedure Call (RPC).

Unit III – Synchronization and Processes

Clock synchronization, Mutual exclusion in distributed systems, Election algorithms, Atomic transactions, Deadlock handling, Processes and threads in distributed systems, System models, Processor allocation, Process scheduling in distributed systems.

Unit IV – Consistency, Replication, and Fault Tolerance

Data-centric and client-centric consistency models, Replica management, Consistency protocols, Fault tolerance in distributed systems, Process resilience, Distributed commit protocols, Reliable client–server communication.

Unit V – Distributed Object-Based Systems and File Systems

Distributed object-based systems, Object-oriented architecture, Processes and communication in object-based systems, Synchronization in object environments, Consistency and replication in object-based systems, Distributed file system design and implementation.

Reference Books:

- Andrew S. Tanenbaum, *Distributed Operating Systems*, Pearson Education, Reprint, 2011,
- Andrew S. Tanenbaum and Maarten Van Steen, *Distributed Systems – Principles and Paradigms*, 2nd Edition, PHI, 2007,
- Pradeep K. Sinha, *Distributed Operating Systems – Concepts and Design*, PHI, 2007.

Subject Code	Subject Name	L	T	P	C
R23CIT-OE0001	Basics of Computer Networks	3	0	0	3

Course Objectives:

1. understand the contemporary technologies in network protocols and network architecture
2. To acquire the knowledge on design principles of network infrastructure. the basics Physical layer and their functionality.
3. Understand the functionalities of the Data Link Layer and their protocols.
4. Understand the functionalities of the Network Link Layer and routing Algorithms.
5. Analyze different protocols in Application Layer

Course Outcomes:

1. Analyze different types of network topologies, various Reference models.[L2]
2. Analyze network performance metrics and data transmission Techniques.[L4]
3. Analyze different data link layer framing techniques and Link Layer Protocols.[L4]
4. Analyze the medium access techniques and different routing algorithms.[L4]
5. Understand various Application layer protocols.[L2]

Unit 1:

10-Hours

Introduction: Components of a Data Communication system, Dataflow , Network Topologies Categories of Networks: LAN, MAN,WAN. Reference models- The OSI Reference Model- the TCP/IP Reference Model, Networking and Internet working Devices.

Learning Outcomes: Student will be able to

- Understand the Basics of Computer Networks (L2).
- Understand the data flow in a Computer Network and the use of protocols.(L2)
- Analyze the importance of each layer in the reference models.(L4).

Applications:

Conceptual Framework of a Network, ATM, Online reservation systems, reservation systems.

Unit 2:

9-Hours

Physical Layer:

Transmission Media: Guided,Unguided.Bandwidth,throughput,Latency.

Multiplexing: frequency division multiplexing, wave length division multiplexing, synchronous time division multiplexing, statistical time division multiplexing, switching techniques.

Learning Outcomes: Studentwill be able to

- Understand the Basics of physical functionality .(L2).
- Analyze different types of Multiplexing Techniques. (L4).
- Analyze the Network performance Evaluation metrics . (L4).

Applications:

Identify the use of different devices in real time computer networks and data processing tasks.

Unit 3:**10- Hours**

Data Link Layer: Design issues, Framing, flow control, error control, error detection and correction, CRC.

Data Link Layer protocols: simplex protocol, Simplex stop and wait, Simplex protocol for Noisy Channel. Sliding window protocols. HDLC configuration and transfer modes, HDLC frame format, control field

Learning Outcomes: Student will be able to

- Understand DataLink Layer Services to the Network Layer. (L2)
- Understand Error Correction and Detection techniques. (L2)
- Apply Detecting Codes for sample data. (L3)

Applications: Error correction and detecting procedures on binary data.

Unit 4:**10- Hours**

Random Access: ALOHA protocols, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance

Network Layer: Routing algorithm, shortest path routing, Flooding, distance vector routing, Link state routing Algorithms, IPv4 address, subnetting, Congestion Control Algorithms.

Learning Outcomes: Student will be able to

- Understand random access protocols in data link layer and their functions. (L2)
- Analyze the static and dynamic routing Algorithms. (L4)
- Analyze the IPv4 Addressing ,sub netting.(L4)

Applications: setting up the routes for data packets to take, checking to see if a server in another network is up and running, and addressing and receiving IP packets from other networks.

UNIT –5 :**09-Hours**

The Transport Layer: addressing, TCP establishing a connection, releasing connection, TCP Header format, End to end protocols: UDP,.

Application layer: File Transfer(FTP), WWW: architecture ,client / server ,uniform resource locator, cookies, web documents: static ,dynamic, active document, HTTP transaction: persistent, non-persistent, Proxy server, HTTP Generic Message Format, HTTP Request Message Format, HTTP Response Message Format, Domain Name System (DNS), SMTP (Simple Mail Transfer Protocol).

Learning Outcomes: Student will be able to

- Understand the functions of Transport Layer protocols.(L2)
- Analyze the various protocols in application layer .(L4)

Applications: Users can forward several emails and it also provides a storage facility, allows users to access, retrieve and manage files in a remote computer layer provides access to global information about various services.

Text Books:

1. Data Communications and Networking ,Behrouz A Forouzan,fifth Edition.
2. Tanenbaum and David J Wetherall, Computer Networks, 5th Edition, Pearson Edu, 2010

Reference Books:

1. Computer Networks, Mayank Dave, CENGAGE
2. Larry L. Peterson and Bruce S. Davie, “Computer Networks - A Systems Approach” (5th ed), Morgan Kaufmann/ Elsevier, 2011

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1):

SNO	PO 1	PO 2	P O3	P O4	P O5	P O6	P O7	P O8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
Cxx.1	3	3	2	1	3				3			1		2	3
Cxx.2	3	3	2	1					3			1		2	3
Cxx.3	3	3	2	1					3					2	3
Cxx.4	3	3	2	1	3				3			1		2	3
Cxx.5	3	1	1	1	3				3			1		2	3
Cxx.*	3	3	2	1	3				3			1		2	3

** For Entire Course, PO & PSO Mapping*

Subject Code	Subject Name	L	T	P	C
R23CIT-OE0002	Cryptography & Network Security	3	0	0	3

Course Objectives:

- Classical systems, symmetric block ciphers (DES, AES, other contemporary symmetric ciphers) are Introduced.
- Introduction to Public- key cryptography (RSA, discrete logarithms) is provided.
- Algorithms for factoring and discrete logarithms, cryptographic protocols, hash functions, authentication, key management, key exchange, signature schemes are learnt.
- An overview of e-mail and web security is provided.
- An overview of viruses, firewalls and system security is provided.

Course Outcomes:

1. Understand the basics of Cryptography, the goals, services and mechanisms.
2. Analyze the Symmetric Encryption Algorithms.
3. Analyze the Asymmetric Cryptographic Algorithms.
4. Understand the Digital signature Schemes.
5. Understand the email security and system security.

UNIT- I

Basic Principles Security Goals, Cryptographic Attacks, Services and Mechanisms, Mathematics of Cryptography

Learning Outcomes: Student will be able to

- Understand what is meant by Cryptography.(L1)
- Understand the goals, mechanisms and services of Cryptography.(L1)

UNIT- II

Symmetric Encryption Mathematics of Symmetric Key Cryptography, Introduction to Modern Symmetric Key Ciphers, Data Encryption Standard, Advanced Encryption Standard.

Learning Outcomes: Student will be able to

- Understand symmetric key Cryptography (L2)
- Analyze the various algorithms of Symmetric key Cryptography (L3)

UNIT- III

Asymmetric Encryption Mathematics of Asymmetric Key Cryptography, Asymmetric Key Cryptography

Learning Outcomes: Student will be able to

- Understand symmetric key Cryptography (L1)
- Analyze the various algorithms of Asymmetric key Cryptography(L2)

UNIT- IV

Data Integrity, Digital Signature Schemes & Key Management Message Integrity and Message Authentication, Cryptographic Hash Functions, Digital Signature, KeyManagement.

Learning Outcomes: Student will be able to

- Understand about Digital Signature and the security schemes.(L1)
- Understand the Hash functions and its importance.(L2)

UNIT -V

Network Security: Security at application layer: PGP and S/MIME, Security at the Transport Layer: SSL and TLS, IPSec, System Security.

Learning Outcomes: Student will be able to

- Understand email-security.(L1)
- Understand the mechanisms of Transport Layer Security.(L1)
- Understand about system security.(L2)

Text Books:

1. Cryptography and Network Security, Behrouz A Forouzan, Debdeep Mukhopadhyay, (3e) McGraw Hill.
2. Cryptography and Network Security, William Stallings, (6e) Pearson.
3. Everyday Cryptography, Keith M. Martin, Oxford.

Reference Books:

4. Network Security and Cryptography, Bernard Meneges, Cengage Learning

COURSE OUTCOMES VS POs MAPPING (DETAILED: HIGH: 3, MEDIUM: 2, LOW: 1)

CO \ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	3	2	1	1	1	1	1	2	3	2	2
CO2	3	3	2	2	3	1	1	1	1	1	1	2	3	3	2
CO3	3	3	3	2	3	1	1	1	2	2	2	3	3	3	3
CO4	3	3	2	3	3	1	1	1	2	2	2	3	3	3	3
CO5	3	3	2	3	3	1	1	1	2	2	2	3	3	3	3
	3	3	3	3	3	1	1	1	2	2	2	3	3	3	3

**For Entire Course, PO & PSO Mapping*

Subject Code	Subject Name	L	T	P	C
R23CIT-OE0003	Mobile Computing	3	0	0	3

Course Objectives:

- To understand the fundamentals of mobile communication
- To understand the architecture of various Wireless Communication Networks
- To understand the significance of different layers in mobile system Course Contents
- To understand the mobility supported protocols
- To apply the mobility support in real time

Course Outcomes:

1. Understand the fundamentals of mobile Networks
2. Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network
3. Comprehend, design, and develop a lightweight network stack
4. Analyze the Mobile Network Layer system working
5. Understand WAP Model

UNIT- I

Introduction to Wireless Networks: Applications, History, Simplified Reference Model, Wireless transmission, Frequencies, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular Systems: Frequency Management and Channel Assignment, types of hand-off and their characteristics.

Learning Outcomes: Student will be able to

1. Understand the basic concepts of wireless networks (L2)
2. Understand the fundamentals of cellular system(L2)

UNIT-II

MAC – Motivation, SDMA, FDMA, TDMA, CDMA, Telecommunication Systems, GSM: Architecture Location tracking and call setup, Mobility management, Handover, Security, GSM, SMS, International roaming for GSM, call recording functions, subscriber and service data management, DECT, TETRA, UMTS, IMT-2000.

Learning Outcomes: Student will be able to

1. Understand the MAC layer functionalities (L2)
2. apply the strategy of subscriber and service data management(L3)

UNIT-III

Wireless LAN: Infrared vs. Radio transmission, Infrastructure, Adhoc Network, IEEE 802.11 WLAN Standards, Architecture, Services, HIPERLAN, Bluetooth Architecture & protocols.

Learning Outcomes: Student will be able to

1. Understand the wireless LAN functionalities(L2)
2. Understand the the various protocols in WLAN(L2)

UNIT-IV

Mobile Network Layer: Mobile IP, Dynamic Host Configuration Protocol, Mobile Transport Layer, Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/Fast recovery, Transmission/Time-out freezing, Selective retransmission, Transaction Oriented TCP.

Learning Outcomes: Student will be able to

1. Understand the working of mobile network layer (L2)
2. Understand the concepts of mobile transport layer(L2)

UNIT-V

Support for Mobility: Wireless Application Protocol: Architecture, Wireless Datagram Protocol, Wireless Transport Layer Security, Wireless Transaction Protocol, Wireless Session Protocol, Wireless Application Environment, Wireless Markup Language, WML Scripts, Wireless Telephone Application.

Learning Outcomes: Student will be able to

1. Understand the working functionality of wireless protocols(L2)
2. Apply the wireless markup language in real time (L3)

Text Books:

1. Jochen Schiller, "Mobile Communication", Second Edition, Pearson Education, 2008.
2. "Mobile Computing: Principles and Practices" by Asoke K. Talukder, Roopa R. Yavagal

Reference Books:

1. William Stallings, "Wireless Communications and Networks", Second Edition, Pearson Education, 2004.
2. C. Siva Ram Murthy, B. S. Manoj, "Adhoc Wireless Networks: Architectures and Protocols", Second Edition, Pearson Education, 2008.

COURSE OUTCOMES VS POs MAPPING (DETAILED: HIGH: 3, MEDIUM: 2, LOW: 1)

COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	2	2				1		1	2	3	1	2
CO2	3	3	2	2	2				1			2	3	1	2
CO3	3	3	2		2			1			1	2	3	1	2
CO4	3	3	2		2			1	1			2	3	1	2
CO5	3	3	2		2			1	1		1	2	3	1	2
CO*	3	3	2	2	2				1			2	3	1	2

**For Entire Course, PO & PSO Mapping*

Subject Code	Subject Name	L	T	P	C
R23CIT-OE0004	Wireless Sensor Networks	3	0	0	3

Course Objectives:

- Define WSN and Dynamic modulation scaling.
- Explore working of the MAC protocols
- Demonstrate Routing and Data gathering protocols
- Illustrate working of Embedded OS.
- Explore a wide range of WSN applications in different sectors

Course Outcomes:

1. Understand the basics, characteristics and challenges of Wireless Sensor Network
2. Apply the knowledge to identify appropriate physical and MAC layer protocol
3. Apply the knowledge to identify the suitable routing algorithm based on the network and user requirement
4. Analysis of OS used in Wireless Sensor Networks and build basic modules
5. Analyze specific WSN application using a case study approach

Unit-I – CHARACTERISTICS OF WSN (8 Hours)

Characteristic requirements for WSN – Challenges for WSNs – WSN vs Adhoc Networks – Sensor node architecture – Commercially available sensor nodes – Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.

Learning Outcomes:

- Identify and explain the key characteristics
- Differentiate between Wireless Sensor Networks (WSNs) and Ad-hoc Networks
- Understand the role and functionalities of each component within the sensor node.

Unit – II: MEDIUM ACCESS CONTROL PROTOCOLS (10 Hours)

Fundamentals of MAC protocols – Low duty cycle protocols and wakeup concepts – Contention based protocols – Schedule-based protocols – SMAC – BMAC – Traffic adaptive medium access protocol (TRAMA) – The IEEE 802.15.4 MAC protocol.

Learning Outcomes:

- Describe the main challenges of MAC protocols in wireless sensor networks (WSNs)
- Understand the concept of low duty cycle operation and its importance
- Evaluate the performance characteristics of contention-based protocols, including throughput, latency, and energy efficiency

Unit – III: ROUTING AND DATA GATHERING PROTOCOLS (10 Hours)

Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing – Gradient-based routing –Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing – LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP – Data aggregation - data aggregation operations – Aggregate Queries in Sensor Networks – Aggregation Techniques – TAG, Tiny DB.

Learning Outcomes:

- Identify the key routing challenges in WSNs compared to traditional wired networks
- Analyze popular hierarchical routing protocols
- Analyze location-based routing protocols, Real-Time Routing Protocols

Unit – IV: EMBEDDED OPERATING SYSTEMS (10 Hours)

Operating Systems for Wireless Sensor Networks – Introduction – Operating System Design Issues – Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS – OSPM – EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules – Configurations and Wiring – Generic Components – Programming in Tiny OS using NesC, Emulator TOSSIM.

Learning Outcomes:

- Understand the role and importance of operating systems in managing the resources and functionalities of Wireless Sensor Networks.
- Compare and contrast prominent WSN operating systems like TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, and PicOS.
- Understand the strengths and weaknesses of each operating system in terms of features, resource management, and suitability.

Unit – V: APPLICATIONS OF WSN (10 Hours)

WSN Applications – Home Control – Building Automation – Industrial Automation – Medical Applications – Reconfigurable Sensor Networks – Highway Monitoring – Military Applications – Civil and Environmental Engineering Applications – Wildfire Instrumentation – Habitat Monitoring – Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard – Target detection and tracking – Contour/edge detection – Field sampling

Learning Outcomes:

- Identify the key characteristics of Wireless Sensor Networks (WSNs) that make them suitable for various applications.
- Analyze a specific WSN application through a Case Study
- Develop a basic understanding of common data analysis techniques used with WSN data

Text Books:

1. Wireless Sensor Networks Technology, Protocols, and Applications, KazemSohraby, Daniel Minoli and TaiebZnati, John Wiley & Sons, 2007
2. Protocols and Architectures for Wireless Sensor Network, Holger Karl and Andreas Willig John Wiley & Sons, Ltd ,2005

References Books:

1. A survey of routing protocols in wireless sensor networks , K. Akkaya and M. Younis, Elsevier
2. Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
3. TinyOS Programming , Philip Levis
4. Wireless Sensor Network Designs , Anna Ha'c , John Wiley & Sons Ltd

COURSE OUTCOMES VS POs MAPPING (DETAILED; HIGH: 3; MEDIUM: 2; LOW: 1) :

[illegible]