

# **COURSE STRUCTURE (R23)**

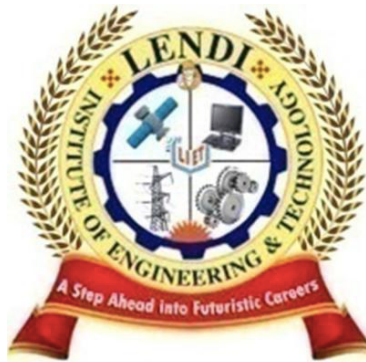
**AND**

## **DETAILED SYLLABUS**

**IV Year**

### **COMPUTER SCIENCE & SYSTEMS ENGINEERING**

**For**  
**B.Tech., Four Year Degree Course**  
**( Applicable for the batches admitted from 2023-2024 )**



#### **LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY**

*An Autonomous Institution*

Approved by AICTE & Permanently Affiliated to JNTUGV, Accredited by NAAC with "A"  
Grade and NBA (CSE, ECE, EEE & ME)

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**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (CSSE)**  
**B. Tech IV-Year Course Structure–R23**

| <b>IV Year – I SEMESTER</b> |                    |                                                                                                                                          |                 |          |          |          |                |
|-----------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------|----------|----------|----------------|
| <b>S.No</b>                 | <b>Course Code</b> | <b>Course Title</b>                                                                                                                      | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credits</b> |
| 1                           | R23CSS-PC4101      | Cryptography & Network Security                                                                                                          | PC              | 3        | 0        | 0        | 3              |
| 2                           | R23BSH-HM4101      | Management Science for Engineers                                                                                                         | Management      | 2        | 0        | 0        | 2              |
| 3                           |                    | <b>Professional Elective – IV</b>                                                                                                        | PE              | 3        | 0        | 0        | 3              |
|                             | R23CSS-PE4101.1    | 1. Machine Learning                                                                                                                      |                 |          |          |          |                |
|                             | R23CSS-PE4101.2    | 2. Security in Wireless Ad Hoc Networks                                                                                                  |                 |          |          |          |                |
|                             | R23CSS-PE4101.3    | 3. Fuzzy Logic Applications                                                                                                              |                 |          |          |          |                |
| 4                           | R23CSS-PE4102.1    | <b>Professional Elective – V</b>                                                                                                         | PE              | 3        | 0        | 0        | 3              |
|                             | R23CSS-PE4102.2    | 1. AI in E-Commerce                                                                                                                      |                 |          |          |          |                |
|                             | R23CSS-PE4102.3    | 2. Neural Networks<br>3. Big Data Analytics                                                                                              |                 |          |          |          |                |
| 5                           |                    | <b>Open Elective Course - III</b><br>1. Introduction to Internet of Things<br>2. Electrical Safety & Standards<br>3. Industrial Robotics | OE              | 3        | 0        | 0        | 3              |
| 6                           |                    | <b>Open Elective Courses - IV</b><br>1. Satellite Communication<br>2. Utilization of Electrical Energy<br>3. Nano Materials              | OE              | 3        | 0        | 0        | 3              |
| 7                           | R23CSS-SC4101      | User Interface / User eXperience Design Lab (UI / UX)                                                                                    | SC              | 1        | 1        | 2        | 2              |
| 8                           | R23CSS-MC4101      | Entrepreneurship and Incubation                                                                                                          | AC              | 2        | 0        | 0        | 0              |
| 9                           | R23CSS-SI3101      | Internship (Evaluation of Industry Internship)                                                                                           | SI              | 0        | 0        | 0        | 2              |
| <b>Total</b>                |                    |                                                                                                                                          |                 |          |          |          | 21             |

| <b>IV Year – II SEMESTER</b> |                    |                        |                 |          |          |          |                |
|------------------------------|--------------------|------------------------|-----------------|----------|----------|----------|----------------|
| <b>S.No</b>                  | <b>Course Code</b> | <b>Course Title</b>    | <b>Category</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>Credits</b> |
| 1                            | R23CSS-PR4201      | Internship and Project |                 | -        | -        | 24       | 12             |
|                              |                    | Internship (100 M)     |                 | -        | -        | 8        |                |
|                              |                    | Project (200M)         |                 | -        | -        | 16       |                |

## HONORS SUBJECT TRACKS

| S. No        | Course Code     | Course Title                      | L | T | P | Credits |
|--------------|-----------------|-----------------------------------|---|---|---|---------|
| 1            | R23CSS-HN2201   | Introduction to Cloud Computing   | 3 | 0 | 0 | 3       |
| 2            | R23CSS-HN3101   | Cloud Infrastructure and Services | 3 | 0 | 0 | 3       |
| 3            | R23CSS-HN3201   | Cloud Security and Governance     | 3 | 0 | 0 | 3       |
| 4            | R23CSS-HN4101   | Cloud Architecture and Design     | 3 | 0 | 0 | 3       |
| 5            | R23CSS-HNM001.1 | NPTEL from Above Track            | 0 | 0 | 0 | 3       |
| 6            | R23CSS-HNM001.2 | NPTEL from Above Track            | 0 | 0 | 0 | 3       |
| <b>TOTAL</b> |                 |                                   |   |   |   | 18      |

| S.No         | Course Code     | Course Title                                      | L | T | P | Credits |
|--------------|-----------------|---------------------------------------------------|---|---|---|---------|
| 1            | R23CSS-HN2202   | Introduction to Data Science                      | 3 | 0 | 0 | 3       |
| 2            | R23CSS-HN3102   | Data Analysis and Visualization                   | 3 | 0 | 0 | 3       |
| 3            | R23CSS-HN3202   | Advanced Data Analysis Techniques                 | 3 | 0 | 0 | 3       |
| 4            | R23CSS-HN4102   | Applied Data Science Projects and Specializations | 3 | 0 | 0 | 3       |
| 5            | R23CSS-HNM002.1 | NPTEL from Above Track                            | 0 | 0 | 0 | 3       |
| 6            | R23CSS-HNM002.2 | NPTEL from Above Track                            | 0 | 0 | 0 | 3       |
| <b>TOTAL</b> |                 |                                                   |   |   |   | 18      |

| S.No         | Course Code     | Course Title                                | L | T | P | Credits |
|--------------|-----------------|---------------------------------------------|---|---|---|---------|
| 1            | R23CSS-HN2203   | Fundamentals of Cybersecurity               | 3 | 0 | 0 | 3       |
| 2            | R23CSS-HN3103   | Defensive Security                          | 3 | 0 | 0 | 3       |
| 3            | R23CSS-HN3203   | Risk Management and Governance              | 3 | 0 | 0 | 3       |
| 4            | R23CSS-HN4103   | Cybersecurity Innovations and Future Trends | 3 | 0 | 0 | 3       |
| 5            | R23CSS-HNM003.1 | NPTEL from Above Track                      | 0 | 0 | 0 | 3       |
| 6            | R23CSS-HNM003.2 | NPTEL from Above Track                      | 0 | 0 | 0 | 3       |
| <b>TOTAL</b> |                 |                                             |   |   |   | 18      |

| S.No         | Course Code     | Course Title                         | L | T | P | Credits |
|--------------|-----------------|--------------------------------------|---|---|---|---------|
| 1            | R23CSS-HN2204   | Fundamentals of Ethical Hacking      | 3 | 0 | 0 | 3       |
| 2            | R23CSS-HN3104   | Network Penetration Testing          | 3 | 0 | 0 | 3       |
| 3            | R23CSS-HN3204   | Web Application Penetration Testing  | 3 | 0 | 0 | 3       |
| 4            | R23CSS-HN4104   | Wireless Network Penetration Testing | 3 | 0 | 0 | 3       |
| 5            | R23CSS-HNM004.1 | NPTEL from Above Track               | 0 | 0 | 0 | 3       |
| 6            | R23CSS-HNM004.2 | NPTEL from Above Track               | 0 | 0 | 0 | 3       |
| <b>TOTAL</b> |                 |                                      |   |   |   | 18      |

*\* Honors Student should complete 2 Courses from the Track or NPTEL*

| Subject Code  | Subject Name                    | L | T | P | C |
|---------------|---------------------------------|---|---|---|---|
| R23CSS-PC4101 | Cryptography & Network Security | 3 | 0 | 0 | 3 |

### Course Objectives:

- Understand the fundamental concepts of cryptography and network security.
- Analyze and apply symmetric key cryptographic techniques, including classical and modern encryption algorithms such as DES, AES, and Triple DES.
- Understand and evaluate asymmetric key cryptographic algorithms and their mathematical principles, including RSA, Diffie-Hellman, ElGamal, and Elliptic Curve Cryptography.
- Explain digital signature schemes, key management techniques, and public key infrastructures for ensuring authentication, integrity, and secure key distribution.
- Understand network and system security mechanisms such as PGP, S/MIME, SSL/TLS, IPSec, and security solutions at different layers of communication.

### Course Outcomes:

**CO1:** Explain the fundamentals of cryptography and security principles.

**CO2:** Analyze symmetric key cryptographic algorithms.

**CO3:** Apply asymmetric key cryptographic techniques and hash functions.

**CO4:** Explain digital signatures, key management, and PKI.

**CO5:** Analyze network security protocols and system security mechanisms.

### UNIT- I

**Basic Principles :** Security Goals, Cryptographic Attacks, Services and Mechanisms, **Mathematics of Cryptography :** Divisibility and the Division Algorithm, The Euclidean Algorithm, Modular Arithmetic, Matrices

### Learning Outcomes:

After Completion of this unit, student will be able to

- Understand what is meant by Cryptography
- Understand the goals, mechanisms and services of Cryptography.

### UNIT- II

**Mathematics of Symmetric Key Cryptography:** Algebraic Structures (Groups, Rings, Fields and Galois Fields),

**Introduction to Modern Symmetric Key Ciphers:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, The Data Encryption Standard, The Strength of DES, Block Cipher Design Principles, Advanced Encryption Standard, AES Structure, AES Transformation Functions, AES Key Expansion, Multiple Encryption and Triple DES.

### Learning Outcomes:

After Completion of this unit, student will be able to

- Understand symmetric key Cryptography
- Analyze the various algorithms of Symmetric key Cryptography

### UNIT- III:

**Asymmetric Encryption:** Mathematics of Asymmetric Key Cryptography- Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms.

**Public-Key Cryptography:** Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie- Hellman Key Exchange, Elgamal Cryptographic System, Elliptic Curve Cryptography, Secure Hash Algorithm (SHA), Message Authentication Codes

#### **Learning Outcomes:**

After Completion of this unit, student will be able to

- Understand Asymmetric key Cryptography
- Understand the Hash functions and its importance

### UNIT- IV:

**Digital Signatures:** Digital Signatures, Elgamal Digital Signature Scheme, Schnorr Digital Signature Scheme, Elliptic Curve Digital Signature Algorithm

**Key Management and Distribution:** Symmetric Key Distribution Using Symmetric Encryption, Symmetric Key Distribution Using Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure

#### **Learning Outcomes:**

After Completion of this unit, student will be able to

- Understand about Digital Signature and the security schemes.
- Understand about Key Management and Distribution

### 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:**

After Completion of this unit, student will be able to

- Understand email-security.
- Understand the mechanisms of Transport Layer Security.
- Understand about system security.

#### **Text Book:**

1. Cryptography and Network Security, William Stallings, 8th Edition, Pearson Education

#### **References:**

1. Cryptography, Network Security and Cyber Laws, Bernard L. Menezes, Ravinder Kumar, Cengage Learning.
2. Cryptography and Network Security, Behrouz A Forouzan, Debdeep Mukhopadhyaya, 3rd Edition, Mc-GrawHill.
3. Network Security Illustrated, Jason Albanese, Wes Sonnenreich, McGrawHill.

| Subject Code  | Subject Name                    | L | T | P | C |
|---------------|---------------------------------|---|---|---|---|
| R20BSH-HM4101 | Managerial Skills for Engineers | 2 | 0 | 0 | 2 |

### Course Objectives:

- To Provide fundamental knowledge on Management, Administration, Organizational methodologies
- To Equip with the knowledge of long term business value for the organization
- To Explain basics of human resource management & marketing required for organization
- To Analyze the PERT/CPM techniques for better Project Management
- To Incorporate technology perspectives with Managerial practices

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

- Apply principles of management & designs of organization in practical world.(L3)
- Realize concepts of business value development for organizational growth.(L2)
- Provided awareness of human resource management and marketing concepts.(L3)
- Develop PERT/CPM Charts for projects of enterprise and estimate time & cost of project.(L3)
- Analysis of improved decision making with the implementation of technology in Management(L2)

### UNIT-I

**Introduction to Management:** Management-Concept -Nature-Functions- Evolution of Management Thought -Principles of Management-Theories of Motivation- Managerial skills-Data driven Decision making-Leadership styles - Interpersonal skills- 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 Value Development:** Business Environment-Building business value through Modernization-Business Analytics- Types-Principles of Value Engineering- Approaches and methods of Business value- Strategies for enhancing Business Value -Corporate Social Responsibility-SWOT analysis of Business.

**Application:** Analyze a Multi-National 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-Negotiation skill- Employee performance appraisal.

**Marketing Management:** Concept- Meaning - Nature-Functions of Marketing- Marketing Mix-Marketing Strategies based on Product Life Cycle-Digital Marketing.

**Application:** Apply Human resource and marketing aspects in professional decisions through case studies

## UNIT-IV

**Project Management:** Project Selection and criteria of choice - Project planning and control - Development of Network - Difference between Program Evaluation Review Technique and Critical Path Method - Identifying critical path-crashing (simple problems).

**Application:** Analyze various parameters of the project like critical path, crashing etc. for best cost decisions according to operations of the project.

## UNIT-V

**Technology In Management:** AI (Artificial Intelligence) in Management-Finance, Operations, Human Resource- Development Phases of AI for Management Support-Benefits, Challenges and considerations-Best Practices for AI Implementation-Case Examples.

**Application:** Integrate AI with existing management systems (ERP, CRM).

### TEXT BOOKS:

1. Management Science by Aryasri; Publisher: Tata McGraw Hill, 2009
2. L.M. Prasad, Principles and Practice of Management.

### Reference Books:

1. Robins, Stephen P., *Fundamentals of Management*, Pearson, India.
2. Kotler Philip & Keller Kevin Lane: *Marketing Management* 12/e, PHI, 2007
3. Koontz & Weihrich: *Essentials of Management*, 6/e, TMH, 2007
4. Valuing a Business, 5th Edition : The Analysis and Appraisal of Closely Held Companies, Shannon P.Pratt
5. Artificial Intelligence Concepts for Management, Paperback, Katzan Harry Jr, 2023

### Web links:

1. [www.managementstudyguide.com](http://www.managementstudyguide.com)
2. [www.citehr.com](http://www.citehr.com)
3. [www.nptel.ac.in/courses/122106032](http://www.nptel.ac.in/courses/122106032)
4. <https://nptel.ac.in/courses/110/106/110106145/>
5. [www.btechguru.com/courses--nptel--basic-course](http://www.btechguru.com/courses--nptel--basic-course)

| <b>Subject Code</b> | <b>Subject Name</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------------|---------------------|----------|----------|----------|----------|
| R23CSS-PE4101.1     | Machine Learning    | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

## Course Objectives

1. To develop familiarity with a wide range of supervised, unsupervised, and semi-supervised learning algorithms.
2. To provide hands-on experience in implementing basic machine learning algorithms.
3. To build an understanding of how machine learning models are evaluated and optimized.
4. To equip students to apply core concepts and techniques of machine learning to real-world problems.
5. To introduce advanced methods like neural networks and dimensionality reduction for high-dimensional data.

## Course Outcomes

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

1. Understand the characteristics and applications of machine learning in solving real-world problems.
2. Classify machine learning techniques as supervised, semi-supervised, and unsupervised.
3. Analyze the use of machine learning tools and implement algorithms such as support vector machines and rule-based models.
4. Apply regularized regression techniques, clustering algorithms, and ensemble methods to practical datasets.
5. Understand and implement neural networks and dimensionality reduction methods such as PCA.

### Unit I: Introduction to Machine Learning and Binary Classification

Tasks in ML, Types of models, Features and feature engineering, Binary classification, Scoring functions, Ranking models.

#### Learning Outcomes:

- Understand machine learning as a framework of algorithms and problem-solving techniques.
- Analyze binary classification and related problems using scoring and ranking techniques.

### Unit II: Multi-Class Classification, Regression, and Tree Models

Multi-class classification, Regression, Descriptive learning, Decision trees, Ranking trees, Probability estimation, Variance reduction in tree learning.

#### Learning Outcomes:

- Handle classification tasks with more than two classes.
- Understand and construct decision trees and probability estimation models.

### **Unit III: Rule-Based and Linear Models**

Rule models – ordered lists, unordered sets, first-order rules, Least-squares method, Perceptron algorithm, Support Vector Machines (SVM), Kernel methods, Probabilities from linear classifiers.

#### **Learning Outcomes:**

- Understand and apply rule learning techniques.
- Implement and evaluate linear classifiers and SVMs for machine learning tasks.

### **Unit IV: Distance-Based, Probabilistic, and Ensemble Models**

K-Nearest Neighbors, Distance-based clustering, Hierarchical clustering, Normal distribution, Conditional likelihood, Hidden variables, Bagging, Random forests, Boosting.

#### **Learning Outcomes:**

- Apply distance-based learning algorithms for classification and clustering.
- Implement probabilistic models and ensemble learning techniques.

### **Unit V: Dimensionality Reduction and Neural Networks**

Principal Component Analysis (PCA), Artificial Neural Networks (ANN), Neural network architecture, Backpropagation, Multilayer networks, CNN (if included), Use cases of ANN.

#### **Learning Outcomes:**

- Apply PCA for dimensionality reduction and visualization.
- Understand and implement the basics of neural networks and backpropagation.

### **Textbooks**

1. Peter Flach, *Machine Learning: The Art and Science of Algorithms That Make Sense of Data*, Cambridge University Press.
2. Tom M. Mitchell, *Machine Learning*, McGraw Hill.

### **Reference Books**

1. Shai Shalev-Shwartz & Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press.
2. Peter Harrington, *Machine Learning in Action*, Cengage Learning.

| Course code     | Course Title                         | L | T | P | Credits |
|-----------------|--------------------------------------|---|---|---|---------|
| R23CSS-PE4101.2 | Security in Wireless Ad Hoc Networks | 3 | 0 | 0 | 3       |

## Course Objectives

- To introduce the unique challenges of securing wireless ad hoc networks.
- To analyze threats and attacks on routing, forwarding, and trust.
- To study cryptographic and trust-based mechanisms suitable for resource-constrained environments.
- To explore secure routing, intrusion detection, and
- To explore authentication techniques.

## Course Outcomes

### Students will be able to:

1. Understand security challenges specific to infrastructure-less wireless networks.
2. Analyze vulnerabilities in routing and data forwarding in mobile ad hoc settings.
3. Apply cryptographic and trust-based techniques to secure wireless communication.
4. Evaluate security protocols and detection mechanisms in ad hoc networks.
5. Design and assess lightweight, scalable security solutions for decentralized wireless networks.

## UNIT I

### Introduction to Wireless Ad Hoc Networks and Security Challenges:

Characteristics of wireless ad hoc networks, Types of ad hoc networks (MANETs, VANETs, WSNs), Applications of ad hoc networks, Security goals (confidentiality, integrity, availability, authentication, non-repudiation), Security challenges due to mobility, decentralization, and resource constraints, Attacker models in ad hoc networks

**Learning Outcome:** Students will be able to explain the basic structure, characteristics, and security challenges in wireless ad hoc networks.

## UNIT II

### Attacks in Wireless Ad Hoc Networks

Classification of attacks (passive vs active, internal vs external), Attacks on routing protocols, Wormhole attack, Blackhole and grayhole attacks, Sybil attack, Spoofing and impersonation, Replay and denial of service attacks, Attacks on neighbor discovery and packet forwarding

### Learning Outcome:

Students will be able to identify and analyze common attacks that target routing, forwarding, and network integrity in ad hoc environments.

## UNIT III

### Secure Routing Protocols and Defense Mechanisms

Security-enhanced routing protocols (Ariadne, SAODV, SEAD, SRP), Hash chains and digital signatures in routing, Route validation techniques, Secure neighbor discovery, Link layer authentication, Defense strategies for wormhole and blackhole attacks

#### Learning Outcome:

Students will be able to evaluate and apply secure routing protocols and defense mechanisms to protect network communication paths.

## UNIT IV

### Trust Models and Lightweight Cryptography

Trust establishment in decentralized networks, Direct and indirect trust, Reputation-based trust systems, Lightweight cryptographic algorithms for constrained devices, Key management in ad hoc networks, Elliptic Curve Cryptography (ECC), Identity-based cryptography

#### Learning Outcome:

Students will be able to apply trust evaluation and lightweight cryptographic techniques suitable for decentralized wireless systems.

## UNIT V

### Intrusion Detection and Security Frameworks in Ad Hoc Networks

Anomaly-based and signature-based intrusion detection systems, Cooperative IDS in ad hoc networks, Secure group communication, Secure data aggregation, Frameworks for holistic security in mobile ad hoc networks, Case studies of security architectures for MANETs and WSNs

#### Learning Outcome:

Students will be able to design and analyze intrusion detection techniques and overall security frameworks for wireless ad hoc environments.

#### Textbooks

1. *Security in Wireless Ad Hoc and Sensor Networks* – Erdal Cayirci, Chunming Rong
2. *Wireless Ad Hoc and Sensor Networks: Theory and Applications* – Raja Jurdak
3. *Ad Hoc Wireless Networks: Architectures and Protocols* – C. Siva Ram Murthy, B.S. Manoj

#### Reference Books

1. *Security and Cooperation in Wireless Networks* – Levente Buttyán, Jean-Pierre Hubaux
2. *Handbook of Ad Hoc Wireless Networks* – Mohammad Ilyas
3. Selected research papers from IEEE Xplore, ACM Digital Library.

| Course code     | Course Title             | L | T | P | Credits |
|-----------------|--------------------------|---|---|---|---------|
| R23CSS-PE4101.3 | Fuzzy Logic Applications | 3 | 0 | 0 | 3       |

### Course Objectives

- Understand the fundamentals of classical and fuzzy sets.
- Learn membership functions, fuzzification, and defuzzification techniques.
- Analyze classical and fuzzy relations and their operations.
- Understand fuzzy logic and fuzzy rule-based systems.
- Apply fuzzy classification and clustering techniques to solve real-world problems.

### Course Outcomes (COs) Students will be able to

- Differentiate a Fuzzy set, its properties and the operations on Fuzzy sets from their classical set theory counterparts.
- Introduce fuzziness in classical relations and perform various operations on fuzzy relations.
- Fuzzify a crisp set and defuzzify a fuzzy set.
- Develop a Fuzzy rule based inference system.
- Apply the knowledge of fuzzy set theory and logic to various applications such as classification, clustering and development of a fuzzy controller.

### Unit I: Classical Sets and Fuzzy Sets:

Classical Sets, Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions, Fuzzy Sets, Operations on Fuzzy Sets, Properties of Fuzzy Sets, Alternative Fuzzy Set Operations

**Learning Outcomes:** student will be able to

- Define classical and fuzzy sets along with their basic operations. (L1)
- Differentiate between properties of crisp and fuzzy sets. (L2)
- Apply set operations and mappings to solve problems involving fuzzy sets. (L4)

### Unit II: Membership Functions, Fuzzification and Defuzzification:

Features of the Membership Function, Various Forms of Membership Functions, Membership Value Assignments, Assignment by Intuition, Inference and Rank Ordering Methods, Fuzzification, Defuzzification to Crisp Sets, Defuzzification to Scalars

**Learning Outcomes:** student will be able to

- Explain the features and types of membership functions. (L2)
- Compare and contrast different methods for assigning membership values. (L3)
- Implement fuzzification and defuzzification techniques in real-world examples. (L4)

### **Unit III:**

Classical Relations and Fuzzy Relations: Cartesian Product, Crisp Relations, Cardinality of Crisp Relations, Operations on Crisp Relations, Properties of Crisp Relations, Composition of Crisp Relations, Crisp Equivalence Relations Fuzzy Relations, Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition of Fuzzy Relations, Fuzzy Equivalence Relations

**Learning Outcomes:** student will be able to

- **Describe** crisp and fuzzy relations and their properties. (L1)
- **Illustrate** the process of composition and equivalence in both crisp and fuzzy relations. (L2)
- **Analyze** the operations and relationships within fuzzy systems using relational models. (L3)

### **Unit IV: Logic and Fuzzy Systems:**

Classical Logic, Tautologies, Contradictions, Equivalence, Exclusive Or and Exclusive Nor, Logical Proofs, Deductive Inferences, Fuzzy Logic, Approximate Reasoning, Fuzzy Systems, Natural Language, Linguistic Hedges, Fuzzy Rule-Based Systems

**Learning Outcomes:** student will be able to

- **Explain** classical and fuzzy logic principles and reasoning. (L2)
- **Construct** logical expressions and proofs involving tautologies, equivalences, and contradictions. (L4)
- **Evaluate** fuzzy rule-based systems and their use in natural language and decision-making. (L4)

### **Unit V: Fuzzy Classification:**

Classification, Classification by Crisp and Fuzzy Equivalence Relations, Cluster Analysis, Cluster Validity,  $c$ -Means Clustering, Hard  $c$ -Means (HCM), Fuzzy  $c$ -Means (FCM), Classification Metric, Hardening the Fuzzy  $c$ -Partition

**Learning Outcomes:** student will be able to

- **Discuss** the concepts of fuzzy classification and clustering techniques. (L2)
- **Apply** hard and fuzzy  $c$ -means algorithms to classify datasets. (L4)
- **Assess** the effectiveness of clustering using validity indices and classification metrics. (L4)

### **Textbooks**

- Fuzzy Logic with Engineering Applications by Timothy J. Ross, Second Edition, Wiley India
- Fuzzy Sets, Uncertainty and Information by G. Klir, PHI Publication
- Fuzzy Set Theory and Its Applications by H. Zimmermann, Fourth Edition, Springer Publication

### **Reference Books**

- Neural Networks, Fuzzy Logic and Genetic Algorithms, Synthesis and Applications by S. Rajasekaran, PHI
- Neuro-Fuzzy and Soft Computing By J. Jang, Pearson Education

| Course code     | Course Title     | L | T | P | Credits |
|-----------------|------------------|---|---|---|---------|
| R23CSS-PE4101.3 | AI in E-Commerce | 3 | 0 | 0 | 3       |

### Course Objectives

- Introduce students to the intersection of Artificial Intelligence and E-Commerce.
- Enable understanding of AI-based techniques used for recommendation, personalization, and fraud detection.
- Develop practical skills in analyzing customer data, optimizing business operations, and improving customer experience through AI.
- Examine the ethical and regulatory considerations involved in deploying AI in E-Commerce systems.
- Study real-world applications and trends of AI tools in commercial digital platforms.

### Course Outcomes (COs)

- Describe AI's role and application in E-Commerce ecosystems.
- Build and evaluate AI models for customer behavior analysis and targeting.
- Develop recommendation systems suited for E-Commerce platforms.
- Analyze and implement AI-based fraud detection and secure transaction mechanisms.
- Critically assess ethical challenges and the future direction of AI in digital commerce.

### Unit I: Introduction to AI and E-Commerce

Overview of E-Commerce: B2B, B2C, C2C models, Introduction to Artificial Intelligence and its components, Benefits of integrating AI in E-Commerce, Case studies: AI in Amazon, Alibaba, Flipkart

**Learning Outcomes:** student will be able to

- Understand the basic models of E-Commerce and AI concepts. (L1)
- Explain how AI enhances user experience and operational efficiency in digital commerce. (L1)
- Analyze successful case studies of AI implementation in global E-Commerce platforms. (L4)

### Unit II: Customer Analytics and Behavior Prediction

Customer segmentation: clustering, RFM analysis, Predictive modeling for customer churn and purchase patterns, Sentiment analysis from customer reviews using NLP, AI for targeted marketing and pricing optimization

**Learning Outcomes:** student will be able to

- Apply machine learning techniques to predict and analyze customer behavior. (L3)
- Utilize NLP for analyzing user-generated content and customer reviews. (L3)
- Design data-driven marketing strategies using AI analytics. (L6)

### **Unit III: Recommendation Systems**

Types of recommendation systems: collaborative filtering, content-based, hybrid, Algorithms: k-NN, SVD, deep learning models, Evaluation: MAE, RMSE, Precision, Recall  
Use cases: Netflix, Amazon, Spotify

**Learning Outcomes:** student will be able to

- Differentiate various recommendation system approaches and their use cases. (L4)
- Implement and evaluate recommendation models using appropriate datasets. (L4)
- Assess the impact of recommendation systems on business performance. (L5)

### **Unit IV: Fraud Detection and AI in Payment Systems**

Common fraud types in E-Commerce: phishing, card fraud, fake returns, Supervised and unsupervised techniques for fraud detection, AI in transaction monitoring and real-time fraud prevention, Introduction to Blockchain and its synergy with AI

**Learning Outcomes:** student will be able to

- Identify fraud patterns and apply AI techniques for detection. (L3)
- Implement AI models for anomaly detection in transactions. (L3)
- Analyze the role of secure AI systems in payment and identity protection. (L4)

### **Unit V: Operational AI and Ethical Considerations**

AI in inventory and logistics optimization, Virtual assistants and customer service automation, Ethical concerns: bias, privacy, data misuse, AI policy and compliance in global E-Commerce markets, Future trends: voice commerce, autonomous agents, personalization 2.0

**Learning Outcomes:** student will be able to

- Understand AI's applications in back-end operations like supply chain and support. (L3)
- Discuss the ethical and legal implications of deploying AI in commerce. (L4)
- Predict emerging AI technologies and their impact on E-Commerce innovation. (L5)

### **Textbooks**

- Amit Kumar Tyagi, Artificial Intelligence in E-Commerce, Wiley, 2023.
- Mark Ryan, The Future of AI in E-Commerce, Springer, 2021.

### **Reference Books**

- Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 2020.
- Tom Markiewicz & Josh Gordon, Machine Learning for E-Commerce with Python, O'Reilly, 2018.
- Rajendra Akerkar, Artificial Intelligence for Business, Springer, 2019.

| Course code     | Course Title    | L | T | P | Credits |
|-----------------|-----------------|---|---|---|---------|
| R23CSS-PE4102.2 | NEURAL NETWORKS | 3 | 0 | 0 | 3       |

### Course Objectives:

- To provide foundational knowledge of artificial neural networks and their biological motivation.
- To impart knowledge of perceptron, multilayer networks, and learning algorithms including backpropagation.
- To introduce deep neural networks like CNNs and RNNs, and explain optimization techniques for model training.
- To explore advanced neural architectures such as autoencoders, GANs, and transfer learning.
- To enable students to apply neural networks to real-world problems using tools like TensorFlow and PyTorch

### Course Outcomes

*A student after completion of the course will be able to:*

**CO1:** Understand the fundamentals of Artificial Neural Networks and learning techniques.

**CO2:** Apply Multilayer Perceptron (MLP) and backpropagation algorithms for solving problems.

**CO3:** Use deep learning models such as CNN, RNN, and LSTM for real-world applications.

**CO4:** Apply advanced neural network techniques such as Autoencoders, GANs, and Transfer Learning.

**CO5:** Develop neural network applications using TensorFlow, Keras, and PyTorch for domains such as NLP, Computer Vision, healthcare, finance, and robotics.

**UNIT I: Fundamentals of Neural Networks-** Introduction to Artificial Neural Networks (ANNs), Biological neuron vs. artificial neuron, Perceptron model and limitations, Activation functions: Sigmoid, Tanh, ReLU, Learning paradigms: Supervised, Unsupervised, Reinforcement.

### Learning Outcomes:

1. Distinguish between biological and artificial neural networks.
2. Apply basic ANN models such as perceptron to solve classification problems.
3. Analyze the effect of activation functions on model performance

**UNIT II: Multilayer Networks and Learning Algorithms-** Multilayer Perceptron (MLP) architecture, Backpropagation algorithm: Theory and implementation, Gradient descent variants: Stochastic, Mini-batch, Momentum, Regularization techniques: L1, L2, Dropout

### Learning Outcomes:

1. Design and implement MLPs using backpropagation.
2. Choose appropriate optimization techniques for training.
3. Evaluate neural network models using error minimization strategies.

**UNIT III: Deep Neural Networks and Optimization-** Deep Learning overview and challenges, Convolutional Neural Networks (CNNs): Architecture and applications Recurrent Neural Networks (RNNs): Basics and limitations, Long Short-Term Memory (LSTM) networks, Optimization algorithms: RMSprop, Adam

**Learning Outcomes:**

1. Implement CNN and RNN architectures for practical problems.
2. Solve real-world tasks using deep neural network techniques.
3. Compare performance metrics across different deep learning models.

**UNIT IV: Advanced Topics in Neural Networks-**Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): Introduction and applications, Transfer Learning and Fine-tuning, Hyperparameter tuning and model selection

**Learning Outcomes:**

1. Use GANs and autoencoders in generating and compressing data.
2. Apply transfer learning for efficient model building.
3. Perform hyperparameter tuning to optimize deep models.

**UNIT V: Applications and Tools-** Natural Language Processing (NLP) with Neural Networks, Computer Vision tasks: Image classification, Object detection, Frameworks: TensorFlow, Keras, PyTorch, Case studies: Real-world applications in healthcare, finance, and robotics.

**Learning Outcomes:**

1. Build simple models using neural network frameworks.
2. Demonstrate neural network usage in real-world case studies.
3. Integrate learned models in practical applications like health, finance, or robotics.

**Textbook:**

1. Comprehensive coverage of both classical and modern models in deep learning, focusing on theory and algorithms - Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer, 2018.
2. Designed as an introductory level textbook on Artificial Neural Networks at the postgraduate and senior undergraduate levels.
3. Gunjan Goswami, *Introduction to Artificial Neural Network*, S.K. Kataria & Sons, 2009 B. Yegnaranarayana, *Artificial Neural Networks*, PHI Learning, 2009.

**Reference Books:**

1. Michael A. Nielsen, *Neural Networks and Deep Learning*, Determination Press, 2015.
2. Dr. Vishwas Mishra et al., *Neural Networks and Deep Learning*, AMK Publications, 2023.

| Course code     | Course Title       | L | T | P | Credits |
|-----------------|--------------------|---|---|---|---------|
| R23CSS-PE4102.3 | Big Data Analytics | 3 | 0 | 0 | 3       |

## Course Objectives

- To introduce students to the concepts, tools, and techniques used in big data analytics
- To enable students to understand the Hadoop ecosystem and its core components
- To provide hands-on exposure to distributed computing frameworks and tools
- To develop the ability to analyze large datasets using scalable algorithms
- To apply big data solutions in real-world domains such as finance, health care, and IoT

## Course Outcomes

Students will be able to

1. Understand big data characteristics, challenges, and technologies
2. Use the Hadoop ecosystem to store, process, and analyze large datasets
3. Design MapReduce programs and perform data processing with Hive and Pig
4. Analyze structured and unstructured data using real-time analytics tools
5. Apply big data analytics techniques to solve domain-specific problems

## UNIT I

### Introduction to Big Data:-

Definition and characteristics of big data, Types of big data, Challenges in big data management, Traditional data processing vs big data processing, Big data analytics lifecycle, Introduction to Hadoop and its ecosystem

### Learning Outcome:

Students will be able to explain the need for big data technologies and describe the fundamental characteristics and lifecycle of big data analytics

## UNIT II

### Hadoop Architecture and HDFS:

Hadoop overview and components, Hadoop Distributed File System architecture, Data blocks and replication, HDFS read and write operations, NameNode and DataNode, Fault tolerance and scalability in Hadoop, Installation and configuration of Hadoop

**Learning Outcome:** Students will be able to describe the architecture of Hadoop and use HDFS for managing large-scale data storage

## UNIT III

### MapReduce Programming and Data Processing Tools

MapReduce programming model, Writing MapReduce jobs in Java or Python, Input and output formats, Combiner and Partitioner, Common MapReduce algorithms, Introduction to Hive, HiveQL queries, Introduction to Pig and Pig Latin scripts

**Learning Outcome:** Students will be able to develop MapReduce programs and perform data analysis using Hive and Pig

## UNIT IV

### NoSQL Databases and Real-Time Analytics

NoSQL data models key-value, column-based, document-based, graph-based, Introduction to HBase and Cassandra, Data ingestion using Sqoop and Flume, Stream processing with Apache Kafka and Spark Streaming, Lambda architecture

**Learning Outcome:** Students will be able to apply NoSQL and real-time analytics tools to manage and analyze fast-moving big data streams

## UNIT V

### Big Data Applications and Case Studies

Big data in social media and web analytics, Big data in health care and bioinformatics, Big data in financial services and e-commerce, Recommendation systems, Fraud detection, Case studies using real-world datasets

**Learning Outcome:** Students will be able to analyze domain-specific datasets and design big data solutions for real-world problems

### Textbooks

1. Big Data: Principles and Best Practices of Scalable Real-Time Data Systems by Nathan Marz
2. Hadoop: The Definitive Guide by Tom White
3. Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, and Jeff Ullman

### Reference Books

1. Big Data Analytics with Spark by Mohammed Guller
2. Mastering Hadoop by Sandeep Karanth
3. NoSQL Distilled by Pramod J Sadalage and Martin Fowler

| Course code   | Course Title                                          | L | T | P | Credits |
|---------------|-------------------------------------------------------|---|---|---|---------|
| R23ECE-OE0005 | Introduction to Internet of Things<br>(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

Students will 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)
5. 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 serverintroduction, 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 |
|---------------|--------------------------------------------------|---|---|---|---------|
| R23EEE-OE0003 | Electrical Safety & Standards<br>(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.
- 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](https://onlinecourses.nptel.ac.in/noc20_mg43)
2. [https://onlinecourses.swayam2.ac.in/nou20\\_cs08/preview](https://onlinecourses.swayam2.ac.in/nou20_cs08/preview)
3. <https://www.udemy.com/course/electrical-safety>

| Course code   | Course Title                           | L | T | P | Credits |
|---------------|----------------------------------------|---|---|---|---------|
| R23MEC-OE0005 | Industrial Robotics<br>(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](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](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](https://www.youtube.com/watch?v=hL_GKapQd1k)

| Course code   | Course Title                               | L | T | P | Credits |
|---------------|--------------------------------------------|---|---|---|---------|
| R23ECE-OE0007 | Satellite Communication<br>(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 |
|---------------|-----------------------------------------------------|---|---|---|---------|
| R23EEE-OE0004 | Utilization of Electrical Energy<br>(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. Electrical Power Systems, S. L. Uppal, Khanna publishers.

| Course code   | Course Title                      | L | T | P | Credits |
|---------------|-----------------------------------|---|---|---|---------|
| R23MEC-OE0006 | Nano Materials<br>(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 (FEM), 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=PLMiC7Vx5awsenMs5y02xcW6i5NmdEIRGx&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](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 |
|---------------|----------------------------------------------------------|---|---|---|---------|
| R23CSS-SC4101 | User Interface / User eXperience Design Lab<br>(UI / UX) | 3 | 0 | 0 | 3       |

### Course Objectives

The course should enable the students to:

- Analyse the significance of UI/UX design.
- Conduct user research using interviews, surveys, and observations
- Implement wireframing and prototyping techniques.
- Comprehend typography, colour theory, implementation of interactive UI elements.

### Course Outcomes

By the end of the course, the student will be able to:

**CO1:** Ability to generate innovative ideas to design solutions.

**CO2:** Apply the visual design tools to create user interfaces.

**CO3:** Develop proficiency in designing user experiences for mobile and websites.

**CO4:** Evaluate the UI/UX designs.

### EXPERIMENTS LIST

#### 1. Week 1: (CO1)

- Introduction to UI/UX concepts using AI tools
- Explore UI/UX differences and real-world examples
- Generate UI ideas using ChatGPT
- Analyse basic UI components and user experience principles

#### 2. Week 2: (CO2)

- Introduction to Figma interface
- Explore frames, layers, and components
- Install and use Magician AI Plugin
- Generate UI elements using AI plugins

#### 3. Week 3: (CO2)

- Design Login and Sign-Up UI screens
- Generate layouts using Uizard
- Customize UI elements in Figma
- Apply usability principles in authentication screens

#### 4. Week 4: (CO2)

- Study colour theory principles
- Generate palettes using Khroma
- Refine colours using Coolers
- Design Sign-Up page with proper colour application

5. **Week 5:** (CO3)
- Design mobile home screen layout
  - Use icons from Icons8
  - Arrange UI elements based on usability
  - Create visually balanced mobile UI in Figma
6. **Week 6:** (CO3)
- Create dual-scrolling interface prototype
  - Apply scrolling interactions in Figma
  - Get UX suggestions using ChatGPT
  - Test and refine interaction design
7. **Week 7:** (CO3)
- Design loading spinner UI
  - Create animation using Figma
  - Export and refine animation using LottieFiles
  - Implement responsive animation design
8. **Week 8:** (CO3)
- Design navigation bar layout
  - Generate UI patterns using Galileo AI
  - Add tap interactions in Figma
  - Optimize navigation usability
9. **Week 9:** (CO3)
- Create wireframes for digital interface
  - Generate layouts using Uizard
  - Design low-fidelity wireframes in Figma
  - Focus on layout, hierarchy, and user flow
10. **Week 10:** (CO4)
- Conduct usability testing
  - Upload prototype to Maze
  - Analyse feedback using ChatGPT
  - Improve UI based on testing results
11. **Week 11:** (CO4)
- Case Study:** UI/UX analysis of WhatsApp
- Identify usability issues and strengths
  - Suggest improvements using AI tools
  - Present findings

**12. Week 12:** (CO4)

**Case Study:** UX evaluation of Amazon (CO4)

- Analyse navigation and recommendation system
- Identify UI complexity issues
- Suggest improvements

**13. Week 13:** (CO4)

**Case Study:** UI/UX design of Instagram

- Study visual hierarchy and engagement
- Evaluate user interaction patterns
- Suggest enhancements

**14. Week 14:** (CO4)

**Case Study:** Website UX of Flipkart

- Analyse layout and responsiveness
- Identify usability challenges
- Provide recommendations

## TEXT BOOKS

1. U. Park, *Introduction to Design Thinking for UX Beginners*. Seoul, South Korea: UX Publishing, 2023.
2. Don Norman, *The Design of Everyday Things*, Revised and Expanded ed. New York, NY, USA: Basic Books, 2013.
3. M. Filipiuk, *UI Design Principles: A Comprehensive Guide to User Interface Design*. Self-published, 2023.

## REFERENCE BOOKS:

1. Susan Weinschenk, *100 Things Every Designer Needs to Know About People*, 2nd ed. Berkeley, CA, USA: New Riders, 2020.
2. Jenifer Tidwell, *Designing Interfaces: Patterns for Effective Interaction Design*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2019.
3. J. Gothelf and J. Seiden, *Lean UX: Designing Great Products with Agile Teams*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media.
4. S. Hurff, *Designing Products People Love: How Great Designers Create Successful Products*. Sebastopol, CA, USA: O'Reilly Media, 2023 (reprint/modern use).

## WEB REFERENCES:

1. Nielsen Norman Group, "UX Research and Design Articles." Available: <https://www.nngroup.com/>
2. Interaction Design Foundation, "UI/UX Design Courses and Resources." Available: <https://www.interaction-design.org/>
3. Figma, "Figma Help Center and Tutorials." Available: <https://help.figma.com/>
4. Google, "Material Design Guidelines." Available: <https://material.io/design>

| Course code   | Course Title                    | L | T | P | Credits |
|---------------|---------------------------------|---|---|---|---------|
| R23BSH-MC4102 | Entrepreneurship And Incubation | 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 proportion.(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:**

- Green Business
- Niche Markets
- New perspectives in rural enterprises

##### **Text Books:**

- T.V Rao, Donald F.Kuratko, Entrepreneurship, A South-Asian Perspective, Cengage Learning, 1<sup>st</sup> edition, 2012.
- 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

| Course code   | Course Title                                              | L | T | P | Credits |
|---------------|-----------------------------------------------------------|---|---|---|---------|
| R23CSS-HN4101 | Cloud Architecture and Design<br>Honors Course-4(Track-1) | 3 | 0 | 2 | 3       |

### Course Objectives

1. To provide an understanding of architectural principles and components in cloud environments
2. To explore different models for cloud infrastructure, platforms, and services
3. To introduce cloud-native application design patterns and microservice architectures
4. To analyze scalability, availability, and fault tolerance in cloud system design
5. To guide students in designing secure, cost-effective, and performant cloud solutions

### Course Outcomes

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

1. Understand and explain key components and models of cloud architecture
2. Design scalable and resilient cloud-based systems using best practices
3. Apply cloud design patterns for deployment, integration, and performance
4. Evaluate system requirements for availability, latency, and cost optimization
5. Develop architecture solutions for real-world scenarios using cloud provider services

## UNIT I

### Fundamentals of Cloud Architecture

Overview of cloud architecture, Service models (IaaS, PaaS, SaaS), Deployment models (public, private, hybrid, multi-cloud), Cloud-native vs traditional architecture, Principles of modularity and abstraction, Cloud service lifecycle

#### Learning Outcome:

Students will be able to describe the structure and characteristics of modern cloud architectures and differentiate between service and deployment models.

## UNIT II

### Infrastructure and Platform Design

Virtualization and containerization, Compute services, Block and object storage, Networking in the cloud, Load balancing and auto-scaling, Orchestration tools, Infrastructure as Code (IaC)

#### Learning Outcome:

Students will be able to design and configure compute, storage, and networking components for cloud infrastructure.

## UNIT III

### Cloud Application Architecture and Patterns

Microservices architecture, API gateway and service mesh, Serverless architecture, Event-driven architecture, Stateless vs stateful design, Common cloud design patterns (circuit breaker, bulkhead, queue-based load leveling)

#### Learning Outcome:

Students will be able to design and apply cloud-native architecture patterns for building modern distributed applications.

## **UNIT IV**

### **Performance, Availability, and Cost Optimization**

Horizontal and vertical scaling, High availability zones and regions, Caching strategies, Monitoring and observability, Cost models and budgeting, Cloud cost optimization strategies

#### **Learning Outcome:**

Students will be able to evaluate and optimize cloud system performance, availability, and cost.

## **UNIT V**

### **Security, Governance, and Architecture Case Studies**

Cloud security principles, Identity and Access Management (IAM), Data encryption and privacy, Compliance and governance, Reference architectures (AWS Well-Architected Framework, Azure Architecture Center), Case studies of cloud design in real-world systems

#### **Learning Outcome:**

Students will be able to integrate security and governance into cloud designs and analyze real-world architecture examples.

### **Textbooks**

1. Cloud Architecture Patterns by Bill Wilder
2. Designing Cloud Computing Solutions by Kevin L. Jackson and Scott Goessling
3. The Practice of Cloud System Administration by Thomas A. Limoncelli, Strata R. Chalup, Christina J. Hogan

### **Reference Books**

1. Cloud Native Patterns by Cornelia Davis
2. Site Reliability Engineering by Google (Betsy Beyer et al.)
3. Architecting the Cloud by Michael J. Kavis
4. AWS Well-Architected Framework and Azure Architecture Documentation (online)

| Course code   | Course Title                                                                  | L | T | P | Credits |
|---------------|-------------------------------------------------------------------------------|---|---|---|---------|
| R23CSS-HN4102 | Applied Data Science Projects and Specializations<br>Honors Course-4(Track-2) | 3 | 0 | 0 | 3       |

### Course Objectives

1. To apply data science methodologies to solve real-world problems across multiple domains
2. To guide students in executing complete data science projects from problem definition to deployment
3. To explore specialized areas of data science including NLP, computer vision, and time series analysis
4. To develop skills in data storytelling, dashboarding, and result communication for stakeholders
5. To promote ethical and responsible data science practices

### Course Outcomes

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

1. Design and execute end-to-end data science projects aligned with real-world use cases
2. Apply specialized data science techniques in targeted domains such as healthcare, finance, and e-commerce
3. Develop models for classification, prediction, segmentation, and anomaly detection based on data characteristics
4. Communicate results effectively using visualizations, reports, and dashboards
5. Integrate ethical considerations and responsible AI practices in data-driven solutions

## UNIT I

### Data Science Lifecycle and Project Structuring

Problem scoping, Stakeholder requirements, Dataset identification and exploration, Data cleaning and preparation, Feature engineering strategies, Evaluation metric selection, CRISP-DM methodology, Agile practices in data science

#### Learning Outcome:

Students will be able to structure and plan a data science project by applying a standardized methodology and lifecycle model.

## UNIT II

### Specialized Techniques in Natural Language Processing

Text preprocessing and vectorization, Sentiment analysis, Named Entity Recognition (NER), Topic modeling, Word embeddings, Transformer models, Chatbot workflows, Ethics in NLP applications

#### Learning Outcome:

Students will be able to apply NLP techniques to textual datasets and extract insights for use in real-world applications.

## UNIT III

### Advanced Applications in Computer Vision

Image preprocessing, Feature extraction, Convolutional Neural Networks (CNNs), Transfer learning, Object detection, Image classification use cases, Vision transformers, Model deployment considerations

**Learning Outcome:**

Students will be able to build and apply image-based machine learning models using computer vision techniques and pre-trained architectures.

**UNIT IV****Domain-Specific Case Studies and Specializations**

Healthcare analytics, Financial fraud detection, Customer segmentation in marketing, Retail demand forecasting, Geospatial analytics, Sensor data and IoT, Time series forecasting, Real-time data processing

**Learning Outcome:**

Students will be able to explore and implement domain-specific data science strategies for solving specialized problems in various sectors.

**UNIT V****Model Deployment, Reporting, and Ethics in Data Science**

Model interpretation and explainability, Bias and fairness in models, API development for models, Cloud deployment strategies, Creating dashboards and reports, Data storytelling techniques, Responsible AI practices

**Learning Outcome:**

Students will be able to interpret and present data science results through reports and dashboards while addressing ethical and deployment considerations.

**Textbooks**

1. Doing Data Science by Cathy O’Neil and Rachel Schutt
2. Data Science for Business by Foster Provost and Tom Fawcett
3. Applied Data Science with Python by Paul Teetor

**Reference Books**

1. Practical Statistics for Data Scientists by Peter Bruce
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron
3. Designing Data-Intensive Applications by Martin Kleppmann
4. Responsible Data Science by Peter Cihon and Brent Mittelstadt

| Course code   | Course Title                                                            | L | T | P | Credits |
|---------------|-------------------------------------------------------------------------|---|---|---|---------|
| R23CSS-HN4103 | Cybersecurity Innovations and Future Trends<br>Honors Course-4(Track-3) | 3 | 0 | 0 | 3       |

### Course Objectives

1. To introduce students to the latest trends and emerging innovations in cybersecurity
2. To examine the impact of modern technologies like AI, blockchain, and quantum computing on cyber defense and threats
3. To explore advanced cybersecurity architectures and models for evolving digital systems
4. To analyze the security implications of future technologies such as smart cities, 5G, and autonomous systems
5. To prepare students to anticipate, evaluate, and design strategies for next-generation cyber threats

### Course Outcomes

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

1. Understand the evolving threat landscape and modern cybersecurity challenges
2. Analyze the role of emerging technologies like artificial intelligence, blockchain, and quantum computing in cybersecurity
3. Evaluate advanced security models such as zero trust, adaptive security, and cyber resilience
4. Explore futuristic security domains such as Internet of Things, cyber-physical systems, and smart infrastructure
5. Develop insights into global cybersecurity strategies, frameworks, and the future of cyber defense

## UNIT I

### Emerging Threat Landscape and Cyber Attack Trends

Rise in advanced persistent threats, Sophisticated phishing and ransomware attacks, Threat intelligence evolution, Supply chain attacks, State-sponsored cyber warfare, Attacks on critical infrastructure

#### Learning Outcome:

Students will be able to identify and evaluate the latest forms of cyber attacks and understand their implications on global security.

## UNIT II

### Artificial Intelligence and Machine Learning in Cybersecurity

AI for threat detection and response, ML-based anomaly detection, Adversarial AI and model poisoning, Behavior-based security models, AI-driven SOCs, Limitations and ethical concerns of AI in cybersecurity

#### Learning Outcome:

Students will be able to analyze how AI and ML are applied in cybersecurity, both as defensive tools and attack vectors.

## UNIT III

### Quantum Computing and Post-Quantum Security

Basics of quantum computing, Quantum threats to current encryption standards, Post-quantum cryptographic algorithms, Quantum key distribution, Global standardization efforts (NIST PQC), Challenges in quantum resistance

#### Learning Outcome:

Students will be able to understand quantum computing's impact on encryption and evaluate the need for post-quantum cryptography.

## UNIT IV

### Blockchain, Zero Trust, and Next-Gen Security Models

Blockchain-based identity and authentication, Decentralized security protocols, Zero Trust Architecture, Software-defined perimeter, Secure access service edge (SASE), Adaptive and context-aware security

#### Learning Outcome:

Students will be able to evaluate advanced architectures and decentralized models for future-ready secure systems.

## UNIT V

### Security in Future Technologies and Systems

Cybersecurity for Internet of Things and Industrial IoT, Cyber-physical system security, Security in autonomous vehicles and robotics, 5G network vulnerabilities, Smart city security concerns, Resilience in digital infrastructures

#### Learning Outcome:

Students will be able to assess the cybersecurity challenges in emerging digital ecosystems and suggest appropriate defenses.

#### Textbooks

1. Cybersecurity and Cyberwar: What Everyone Needs to Know – P. W. Singer and Allan Friedman
2. Next-Gen Cybersecurity: Threats and Defense Strategies – Shira Rubinoff
3. Artificial Intelligence for Cybersecurity – Mark Stamp

#### Reference Books

1. Quantum Computing for Everyone – Chris Bernhardt
2. Zero Trust Networks – Evan Gilman and Doug Barth
3. Blockchain Security and Privacy – Ling Liu, Bhavani Thuraisingham
4. NIST Post-Quantum Cryptography Project Documentation
5. Selected IEEE and ACM papers on cybersecurity innovation and future technologies

| Course code   | Course Title                                                     | L | T | P | Credits |
|---------------|------------------------------------------------------------------|---|---|---|---------|
| R23CSS-HN4104 | Wireless Network Penetration Testing<br>Honors Course-4(Track-4) | 3 | 0 | 0 | 3       |

### Course Objectives

1. To understand the working of wireless communication protocols and their vulnerabilities
2. To perform penetration testing of wireless LANs using open-source tools
3. To explore encryption mechanisms and their weaknesses in wireless networks
4. To learn techniques for identifying, analyzing, and exploiting wireless threats
5. To document penetration test results and recommend wireless security solutions

### Course Outcomes

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

1. Explain wireless communication models, protocols, and security mechanisms
2. Detect and analyze vulnerabilities in Wi-Fi networks through hands-on testing
3. Perform wireless reconnaissance, traffic capture, and decryption
4. Conduct real-time attacks such as deauthentication, rogue AP, and WPA cracking
5. Create penetration testing reports with mitigation recommendations

## UNIT I

### Fundamentals of Wireless Networks and Security

Wireless LAN architecture, IEEE 802.11 protocols, Wireless network components, Wireless encryption standards (WEP, WPA, WPA2, WPA3), Wireless attack surfaces, Wireless network scanning and reconnaissance

#### Learning Outcome:

Students will be able to describe wireless network protocols and identify key areas of vulnerability in Wi-Fi communication.

## UNIT II

### Encryption Weaknesses and Traffic Capture

WEP encryption vulnerabilities, WPA/WPA2 PSK cracking, Handshake capture and replay, Dictionary attacks, Rainbow tables, Data sniffing and packet injection

#### Learning Outcome:

Students will be able to capture and crack wireless authentication handshakes using traffic analysis and password attacks.

## UNIT III

### Wireless Attacks and Exploitation Techniques

Deauthentication attacks, Evil twin attacks, Rogue access point setup, Man-in-the-middle attacks, Beacon flooding, Karma attacks

#### Learning Outcome:

Students will be able to simulate and perform real-time wireless attacks using appropriate penetration testing tools.

## **UNIT IV**

### **Advanced Wireless Security Testing and Defense Evasion**

Hidden SSID discovery, MAC spoofing, Channel hopping and jamming, Captive portal bypass, VPN over insecure wireless, IDS/IPS evasion techniques

#### **Learning Outcome:**

Students will be able to perform advanced wireless testing techniques and demonstrate how attackers evade basic defenses.

## **UNIT V**

### **Reporting, Mitigation, and Best Practices**

Wireless penetration test reporting, Vulnerability classification (CVSS), Wireless security audit checklist, Access point hardening, Enterprise Wi-Fi security (802.1X, RADIUS), Monitoring and alerting for wireless threats

#### **Learning Outcome:**

Students will be able to prepare professional wireless penetration test reports and suggest security best practices.

#### **Textbooks**

1. Hacking Wireless Networks: The Ultimate Hands-On Guide by Kevin Mitnick and Robert Vamosi
2. Penetration Testing by Georgia Weidman
3. Wireless Security Architecture by Jennifer Minella

#### **Reference Books**

1. 802.11 Wireless Networks: The Definitive Guide by Matthew Gast
2. Wireshark for Security Professionals by Jessey Bullock and Jeff T. Parker
3. Kali Linux Wireless Penetration Testing Beginner's Guide by Vivek Ramachandran
4. OWASP Testing Guide and Wireless Testing Methodology