CARE COLLEGE OF ENGINEERING
(An Autonomous Institution)

Approved AICTE New Delhi | Affiliated to Anna University Chennai
No 27, Thayanur, Tiruchirappalli 620 009

# M.E. COMPUTER SCIENCE AND ENGINEERING

# (WITH SPECIALIZATION IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

## REGULATIONS – 2026

## Curriculum and Syllabus

# CARE COLLEGE OF ENGINEERING:: TIRUCHIRAPPALLI 620 009
## (AN AUTONOMOUS INSTITUTION)
## REGULATIONS 2026
## CURRICULUM AND SYLLABUS
## CHOICE BASED CREDIT SYSTEM (CBCS)
## M.E. COMPUTER SCIENCE AND ENGINEERING
## (WITH SPECIALIZATION IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

## SEMESTER I

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | P26FC111 | Mathematical Foundations for Artificial Intelligence | FC | 3 | 1 | 0 | 4 | 4 | 40 | 60 |
| 2. | P26RM111 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 | 40 | 60 |
| 3. | P26CS111 | Advanced Data Structures and Algorithms | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CS121 | Agent Based Intelligent Systems | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CS131 | Machine Learning Techniques | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | P26CS141 | Data Analytics | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 7. | P26CS152 | Machine Learning Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| 8. | P26CS162 | Data Analytics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| | | | | **17** | **1** | **8** | **26** | **22** | | |

## SEMESTER II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | P26CS211 | Deep Learning | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CS221 | Reinforcement Learning | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CS231 | Internet of Things with Edge AI | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CS241 | Cloud Computing Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 7. | | Audit Course* | AC | 2 | 0 | 0 | 2 | 0 | | |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 8. | P26CS262 | Deep Learning Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| | | | | **20** | **0** | **4** | **24** | **20** | | |

***Audit Course is optional**

## SEMESTER III

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | | Open Elective | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 4. | P26EM312 | Project Work I | EEC | 0 | 0 | 18 | 18 | 9 | 60 | 40 |
| | | | | **09** | **0** | **18** | **27** | **18** | | |

## SEMESTER IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 1. | P26EM412 | Project Work II | EEC | 0 | 0 | 30 | 30 | 15 | 60 | 40 |
| | | | | **0** | **0** | **30** | **30** | **15** | | |

**TOTAL NO. OF CREDITS: 75**

## PROFESSIONAL ELECTIVES COURSES (PEC)

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | P26CSPE01 | Social Network Analysis | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CSPE02 | Predictive Modeling | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CSPE03 | Smart Convergent Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CSPE04 | Multimedia Communication Networks | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CSPE05 | Information Retrieval Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | P26CSPE06 | Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 7. | P26CSPE07 | Data Visualization Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 8. | P26CSPE08 | Healthcare Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 9. | P26CSPE09 | Blockchain Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 10. | P26CSPE10 | Devops and Microservices | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 11. | P26CSPE11 | Large Language Model | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 12. | P26CSPE12 | Computer Vision | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 13. | P26CSPE13 | Ethics in AI | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |

## AUDIT COURSES (AC)
**Registration for any of these courses is optional to students**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| THEORY COURSES | | | | | | | | | | |
| 1. | P26CSAC01 | Research Paper Writing | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |
| 2. | P26CSAC02 | Disaster Management | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |
| 3. | P26CSAC03 | AI Tools for Empowering Education | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |

## OPEN ELECTIVE COURSES (OEC)

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| THEORY COURSES | | | | | | | | | | |
| 1. | P26CSOE01 | Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CSOE02 | Environmental Impact Assessment | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CSOE03 | Ethical Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CSOE04 | Smart Grid | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CSOE05 | Medical Applications | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |

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## REGULATIONS – 2026

## CHOICE BASED CREDIT SYSTEM

## I TO IV SEMESTERS CURRICULA AND SYLLABI

### SEMESTER I

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | P26FC111 | Mathematical Foundations for Artificial Intelligence | FC | 3 | 1 | 0 | 4 | 4 | 40 | 60 |
| 2. | P26RM111 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 | 40 | 60 |
| 3. | P26CS111 | Advanced Data Structures and Algorithms | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CS121 | Agent Based Intelligent Systems | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CS131 | Machine Learning Techniques | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | P26CS141 | Data Analytics | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 7. | P26CS152 | Machine Learning Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| 8. | P26CS162 | Data Analytics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| | | | | **17** | **1** | **8** | **26** | **22** | | |

### ASSESSMENT SCHEME

| Sl. No | Course Type | L | T | P | C | CIA Weightage (Theory) | | | | CIA | ESE | | CIA (W) | ESE (W) | Min. Marks to Pass for 100 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | T1 | A1 | T2 | A2 | Prac | Th | Prac | | | ESE | Total |
| 1 | P26FC111 | 3 | 1 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 2 | P26RM111 | 2 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 3 | P26CS111 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 4 | P26CS121 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 5 | P26CS131 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 6 | P26CS141 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 7 | P26CS152 | 0 | 0 | 4 | 2 | - | - | - | - | 100 | - | 100 | 60 | 40 | 45 | 50 |
| 8 | P26CS162 | 0 | 0 | 4 | 2 | - | - | - | - | 100 | - | 100 | 60 | 40 | 45 | 50 |

(W) – Weightage

| P26FC111 | MATHEMATICAL FOUNDATIONS FOR ARTIFICIAL INTELLIGENCE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Pre-requisite:** Matrices and Calculus, Discrete Mathematics, Probability and Queueing Theory

**Course Objective:**

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To enable students to understand the concepts of Probability and Random Variables.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the central limit theorem.
- To apply the small / large sample tests through Tests of hypothesis.
- To enable the students to use the concepts of multivariate normal distribution and principal components analysis.

**Detailed Syllabus**

**UNIT I LINEAR ALGEBRA 12**

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization – generalized eigenvectors – Canonical forms – singular value decomposition and applications – pseudo inverse – least square approximations.

**UNIT II PROBABILITY AND RANDOM VARIABLES 12**

Probability – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson , Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

**UNIT III TWO DIMENSIONAL RANDOM VARIABLES 12**

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

**UNIT IV TESTING OF HYPOTHESIS 12**

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean , variance and proportions – Tests for independence of attributes and goodness of fit.

**UNIT V MULTIVARIATE ANALYSIS 12**

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

**Total Periods: 60**

**Learning Resources**


| | |
|---|---|
| 1 | Dallas E Johnson, “Applied multivariate methods for data Analysis”, Thomson and Duxbury press, Singapore, 1998. |
| 2 | Richard A. Johnson and Dean W. Wichern, “Applied multivariate statistical Analysis”, Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013. |
| 3 | Bronson, R.,”Matrix Operation” Schaum’s outline series, Tata McGraw Hill, New York, 2011. |
| 4 | Oliver C. Ibe, “Fundamentals of Applied probability and Random Processes”, Academic Press, Boston, 2014. |

| | |
|---|---|
| 5 | Johnson R. A. and Gupta C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| **CO1** | Apply the principles of Linear Algebra to solve real-world engineering problems. | Apply |
| **CO2** | Apply concepts of probability and random variables to analyze engineering problems. | Apply |
| **CO3** | Explain and interpret two-dimensional random variables and extend the concepts to multivariate analysis. | Understand |
| **CO4** | Analyze data using appropriate statistical tests for hypothesis testing. | Analyse |
| **CO5** | Evaluate problems using empirical evidence and scientific reasoning to support decision-making. | Evaluate |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 1 | | | | | |
| **CO2** | | | 3 | | | |
| **CO3** | 1 | 3 | 2 | 3 | 2 | 1 |
| **CO4** | 2 | 1 | 3 | | 1 | 3 |
| **CO5** | 3 | 1 | 2 | 1 | 3 | |
| **Average** | 2 | 2 | 3 | 2 | 2 | 3 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium

| P26RM111 | RESEARCH METHODOLOGY AND IPR | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**Pre-requisite:** Basic understanding of Ethics and Professional Practices

**Course Objective:**

- To understand the fundamental concepts, processes, and types of research in various domains.
- To develop the ability to formulate research problems, design methodologies, and analyze data effectively.
- To familiarize students with different research tools, techniques, and report writing standards.
- To provide knowledge on Intellectual Property Rights (IPR), including patents, copyrights, trademarks, and their applications.
- To create awareness about ethical issues in research and the importance of protecting intellectual property.

**Detailed Syllabus**

**UNIT I RESEARCH DESIGN 6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

**UNIT II DATA COLLECTION AND SOURCES 6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

**UNIT III DATA ANALYSIS AND REPORTING 6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

**UNIT IV INTELLECTUAL PROPERTY RIGHTS 6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

**UNIT V PATENTS 6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**Total Periods: 30**

**Learning Resources**


| | |
|---|---|
| 1 | Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012). |
| 2 | Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007. |
| 3 | David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007. |

| | |
|---|---|
| 4 | The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Explain the research design process, types of research, and methods such as qualitative studies, surveys, and experiments. | Understand |
| CO2 | Apply appropriate data collection methods, measurement scales, and sampling techniques for research problems. | Apply |
| CO3 | Analyze data using statistical methods including hypothesis testing and interpret results for decision-making. | Analyze |
| CO4 | Examine the concepts, types, and legal frameworks of Intellectual Property Rights and their global significance. | Analyze |
| CO5 | Evaluate patent processes, including filing, examination, and licensing, for innovation and research applications. | Evaluate |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 1 | 3 | 2 | | 3 | 2 |
| **CO2** | 2 | 3 | 3 | 1 | | |
| **CO3** | | 2 | 2 | | 1 | |
| **CO4** | 1 | 3 | 2 | 3 | | 2 |
| **CO5** | 2 | 1 | | 2 | 3 | |
| **Average** | 1 | 2 | 2 | 1 | 1 | 1 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS111 | ADVANCED DATA STRUCTURES AND ALGORITHMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Data Structures, Algorithms

**Course Objective:**

- To understand the usage of algorithms in computing
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To select and design data structures and algorithms that is appropriate for problems
- To study about NP Completeness of problems.

**Detailed Syllabus**

**UNIT I ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS 9**

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method- Data structures and algorithms.

**UNIT II HIERARCHICAL DATA STRUCTURES 9**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B - trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

**UNIT III GRAPHS 9**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra‘s Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd- Warshall Algorithm.

**UNIT IV ALGORITHM DESIGN TECHNIQUES 9**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity- Selection Problem - Huffman Coding.

**UNIT V NP COMPLETE AND NP HARD 9**

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | S.Sridhar,” Design and Analysis of Algorithms”, Oxford University Press, 1st Edition, 2014. |
| 2 | Adam Drozdex, “Data Structures and algorithms in C++”, Cengage Learning, 4th Edition, 2013. |
| 3 | T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012. |

| | |
|---|---|
| 4 | Mark Allen Weiss, “Data Structures and Algorithms in C++”, Pearson Education, 3rd Edition, 2009. |
| 5 | E. Horowitz, S. Sahni and S. Rajasekaran, “Fundamentals of Computer Algorithms”, University Press, 2nd Edition, 2008. |
| 6 | Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, Reprint 2006. |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Apply appropriate data structures and algorithms to solve computing problems. | Apply |
| CO2 | Select and implement efficient data structures to solve computational problems. | Apply |
| CO3 | Design algorithms using graph structures and string-matching techniques for real-world applications. | Create |
| CO4 | Develop novel algorithms to solve unfamiliar or complex problems. | Create |
| CO5 | Apply suitable algorithm design strategies to solve computational problems efficiently. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 3 | 1 | 2 | 3 | 2 | 1 |
| **CO2** | 2 | 1 | 3 | 3 | 3 | 2 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 1 | 3 | 2 | 3 | 3 |
| **Average** | 2 | 1 | 3 | 3 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS121 | AGENT BASED INTELLIGENT SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Artificial Intelligence, Object-Oriented Programming

**Course Objective:**

- To understand basic problem solving strategies.
- To outline game theory based search and constraint satisfaction
- To study knowledge representation techniques
- To explore reasoning and planning associated with AI.
- To study the techniques of knowledge representation.

**Detailed Syllabus**

**UNIT I INTRODUCTION AND PROBLEM SOLVING 9**

Artificial Intelligence -Introduction - Problem-solving -Solving Problems by Searching – Uninformed Search Strategies -Informed (Heuristic) Search Strategies - Local Search - Search in Partially Observable Environments.

**UNIT II ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS 9**

Game Theory- Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search- Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP)– Examples - Constraint Propagation- Backtracking Search for CSPs - Local Search for CSPs.

**UNIT III KNOWLEDGE, REASONING AND PLANNING 9**

First Order Logic – Inference in First Order Logic -Using Predicate Logic - Knowledge Representation - Issues -Ontological Engineering - Categories and Objects – Reasoning Systems for Categories - Planning -Definition -Algorithms -Heuristics for Planning -Hierarchical Planning.

**UNIT IV UNCERTAIN KNOWLEDGE AND REASONING 9**

Quantifying Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time Probabilistic Programming -Making Simple Decisions - Making Complex Decisions - Case Based Reasoning –Explanation-Based Learning – Evolutionary Computation.

**UNIT V PHILOSOPHY, ETHICS AND SAFETY OF AI 9**

The Limits of AI – Knowledge in Learning –Statistical Learning Methods – Reinforcement Learning - Introduction to Machine Learning and Deep Learning -Can Machines Really Think? - Distributed AI Artificial Life-The Ethics of AI - Interpretable AI- Future of AI - AI Components –AI Architectures.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Stuart Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson, 4thEdition, 2020. |
| 2 | Zhongzhi Shi “Advanced Artificial Intelligence”, World Scientific; 2019. |
| 3 | Kevin Knight, Elaine Rich, Shivashankar B. Nair, “Artificial Intelligence”, McGraw Hill Education; 3rd edition, 2017. |
| 4 | Richard E. Neapolitan, Xia Jiang, “Artificial Intelligence with an Introduction to Machine Learning”, Chapman and Hall/CRC; 2nd edition, 2018 |
| 5 | Dheepak Khemani, “A first course in Artificial Intelligence”, McGraw Hill Education Pvt. Ltd., New Delhi, 2013. |

| | |
|---|---|
| 6 | Nils J. Nilsson, “Artificial Intelligence: A New Synthesis”, Morgan Kaufmann Publishers Inc; Second Edition, 2003. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| CO | Course Outcome Statement | Knowledge Level |
| CO1 | Apply any three problem solving methods for a puzzle of your choice | Apply |
| CO2 | Understand Game playing and implement a two player game using AI techniques. | Understand |
| CO3 | Design and Implement an example using predicate Logic. | Apply |
| CO4 | Implement a case based reasoning system | Apply |
| CO5 | Design some methodologies for ethical and explainable AI systems. | Apply |

**Course Articulation Matrix**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 3 | 1 | 1 | 2 | 3 | 2 |
| CO2 | 2 | 1 | 2 | 3 | 2 | 3 |
| CO3 | 1 | 3 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 2 | 3 | 3 | . | 2 | 3 |
| Average | 1.8 | 2.2 | 2.2 | 2.2 | 2.6 | 2.2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS131 | MACHINE LEARNING TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Artificial Intelligence

**Course Objective:**

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

**Detailed Syllabus**

**UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9**

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages& Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory.

**UNIT II SUPERVISED LEARNING 9**

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms.

**UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9**

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning Temporal Difference Learning.

**UNIT IV PROBABILISTIC METHODS FOR LEARNING 9**

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models.

**UNIT V NEURAL NETWORKS AND DEEP LEARNING 9**

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014. |
| 2 | Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012. |
| 3 | Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014. |
| 4 | Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013. |
| 5 | Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012. |


| | |
|---|---|
| 6 | Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2015. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand and outline problems for each type of machine learning | Understand |
| CO2 | Design a Decision tree and Random forest for an application. | Create |
| CO3 | Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results. | analyze |
| CO4 | Design a tool to implement typical Clustering algorithms for different types of applications. | Create |
| CO5 | Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification. | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 1 | 1 | | 3 | 3 | 2 |
| **CO2** | | 1 | 1 | 2 | 1 | 3 |
| **CO3** | 1 | | 2 | 1 | 2 | 3 |
| **CO4** | 2 | 3 | 3 | 2 | 1 | 3 |
| **CO5** | 1 | 2 | 2 | 3 | 3 | 1 |
| **Average** | 1 | 2 | 2 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS141 | DATA ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Programming Fundamentals, Database Management Systems

**Course Objective:**

- To understand the computational approaches to Modeling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyse and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

**Detailed Syllabus**

**UNIT I DATA MINING AND LARGE SCALE FILES 9**

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

**UNIT II SIMILAR ITEMS 9**

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.

**UNIT III MINING DATA STREAMS 9**

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

**UNITIV LINK ANALYSIS AND FREQUENT ITEMSETS 9**

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

**UNIT V CLUSTERING 9**

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd Edition, 2020. |
| 2 | Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2012. |
| 3 | Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011. |
| 4 | David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS, 2001. |
| 5 | https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf |
| 6 | https://www.tutorialspoint.com/big_data_analytics/index.htm |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Design algorithms by employing Map Reduce technique for solving Big Data problems. | Create |
| CO2 | Design algorithms for Big Data by deciding on the apt Features set. | Create |
| CO3 | Design algorithms for handling petabytes of datasets. | Create |
| CO4 | Design algorithms and propose solutions for Big Data by optimizing main memory consumption. | Create |
| CO5 | Design solutions for problems in Big Data by suggesting appropriate clustering techniques. | Create |

**Course Articulation Matrix**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 2 | 3 | | 2 | 3 | 2 |
| **CO2** | 1 | 3 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 3 | 2 | 3 | 3 | 3 |
| **Average** | 2 | 2 | 2 | 2 | 3 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS152 | MACHINE LEARNING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Pre-requisite:** Programming in Python, Data Structures and Algorithms

**Course Objective:**

- To implement and analyze regression models using real-world datasets
- To develop and evaluate binary classification models
- To apply machine learning algorithms such as K-Nearest Neighbors and Naïve Bayes
- To understand and apply model validation techniques
- To design and implement machine learning solutions for real-world applications

**List of Experiments**

| Sl No | List of Experiments |
|---|---|
| 1 | Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyper parameters. |
| 2 | Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness. |
| 3 | Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifer to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset |
| 4 | In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem. |
| 5 | Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset. |
| 6 | Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classification dataset |
| 7 | Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.<br>**a.** Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.<br>**b.** You can either pick a project of your own design, or you can choose from the set of pre- defined projects.<br>**c.** You are free to use any third-party ideas or code that you wish as long as it is publicly available.<br>**d.** You must properly provide references to any work that is not your own in the write-up.<br>**e.** Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read. |

| | |
|---|---|
| | List of Projects (datasets available)<br>1. Sentiment Analysis of Product Reviews<br>2. Stock Prediction<br>3. Sales Forecasting<br>4. Music Recommendation<br>5. Handwriting Digit Classification<br>6. Fake News Detection<br>7. Sports Prediction<br>**8.** Object Detection<br>**9.** Disease Prediction |
| | **Total Periods: 60** |

**Learning Resources**

| | |
|---|---|
| 1 | Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014. |
| 2 | Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012. |
| 3 | Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014. |
| 4 | Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013. |
| 5 | Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012. |
| 6 | Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2015. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Apply linear regression techniques on real-world datasets, including feature selection and hyperparameter tuning. | Apply |
| CO2 | Analyze and evaluate binary classification models using threshold tuning and performance metrics. | Analyze |
| CO3 | Apply machine learning algorithms such as K-Nearest Neighbors and Naïve Bayes for classification tasks. | Apply |
| CO4 | Analyze model performance using training, validation, and test datasets to detect and mitigate overfitting. | Analyze |
| CO5 | Design and evaluate machine learning solutions for real-world problems through project-based implementation and comparison of algorithms. | Create |

**Course Articulation Matrix**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1 | 3 | 2 | 1 | 2 | 2 | |
| CO2 | 3 | 3 | 1 | 2 | 2 | |
| CO3 | 3 | 2 | 2 | 2 | 2 | |
| CO4 | 3 | 3 | 1 | 2 | 2 | |
| CO5 | 3 | 3 | 1 | 2 | 2 | |
| Average | 3 | 3 | 1 | 2 | 2 | |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS162 | DATA ANALYTICS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Pre-requisite:** Programming in Python, Database Management Systems

Course Objective:

- To analyze the data using statistical methods.
- To understand data analysis tools.
- To learn a Data Mining Tool.
- To learn various data analysis algorithms.
- To learn Data Mining Algorithms.

**List of Experiments**

| Sl No | List of Experiments |
|---|---|
| 1 | Explore and understand datasets using tools like **ORANGE/WEKA** (data types, attributes, and summary statistics). |
| 2 | Perform **data pre-processing techniques** such as handling missing values, normalization, and data transformation. |
| 3 | Prepare datasets for analysis by applying **data cleaning and feature selection** methods. |
| 4 | Compute **descriptive statistics** including mean, variance, and standard deviation for a given dataset. |
| 5 | Perform **parametric tests** such as **T-Test** to compare datasets and draw inferences. |
| 6 | Conduct **correlation analysis** to identify relationships between variables. |
| 7 | Implement **Linear Regression** to predict numerical outcomes and evaluate model performance. |
| 8 | Implement **Classification using Decision Tree algorithm** and analyze the results. |
| 9 | Implement Classification using Backpropagation (Neural Network) and evaluate accuracy. |
| 10 | Implement **Clustering algorithm (e.g., K-Means)** and visualize clusters using data visualization techniques. |
| | **Total Periods: 60** |

**Learning Resources**


| | |
|---|---|
| 1 | Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd Edition, 2020. |
| 2 | Jiawei Han, Micheline Kamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2012. |
| 3 | Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011. |
| 4 | David Hand, Heikki Mannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS,2001. |
| 5 | https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf |
| 6 | https://www.tutorialspoint.com/big_data_analytics/index.htm |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Design algorithms by employing Map Reduce technique for solving Big Data problems. | Create |
| CO2 | Design algorithms for Big Data by deciding on the apt Features set. | Create |
| CO3 | Design algorithms for handling petabytes of datasets. | Create |
| CO4 | Design algorithms and propose solutions for Big Data by optimizing main memory consumption. | Create |
| CO5 | Design solutions for problems in Big Data by suggesting appropriate clustering techniques. | Create |

**Course Articulation Matrix**

| | **POs** | | | | | |
|---|---|---|---|---|---|---|
| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **CO1** | 2 | 3 | | 2 | 3 | 2 |
| **CO2** | 1 | 3 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 3 | 2 | 3 | 3 | 3 |
| **Average** | 2 | 2 | 2 | 2 | 3 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

## SEMESTER II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| **THEORY COURSES** | | | | | | | | | | |
| 1. | P26CS211 | Deep Learning | PCC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CS221 | Reinforcement Learning | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CS231 | Internet of Things with Edge AI | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CS241 | Cloud Computing Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 7. | | Audit Course* | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |
| **PRACTICAL COURSES** | | | | | | | | | | |
| 8. | P26CS262 | Deep Learning Laboratory | PCC | 0 | 0 | 4 | 4 | 2 | 60 | 40 |
| | | | | **20** | **0** | **4** | **24** | **20** | | |

## ASSESSMENT SCHEME

| Sl. No | Course Type | L | T | P | C | CIA Weightage (Theory) | | | | CIA | ESE | | CIA (W) | ESE (W) | Min. Marks to Pass for 100 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | T1 | A1 | T2 | A2 | Prac | Th | Prac | | | ESE | Total |
| 1 | P26CS211 | 3 | 1 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 2 | P26CS221 | 2 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 3 | P26CS231 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 4 | P26CS241 | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 5 | | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 6 | | 3 | 0 | 0 | 3 | 60 | 40 | 60 | 40 | - | 100 | - | 40 | 60 | 45 | 50 |
| 7 | P26CS262 | 0 | 0 | 4 | 2 | - | - | - | - | 100 | - | 100 | 60 | 40 | 45 | 50 |

(W) – Weightage

| P26CS211 | DEEP LEARNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Machine Learning Fundamentals

**Course Objective:**

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

**Detailed Syllabus**

**UNIT I DEEP LEARNING CONCEPTS 6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

**UNIT II NEURAL NETWORKS 9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

**UNIT III CONVOLUTIONAL NEURAL NETWORK 10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R- CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO.

**UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

**UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy GradientMethods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc., 2017. |

| | |
|---|---|
| 2 | Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress, 2018. |
| 3 | Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020. |
| 4 | Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017. |
| 5 | Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Extract features from image and video data using appropriate techniques. | Apply |
| CO2 | Implement and analyze image segmentation and instance segmentation techniques on images. | Analyse |
| CO3 | Apply transfer learning using pretrained networks to perform image recognition and classification. | Apply |
| CO4 | Analyze social media data to derive traffic-related insights. | Analyse |
| CO5 | Implement and evaluate autoencoders for classification and feature extraction tasks. | Evaluate |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 3 | 3 | 3 | 3 |
| **2** | 1 | 2 | 1 | 3 | 3 | 3 |
| **3** | 1 | 2 | 1 | 3 | 2 | 3 |
| **4** | 3 | 1 | 2 | 2 | 3 | 2 |
| **5** | 2 | 1 | 3 | | 1 | 1 |
| **Average** | 2 | 2 | 2 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS221 | REINFORCEMENT LEARNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Machine Learning Fundamentals, Programming in Python

**Course Objective:**

- To understand the fundamental concepts and framework of Reinforcement Learning, including agents, environments, rewards, and policies.
- To analyze Markov Decision Processes (MDP) and value functions for modeling decision-making problems.
- To apply Dynamic Programming, Monte Carlo, and Temporal Difference methods for solving reinforcement learning problems.
- To implement reinforcement learning algorithms such as Q-learning, SARSA, and policy gradient methods.
- To explore advanced reinforcement learning techniques including deep reinforcement learning and their applications in real-world problems.

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Overview of Reinforcement Learning- Elements of RL- RL Framework- Types of RL Problems- Exploration vs Exploitation- Applications of RL.

**UNIT II MARKOV DECISION PROCESSES 9**

Markov Property - MDP Components – Policies- Value Functions - Bellman Equations - Optimal Policy.

**UNIT III DYNAMIC PROGRAMMING METHODS 9**

Policy Evaluation - Policy Improvement - Policy Iteration - Value Iteration - Convergence Properties - Limitations of DP.

**UNIT IV MONTE CARLO & TEMPORAL DIFFERENCE LEARNING 9**

Monte Carlo Methods - MC Prediction & Control - Temporal Difference (TD) Learning - TD(0) Algorithm - SARSA Algorithm - Q-Learning – Comparison.

**UNIT V ADVANCED REINFORCEMENT LEARNING 9**

Function Approximation - Deep Reinforcement Learning - Policy Gradient Methods - Actor-Critic Methods - Multi-Agent Reinforcement Learning - Real-World Challenges.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Reinforcement Learning: An Introduction , Richard S. Sutton, Andrew G. Barto , MIT Press , 2020. |
| 2 | Algorithms for Reinforcement Learning, Csaba Szepesvári, Morgan & Claypool, 2019. |
| 3 | Deep Reinforcement Learning Hands-On, Maxim Lapan, Packt, 2020. |
| 4 | Markov Decision Processes: Discrete Stochastic Dynamic Programming, Martin L. Puterman, Wiley. |
| 5 | Artificial Intelligence: A Modern Approach, Stuart Russell, Peter Norvig, Pearson, 2018. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Explain the fundamental concepts and components of Reinforcement Learning, including agents, environments, policies, and rewards. | Understand |
| CO2 | Analyze Markov Decision Processes (MDPs) and apply Bellman equations to solve decision-making problems. | Analyse |
| CO3 | Apply Dynamic Programming, Monte Carlo, and Temporal Difference methods to evaluate and improve policies. | Apply |
| CO4 | Implement reinforcement learning algorithms such as Q-learning, SARSA, and policy gradient methods. | Apply |
| CO5 | Evaluate advanced reinforcement learning techniques, including Deep Reinforcement Learning, for solving complex real-world problems. | Evaluate |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 3 | 3 | 3 | 3 |
| **2** | 1 | 2 | 1 | 3 | 3 | 3 |
| **3** | 1 | 2 | 1 | 3 | 2 | 3 |
| **4** | 3 | 1 | 2 | 2 | 3 | 2 |
| **5** | 2 | 1 | 3 | | 1 | 1 |
| **Average** | 2 | 2 | 2 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS231 | INTERNET OF THINGS with EDGE AI | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Embedded Systems / Microprocessors and Microcontrollers

**Course Objective:**

- To Understand the Architectural Overview of IoT and Edge AI
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT levels
- To understand the basics of cloud architecture
- To gain experience in Raspberry PI and experiment simple IoT application on it.

**Detailed Syllabus**

**UNIT I INTRODUCTION TO IoT AND EDGE COMPUTING 9**

Overview of IoT – Characteristics and Applications – IoT Architecture – Sensors and Actuators – Communication Protocols (HTTP, MQTT, CoAP) – Introduction to Edge Computing – Cloud vs Edge Computing – Need for Edge AI – IoT Ecosystem and Platforms.

**UNIT II FUNDAMENTALS OF EDGE AI 9**

Introduction to Artificial Intelligence and Machine Learning – Types of Machine Learning – Deep Learning Basics – Edge AI Concepts – Edge Devices and Hardware (Raspberry Pi, Microcontrollers) – AI Model Deployment at Edge – Data Preprocessing at Edge – TinyML Overview.

**UNIT III IoT DATA PROCESSING AND ANALYTICS 9**

Data Acquisition in IoT – Data Transmission and Storage – Real-time Data Processing – Edge Analytics vs Cloud Analytics – Stream Processing – Data Filtering and Aggregation – Event-driven Systems – Introduction to Big Data in IoT.

**UNIT IV EDGE AI APPLICATIONS IN IoT 9**

Smart Cities – Smart Healthcare Systems – Industrial IoT (IIoT) – Smart Agriculture – Intelligent Transportation Systems – Video Analytics and Surveillance – Predictive Maintenance – Case Studies of Edge AI-enabled IoT Systems.

**UNIT V SECURITY, CHALLENGES AND FUTURE TRENDS 9**

Security Issues in IoT and Edge AI – Data Privacy and Protection – Lightweight Cryptography – Device Authentication – Challenges in Edge AI Deployment – Energy Efficiency – Scalability Issues – Future Trends (5G, Federated Learning, AIoT) – Ethical Considerations.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on approach, Universities Press, 2015. |
| 2 | Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011. |
| 3 | Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015. |
| 4 | Ovidiu Vermesan Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014. |
| 5 | N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd Edition Scitech Publishers, 2014. |
| 6 | Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. 2009. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand IoT architecture and Edge AI concepts. | Understand |
| CO2 | Apply AI techniques on edge devices. | Apply |
| CO3 | Analyze IoT data using edge analytics. | Analyze |
| CO4 | Design real-time IoT applications using Edge AI. | Create |
| CO5 | Evaluate security and challenges in IoT systems. | Evaluate |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 3 | 3 | 3 | 3 |
| **2** | 1 | 2 | 1 | 3 | 3 | 3 |
| **3** | 1 | 2 | 1 | 3 | 2 | 3 |
| **4** | 3 | 1 | 2 | 2 | 3 | 2 |
| **5** | 2 | 1 | 3 | | 1 | 1 |
| **Average** | 2 | 2 | 2 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS241 | CLOUD COMPUTING TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Computer Networks, Operating Systems, Database Management Systems

**Course Objective:**

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

**Detailed Syllabus**

**UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource 38 Management – Virtualization for data center automation.

**UNIT II CLOUD PLATFORM ARCHITECTURE 12**

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges.

**UNIT III AWS CLOUD PLATFORM – IAAS 9**

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager.

**UNIT IV PAAS CLOUD PLATFORM 9**

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops.

**UNIT V PROGRAMMING MODEL 9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013. |


| | |
|---|---|
| 2 | Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019. |
| 3 | Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010. |
| 4 | Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013. |
| 5 | Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner‟s Guide‖, McGraw-Hill Osborne Media, 2009. |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Employ the concepts of virtualization in the cloud computing | Apply |
| CO2 | Develop the architecture, infrastructure and delivery models of cloud computing | Create |
| CO3 | Develop the Cloud Application in AWS platform | Create |
| CO4 | Apply the concepts of Windows Azure to design Cloud Application | Apply |
| CO5 | Develop services using various Cloud computing programming models. | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 3 | 3 | 3 | 3 |
| **2** | 2 | 2 | 1 | 3 | 3 | 3 |
| **3** | 2 | 2 | 1 | 3 | 2 | 3 |
| **4** | 3 | 2 | 2 | 2 | 3 | 2 |
| **5** | 2 | 2 | 3 | | 1 | 1 |
| **Average** | 2.8 | 2 | 2 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CS262 | DEEP LEARNING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Pre-requisite:** Fundamentals of Machine Learning

**Course Objective:**

- To provide fundamental knowledge of feature extraction and selection techniques for image and video data.
- To enable students to design and implement deep learning models for image and video recognition tasks.
- To introduce advanced techniques for image colorization using convolutional and generative models.
- To develop skills in aspect-based topic detection and sentiment analysis using modern NLP approaches.
- To equip students with the ability to design intelligent object detection systems using autoencoders and hybrid deep learning methods.

**List of Experiments**

| Sl No | List of Experiments |
|---|---|
| 1 | Feature Extraction and Selection from Image Data<br>Extract features using SIFT, SURF, ORB and compare PCA, LDA for dimensionality reduction using OpenCV, Scikit-learn. |
| 2 | Feature Selection from Video Data using Temporal Analysis<br>Extract spatio-temporal features from video sequences and implement feature selection using mutual information / chi-square test. |
| 3 | Image Recognition using Convolutional Neural Networks (CNN)<br>Build and train a CNN model for image classification and Evaluate performance using accuracy, precision, recall. |
| 4 | Video Recognition using 3D CNN / LSTM<br>Recognize actions or activities from video datasets and implement 3D CNN or CNN+LSTM hybrid model using Keras, OpenCV. |
| 5 | Automatic Image Colorization using Deep Learning<br>Convert grayscale images to color using CNN and Train encoder-decoder architecture for color prediction using TensorFlow, OpenCV. |
| 6 | GAN-based Image Colorization<br>Implement Generative Adversarial Networks for realistic colorization and Compare results with traditional CNN-based colorization using PyTorch / TensorFlow. |
| 7 | Aspect-Based Topic Detection using NLP Techniques<br>Identify aspects/topics from text data and Use LDA / BERT for topic modelling uing NLTK, Gensim, Transformers. |
| 8 | Aspect-Based Sentiment Analysis using Deep Learning<br>Perform sentiment classification at aspect level and Implement Bi-LSTM / BERT model for sentiment polarity using TensorFlow, HuggingFace. |
| 9 | Object Detection using Autoencoder for Anomaly Detection<br>Detect unusual objects using reconstruction error and Train autoencoder and identify anomalies using Keras, OpenCV. |
| 10 | Hybrid Object Detection using Autoencoder + YOLO<br>Combine deep learning detection with anomaly detection and Compare YOLO results with autoencoder-based detection using YOLOv5/YOLOv8, PyTorch. |
| | **Total Periods: 60** |

**Learning Resources**

| | |
|---|---|
| 1 | Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media Inc., 2017. |
| 2 | Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress, 2018. |
| 3 | Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020. |
| 4 | Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017. |
| 5 | Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Apply feature extraction and selection techniques on image and video data using statistical and machine learning methods. | Apply |
| CO2 | Design and implement deep learning models for image and video recognition tasks using CNN and sequence models. | Create |
| CO3 | Develop and evaluate image colorization techniques using convolutional neural networks and generative models. | Create |
| CO4 | Analyze textual data using aspect-based topic detection and sentiment analysis with advanced NLP techniques. | Analyze |
| CO5 | Design intelligent object detection systems using autoencoders and hybrid deep learning approaches for real-world applications. | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 3 | 3 | 2 | 2 | 2 | 1 |
| **2** | **3** | **3** | **3** | **2** | **3** | **1** |
| **3** | **2** | **3** | **3** | **2** | **3** | **1** |
| **4** | **2** | **3** | **2** | **3** | **2** | **2** |
| **5** | **3** | **3** | **3** | **3** | **3** | **2** |
| **Average** | **2.6** | **3** | **2.6** | **2.4** | **2.6** | **1.4** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

## PROFESSIONAL ELECTIVES COURSES (PEC)

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| THEORY COURSES | | | | | | | | | | |
| 1. | P26CSPE01 | Social Network Analysis | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CSPE02 | Predictive Modeling | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CSPE03 | Smart Convergent Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CSPE04 | Multimedia Communication Networks | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CSPE05 | Information Retrieval Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 6. | P26CSPE06 | Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 7. | P26CSPE07 | Data Visualization Techniques | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 8. | P26CSPE08 | Healthcare Analytics | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 9. | P26CSPE09 | Blockchain Technologies | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 10. | P26CSPE10 | Devops and Microservices | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 11. | P26CSPE11 | Large Language Model | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 12. | P26CSPE12 | Computer Vision | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 13. | P26CSPE13 | Ethics in AI | PEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |

| P26CSPE01 | SOCIAL NETWORK ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Discrete Mathematics, Data Structures and Algorithms, Probability and Statistics

**Course Objective:**

- Formalise different types of entities and relationships as nodes and edges and represent this information as relational data.
- Understand the fundamental concepts in analyzing the large-scale data that are derived from social networks
- Understand the basic concepts and principles of different theoretical models of social networks analysis.
- Choose among social network designs based on research goals

**Detailed Syllabus**

**UNIT I GRAPH THEORY AND STRUCTURE 10**

Breadth First Search (BFS) Algorithm. Strongly Connected Components (SCC) Algorithm. Weakly Connected Components (WCC) Algorithm. First Set of Experiments-Degree Distributions. Second Set of Experiments- Connected Components. Third Set of Experiments-Number of Breadth First Searches. Rank Exponent R. Out-Degree Exponent O. Hop Plot Exponent H. Eigen Exponent E. Permutation Model. Random Graphs with Prescribed Degree Sequences. Switching Algorithms. Matching Algorithm. “Go with the Winners” Algorithm. HyperANF Algorithm. Iterative Fringe Upper Bound (iFUB) Algorithm. Spid. Degree Distribution. Path Length. Component Size. Clustering Coefficient and Degeneracy. Friends-of-Friends. Degree Assortative. Login Correlation.

**UNIT II SOCIAL NETWORK GRAPH ANALYSIS 9**

Social network exploration/ processing and properties: Finding overlapping communities, similarity between graph nodes, counting triangles in graphs, neighborhood properties of graphs. Pregel paradigm and Apache Giraph graph processing system.

**UNIT III INFORMATION DIFFUSION IN SOCIAL NETWORKS 9**

Strategic network formation: game theoretic models for network creation/ user behavior in social networks. Information diffusion in graphs: Cascading behavior, spreading, epidemics, heterogeneous social network mining, influence maximization, outbreak detection. Opinion analysis on social networks: Contagion, opinion formation, coordination and cooperation.

**UNIT IV CASCADING IN SOCIAL NETWORKS 8**

Cascading in Social Networks. Decision Based Models of Cascade. Collective Action. Cascade Capacity. Co-existence of Behaviours. Cascade Capacity with Bilinguality. Probabilistic Models of Cascade. Branching Process. Basic Reproductive Number. SIR Epidemic Model. SIS Epidemic Model. SIRS Epidemic Model. Transient Contact Network. Cascading in Twitter.

**UNIT V LINK ANALYSIS & COMMUNITY DETECTION 9**

Search Engine. Crawling. Storage. Indexing. Ranking. Google. Data Structures. Crawling. Searching. Web Spam Pages Strength of Weak Ties. Triadic Closure. Detecting Communities in a Network. Girvan-Newman Algorithm. Modularity. Minimum Cut Trees. Tie Strengths in Mobile Communication Network. Exact Betweenness Centrality. Approximate Betweenness Centrality.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Practical Social Network Analysis with Python, Krishna Raj P. M. Ankith Mohan and K. G. Srinivasa. Springer, 2018. |
| 2 | Social Network Analysis: Methods And Applications, Stanley Wasserman, And Katherine F' Aust. Cambridge University Press, 2012. |
| 3 | Social Network Analysis: History, Theory and Methodology by Christina Prell, SAGE Publications, 1st edition, 2011. |
| 4 | Sentiment Analysis in Social Networks, Federico Alberto Pozzi, Elisabetta Fersini, Enza Messina, and Bing. Liu Elsevier Inc., 1st edition, 2016. |
| 5 | Social Network Analysis, John Scott. SAGE Publications, 2012. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Analyze and execute network analytical computations. | Analyze |
| CO2 | Implement mining algorithms for social networks | Create |
| CO3 | Analyze and evaluate social communities. | Analyze |
| CO4 | Apply social network analysis in behavior analytics | Apply |
| CO5 | Perform mining on large social networks and illustrate the results. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 3 | | 3 | | 1 | |
| **2** | 2 | 2 | 1 | 3 | 3 | 3 |
| **3** | 1 | | 2 | 3 | 3 | 3 |
| **4** | 1 | 2 | | 1 | 3 | 3 |
| **5** | | 2 | 2 | 3 | 2 | 1 |
| **Average** | 1.75 | 2 | 2 | 2.5 | 2.8 | 2.5 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE02 | PREDICTIVE MODELLING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Basics of Machine Learning / Data Analytics

**Course Objective:**

- To understand the terms and terminologies of predictive modeling.
- To study the various predictive models, their merits, demerits and application.
- To get exposure to various analytical tools available for predictive modeling.
- To learn the predictive modeling markup language
- To get familiar with the technologies in predictive modeling.

**Detailed Syllabus**

**UNIT I INTRODUCTION TO PREDICTIVE MODELING 9**

Core ideas in data mining - Supervised and unsupervised learning - Classification vs. Prediction - Steps in data mining- SEMMA Approach - Sampling -Pre-processing - Data cleaning - Data Partitioning - Building a model - Statistical models - Statistical models for predictive analytics.

**UNIT II PREDICTIVE MODELING BASICS 9**

Data splitting – Balancing- Over fitting –Oversampling –Multiple Regression Artificial neural networks (MLP) - Variable importance- Profit/loss/prior probabilities - Model specification - Model selection - Multivariate Analysis.

**UNIT III PREDICTIVE MODELS 9**

Association Rules-Clustering Models –Decision Trees- Ruleset Models- KNearest Neighbors – Naive Bayes - Neural Network Model – Regression Models – Regression Trees – Classification & Regression Trees (CART) – Logistic Regression – Multiple Linear Regression Scorecards – Support Vector Machines – Time Series Models - Comparison between models - Lift chart Assessment of a single model.

**UNIT IV PREDICTIVE MODELING MARKUP LANGUAGE 9**

Introduction to PMML – PMML Converter - PMML Structure – Data Manipulation in PMML – PMML Modeling Techniques - Multiple Model Support – Model Verification.

**UNIT V TECHNOLOGIES AND CASE STUDIES 9**

Weka – RapidMiner – IBM SPSS Statistics- IBM SPSS Modeler – SAS Enterprise Miner – Apache Mahout – R Programming Language.-Real time case study with modeling and analysis.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Kattamuri S. Sarma, “Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications”, 3rd Edition, SAS Publishing, 2017. |
| 2 | Alex Guazzelli, Wen-Ching Lin, Tridivesh Jena, James Taylor, “PMML in Action Unleashing the Power of Open Standards for Data Mining and Predictive Analytics”, 2nd Edition, Create Space Independent Publishing Platform, 2012. |
| 3 | Ian H. Witten, Eibe Frank , “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann Series in Data Management Systems, Morgan Kaufmann, 3rd Edition, 2011. |
| 4 | Eric Siegel, “Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die”, 2nd Edition, Wiley, 2016. |
| 5 | Conrad Carlberg, “Predictive Analytics: Microsoft Excel”, 1st Edition, Que Publishing, 2012. |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Design and analyze appropriate predictive models. | Analyze |
| CO2 | Analyze the predictive models using PMML. | Analyze |
| CO3 | Apply statistical tools for analysis. | Apply |
| CO4 | Apply various analytical tools available for predictive modeling. | Apply |
| CO5 | Apply predictive modeling markup language in data manipulation | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 3 | 3 | 2 | 2 |
| **2** | 1 | 2 | 3 | 3 | 2 | 2 |
| **3** | 3 | 2 | 2 | 2 | 2 | 2 |
| **4** | 2 | 3 | 3 | 1 | 2 | 2 |
| **5** | 2 | 3 | 2 | 1 | 3 | 3 |
| **Average** | 2 | 3 | 3 | 2 | 2 | 2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE03 | SMART CONVERGENT TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Fundamentals of Networking, Introduction to Internet of Things (IoT) / Embedded Systems

**Course Objective:**

- To learn about Fundamentals of IoT and Security
- To know about IoT applications in Industry
- To learn about RFID Pervasive networks
- To gain fundamental concepts in 5G and Next Gen networks
- To know about IoT implementation

**Detailed Syllabus**

**UNIT I TOWARDS THE IOT UNIVERSE 9**

Internet of Things Vision - IoT Strategic Research and Innovation Directions - IoT Applications - Internet of Things and Related Future Internet Technologies -Infrastructure - Networks and Communication - Processes - Data Management, Security, Privacy & Trust - Device Level Energy Issues.

**UNIT II IOT APPLICATIONS - VALUE CREATION FOR INDUSTRY 9**

Introduction - IoT Applications for Industry — Value Creation and Challenges - Future Factory Concepts - Brownfield IoT: Technologies for Retrofitting - Smart Objects, Smart Applications - Four Aspects in your Business to Master IoT - Value Creation from Big Data and Serialization in the Pharmaceutical Industry - IoT for Retailing Industry- IoT for Oil and Gas Industry - Opinions on IoT Application and Value for Industry- Data Aggregation for the IoT in Smart Cities.

**UNIT III RFID PERVASIVE NETWORKS 9**

RFID Tags- RFID Automatic Identification and Data Capture RFID Data Warehousing and analysis,- RFID Data Management Issues, Solutions, and Directions- RFID Security: Threats and Solutions- RFIG Geometric Context of Wireless Tags- RFID Application in Animal Monitoring- RFID Enabled Logistics Services - Location Tracking in an Office Environment: The Nationwide Case Study- Pervasive Computing Security: Bluetooth's Example- Internet of Things: A Context- Awareness Perspective - Index.

**UNIT IV INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS 9**

Industrial Internet- Key IIoT Technologies- Innovation and the IIoT - Key Opportunities and Benefits

- The Digital and Human Workforce - Logistics and the Industrial Internet- IOT Innovations in Retail - Cyber Physical Systems (CPS) – IP Mobility – Network Virtualization - SDN (Software Defined Networks)- The Cloud and Fog

**UNIT V IIOT ARCHITECTURE AND DESIGNING INDUSTRIAL INTERNET SYSTEMS 9**

Industrial Internet Architecture Framework (IIAF) -Industrial Internet Viewpoints -. Architectural Topology: The Three-Tier Topology - Wireless Communication Technologies- Proximity Network Communication Protocols-Gateways: industrial gateways - CoAP (Constrained Application Protocol) – NFC.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Ovidiu Vermesan, Peter Friess, "Internet of Things – From Research and Innovation to Market Deployment"', River Publishers, 2014(unit I) |

| | |
|---|---|
| 2 | Ovidiu Vermesan, Peter Friess, “The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems”, River Publications, 2013.(Unit II) |
| 3 | Lu Yan, Yan Zhang, Laurence T. Yang and Huansheng Ning “The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems”,. Auerbach Publications, 2019.(Unit III) |
| 4 | Gilchrist, Alasdair, “Industry 4.0 The Industrial Internet of Things”, Apress, 2017. (Unit IV, V) |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Describe the core principles of IoT Network Management | Understand |
| CO2 | Apply the applications of IoT in Industry | Apply |
| CO3 | Explain the basic concepts in RFID and Pervasive Networks | Understand |
| CO4 | Apply the fundamental concepts in IIoT, CPS and Network Virtualization | Apply |
| CO5 | Design Industrial Internet Systems | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 2 | 2 | 2 | 2 |
| **2** | 1 | 1 | 1 | 3 | 3 | 3 |
| **3** | 1 | 3 | 2 | 3 | 2 | 1 |
| **4** | 1 | 1 | 2 | 2 | 3 | 3 |
| **5** | 2 | 1 | 2 | 2 | 3 | 3 |
| **Average** | 1.2 | 1.6 | 1.8 | 2.4 | 2.6 | 2.4 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE04 | MULTIMEDIA COMMUNICATION NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Computer Networks, Multimedia and Animation

**Course Objective:**

- To recapitulate the fundamentals of networking and understand the requirements for multimedia communication.
- To learn guaranteed service model.
- To learn communication protocols that is frequently used in IoT ecosystems.
- To explore the support provided for multimedia communication in 3G and 4G networks.
- To study about VoIP and real time multimedia network applications.

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Switched Networks and Shared media Networks – Circuit Switching, Packet Switching and VirtualCircuits – Flow Control and Congestion Control – TCP/IP reference model – Network Externalities – Service Integration – Elastic and Inelastic Traffic – Playback Applications – Additional Requirements For Inelastic Traffic – Core Networks And Access/Edge Networks.

**UNIT II GUARANTEED SERVICE MODEL 9**

Best Effort Service Model and Its Limitations – Qos Metrics – Diffserv and Intserv Networks – Queuing Techniques – WFQ and Its Variants – RED – Qos Aware Routing – Call Admission Control – RSVP – Policing and Traffic Shaping Algorithms – Multicast Routing – IGMP, Protocol

Independent Multicast – PIM SM and PIM DM Variants.

**UNIT III MULTIMEDIA TRANSPORT 9**

End To End Solutions – Laissez Faire Approach – Multimedia over TCP – Significance of UDP – Multimedia Streaming – Audio and Video Streaming – Accessing Audio And Video from a Web Server And Media Server – Removing Jitter at the Receiver – Recovering from Packet Loss – Forward Error Correction and Interleaving – Interactive And Non-Interactive Multimedia – Transcoding – RTSP – RTP/RTCP.

**UNIT IV MULTIMEDIA OVER WIRELESS NETWORKS 9**

Architecture of IP Multimedia Subsystem in 3G Networks – Application, Control and Data Planes in IMS Networks – Session Control, AAA, Real Time Data Transfer and Policy Control Protocols of IMS Networks – Relay Node and Multiple Radio Access Technologies in LTE – Voice Over IP Basics – IMS Volte Architecture – IP Multimedia Service Identity Module, Private Identity, Public Identity (ISIM, IMPI And IMPU) – SIP User Agent (SIP UAC And SIP UAE) – Real Time Polling Service and Extended Real Time Polling Service in IEEE 802.16/Wimax Networks.

**UNIT V MULTIMEDIA NETWORKED APPLICATIONS 9**

H.322 Standard – Protocol Stack And Call Setup – Session Initiation Protocol – Components, Messages And Operation – Supporting Protocols For SIP – Media Gateway Access Protocol, Resource Reservation Protocol, Session Description Protocol – Case Study – Video Conferencing – Military Surveillance – Interactive TV – Video On Demand – Smart Phone.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Mario Marques da Silva, “Multimedia Communications and Networking”, CRC Press, 2012 |


| | |
|---|---|
| 2 | K. R. Rao, Zoron S. Bojkovic, Bojan M. Bakmaz, "Wireless Multimedia Communication Systems: Design, Analysis and Implementation", CRC Press, 2017 |
| 3 | Jim Kurose, Keith Ross, "Computer Networking: A Top Down Approach", Pearson Education, 2017 |
| 4 | K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Introduction to Multimedia Communications Applications, Middleware, Networking", John Wiley and Sons, 2009 |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Deploy the right multimedia communication models. | Apply |
| CO2 | Apply QoS to multimedia network applications at the network level with efficient scheduling and routing techniques. | Apply |
| CO3 | Apply QoS to multimedia network applications at the end system level with efficient scheduling and routing techniques. | Apply |
| CO4 | Apply IP multimedia subsystem and IP initiatives in cellular networks to support multimedia traffic. | Apply |
| CO5 | Design and implement VoIP based solutions for multimedia transport. | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 2 | 2 | 2 | 2 |
| **2** | 1 | 1 | 1 | 3 | 3 | 3 |
| **3** | 1 | 3 | 2 | 3 | 2 | 1 |
| **4** | 1 | 1 | 2 | 2 | 3 | 3 |
| **5** | 2 | 1 | 2 | 2 | 3 | 3 |
| **Average** | 1.2 | 1.6 | 1.8 | 2.4 | 2.6 | 2.4 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE05 | INFORMATION RETRIEVAL TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Data Structures and Algorithms, Database Management Systems

**Course Objective:**

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the concepts of digital libraries

**Detailed Syllabus**

**UNIT I INTRODUCTION: MOTIVATION 9**

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open-Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR ––IR Versus Web Search–Components of a Search engine.

**UNIT II MODELING 9**

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing.

**UNIT III INDEXING 9**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency.

**UNIT IV EVALUATION AND PARALLEL INFORMATION RETRIEVAL 9**

Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria – Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce.

**UNIT V SEARCHING THE WEB 9**

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008. |
| 2 | Stefan Buttcher, Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016. |


| | |
|---|---|
| 3 | Ricardo Baeza – Yates, Berthier Ribeiro – Neto, “Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011. |
| 4 | Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, “Information Retrieval” |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Build an Information Retrieval system using the available tools. | Create |
| CO2 | Identify and design the various components of an Information Retrieval system. | Create |
| CO3 | Categorize the different types of IR Models. | Apply |
| CO4 | Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval. | Apply |
| CO5 | Design an efficient search engine and analyze the Web content structure. | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 1 | 2 | 2 | 3 | 3 |
| **2** | 2 | 1 | 2 | 2 | 3 | 3 |
| **3** | 1 | 2 | 2 | 3 | 1 | 1 |
| **4** | 2 | 1 | 2 | 2 | 3 | 2 |
| **5** | 3 | 1 | 2 | 2 | 3 | 3 |
| **Average** | **2** | **1.2** | **2** | **2.2** | **2.6** | **2.4** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE06 | WEB ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Web Technologies, Introduction to Programming

**Course Objective:**

- To understand the Web analytics platform, and their evolution.
- To learn about the various Data Streams Data.
- To learn about the benefits of surveys and capturing of data
- To understand Common metrics of web as well as KPI related concepts.
- To learn about the various Web analytics versions.

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, on site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

**UNIT II DATA COLLECTION 9**

Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E- commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

**UNIT III QUALITATIVE ANALYSIS 9**

Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

**UNIT IV WEB METRICS 9**

Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

**UNIT V WEB ANALYTICS 2.0 9**

Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd Edition, 2012. |
| 2 | Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed, 2010. |
| 3 | Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons, 2002. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand the Web analytics platform, and their evolution. | Understand |
| CO2 | Use the various Data Streams Data. | Apply |
| CO3 | Apply how the survey of capturing of data will benefit. | Apply |
| CO4 | Apply Common metrics of web as well as KPI related concepts. | Apply |
| CO5 | Apply various Web analytics versions in existence. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 1 | 2 | 3 | 1 | 1 |
| **2** | 1 | 1 | 1 | 1 | 1 | 1 |
| **3** | 3 | 1 | 2 | 2 | 1 | 1 |
| **4** | 1 | 2 | 2 | 3 | 1 | 1 |
| **5** | 2 | 1 | 1 | 1 | 2 | 2 |
| **Average** | **1.6** | **1.2** | **1.6** | **2** | **1.2** | **1.2** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE07 | DATA VISUALIZATION TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Programming Fundamentals, Database Management Systems

**Course Objective:**

- To develop skills to both design and critique visualization
- To introduce visual perception and core skills for visual analysis.
- To understand technological advancements of data visualization
- To understand various data visualization techniques
- To understand the methodologies used to visualize large data sets

**Detailed Syllabus**

**UNIT I INTRODUCTION AND DATA FOUNDATION 9**

Basics - Relationship between Visualization and Other Fields -The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets.

**UNIT II FOUNDATIONS FOR VISUALIZATION 9**

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson‘s Affordance theory – A Model of Perceptual Processing.

**UNIT III VISUALIZATION TECHNIQUES 9**

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data : Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques - LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.

**UNIT IV INTERACTION CONCEPTS AND TECHNIQUES 9**

Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.

**UNIT V RESEARCH DIRECTIONS IN VISUALIZATIONS 9**

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation , Hardware and Applications.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Matthew Ward, Georges Grinstein and Daniel Keim, “Interactive Data Visualization Foundations, Techniques, Applications”, 2010. |
| 2 | Colin Ware, “Information Visualization Perception for Design”, 4th edition, Morgan Kaufmann Publishers, 2021. |


| | |
|---|---|
| 3 | Robert Spence “Information visualization – Design for interaction”, Pearson Education, 2nd Edition, 2007. |
| 4 | Alexandru C. Telea, “Data Visualization: Principles and Practice,” A. K. Peters Ltd, 2008. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Visualize the objects in different dimensions. | Apply |
| CO2 | Design and process the data for Visualization. | Create |
| CO3 | Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences. | Apply |
| CO4 | Apply the virtualization techniques for research projects. | Apply |
| CO5 | Apply appropriate data visualization techniques given particular requirements imposed by the data. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 1 | 2 | 2 | 2 |
| **2** | 3 | 2 | 2 | 3 | 3 | 3 |
| **3** | 2 | - | - | 2 | 2 | 2 |
| **4** | 2 | - | - | 2 | 2 | 2 |
| **5** | 3 | 1 | - | 2 | 1 | 1 |
| **Average** | **2.2** | **1.66** | **1.5** | **2.2** | **2** | **2** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE08 | HEALTHCARE ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Basics of Data Analytics / Data Science, Basic Knowledge of Healthcare Systems

**Course Objective:**

- To impart the fundamental concepts of Healthcare data analytics
- To give the knowledge about the Health care Data Sources.
- To familiarize Advanced Data Analytics for Healthcare
- To learn the Health IoT data analytics
- To implement the Applications and Practical Systems for Healthcare.

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Introduction- Healthcare Data Sources and Basic Analytics - Healthcare Data Sources : Electronic Health Records: Components of HER- Coding system- Biomedical Image Analysis: Biomedical Imaging Modalities- Object Detection- Image Segmentation- Image Registration- Feature Extraction- Mining of Sensor Data in Healthcare: Mining Sensor Data in Medical Informatics: Scope and Challenges- Sensor Data Mining Applications.

**UNIT II HEALTHCARE DATA SOURCES 9**

Biomedical Signal Analysis: Types of Biomedical Signals- ECG Signal Analysis- Denoising of Signals- Multivariate Biomedical Signal Analysis- Cross-Correlation Analysis- Methods to Study Connectivity- Genomic Data Analysis for Personalized Medicine: Genomic Data Generation- Methods and Standards for Genomic Data Analysis- Types of Computational Genomics Studies towards Personalized Medicine.

**UNIT III ADVANCED DATA ANALYTICS FOR HEALTHCARE 9**

Basic Statistical Prediction Models- Alternative Clinical Prediction Models- Survival Models- Evaluation and Validation- Temporal Data Mining for Healthcare Data: Association Analysis- Temporal Pattern Mining- Sensor Data Analysis- Other Temporal Modeling Methods- Visual Analytics for Healthcare: Visual Analytics and Medical Data Visualization- Visual Analytics in Healthcare.

**UNIT IV HEALTH IOT DATA ANALYTICS 9**

Internet of things in the healthcare industry- IoT healthcare architecture- Characteristics of IoT health data- Health data analytics using Internet of things- Computational intelligence in Internet of things for future healthcare applications.

**UNIT V APPLICATIONS AND PRACTICAL SYSTEMS FOR HEALTHCARE 9**

Data Analytics for Pervasive Health: Supporting Infrastructure and Technology - Basic Analytic Techniques- Advanced Analytic Techniques- Applications - Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Chandan K. Reddy , Charu C. Aggarwal, Healthcare Data Analytics 1st Edition, Kindle Edition, CRC press, 2020. |
| 2 | Sanjay Kumar Singh Ravi Shankar Singh Anil Kumar Pandey Udmale S.S. Ankit Chaudhary , IoT-Based Data Analytics for the Healthcare Industry Techniques and Applications 1st Edition, Elsevier, Academic Press. |

| | |
|---|---|
| 3 | Prasant Kumar Pattnaik, Suneeta Mohanty (Editor), Satarupa Mohanty (Editor) Format: Kindle Edition, Smart Healthcare Analytics in IoT Enabled Environment 1st edition Kindle Edition, Springer Nature Switzerland AG 2020. |
| 4 | Nilanjan Dey, Amira Ashour, Simon James Fong , Chintan Bhatt , Healthcare Data Analytics and Management 1st Edition, Elsevier, Academic Press 2018. |
| 5 | Sanket Shah, Healthcare Analytics: A Comprehensive Guide, Kindly Edition, 2020. |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Describe the basics of healthcare data analytics. | Understand |
| CO2 | Explain the Healthcare Data Sources. | Understand |
| CO3 | Discuss the Advanced Data Analytics for Healthcare. | Understand |
| CO4 | Express the Health IoT data analytics. | Apply |
| CO5 | Apply the practical Systems for Healthcare. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 1 | - | 1 | 2 | 2 |
| **2** | 2 | 1 | - | 1 | - | 2 |
| **3** | 2 | 2 | 2 | 3 | 2 | 2 |
| **4** | 2 | 2 | 2 | 3 | 2 | 2 |
| **5** | 2 | 2 | 2 | 3 | 1 | 2 |
| **Average** | **2** | **1.6** | **2** | **2.2** | **1.75** | **2** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE09 | BLOCKCHAIN TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Data Structures and Algorithms, Computer Networks, Cryptography and Network Security

**Course Objective:**

- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

**Detailed Syllabus**

**UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

**UNIT II BITCOIN AND CRYPTOCURRENCY 9**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

**UNIT III INTRODUCTION TO ETHEREUM 9**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

**UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10**

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

**UNIT V BLOCKCHAIN APPLICATIONS 8**

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Chandan K. Reddy , Charu C. Aggarwal, Healthcare Data Analytics 1st Edition, Kindle Edition, CRC press, 2020. |
| 2 | Sanjay Kumar Singh Ravi Shankar Singh Anil Kumar Pandey Udmale S.S. Ankit Chaudhary , IoT-Based Data Analytics for the Healthcare Industry Techniques and Applications 1st Edition, Elsevier, Academic Press. |
| 3 | Prasant Kumar Pattnaik, Suneeta Mohanty (Editor), Satarupa Mohanty (Editor) Format: Kindle Edition, Smart Healthcare Analytics in IoT Enabled Environment 1st edition Kindle Edition, Springer Nature Switzerland AG 2020. |
| 4 | Nilanjan Dey, Amira Ashour, Simon James Fong , Chintan Bhatt , Healthcare Data Analytics and Management 1st Edition, Elsevier, Academic Press 2018. |


| | |
|---|---|
| 5 | Sanket Shah, Healthcare Analytics: A Comprehensive Guide, Kindly Edition, 2020. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Describe the basics of healthcare data analytics. | Understand |
| CO2 | Explain the Healthcare Data Sources. | Understand |
| CO3 | Discuss the Advanced Data Analytics for Healthcare. | Understand |
| CO4 | Express the Health IoT data analytics. | Apply |
| CO5 | Apply the practical Systems for Healthcare. | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 1 | - | 1 | 2 | 2 |
| **2** | 2 | 1 | - | 1 | - | 2 |
| **3** | 2 | 2 | 2 | 3 | 2 | 2 |
| **4** | 2 | 2 | 2 | 3 | 2 | 2 |
| **5** | 2 | 2 | 2 | 3 | 1 | 2 |
| **Average** | **2** | **1.6** | **2** | **2.2** | **1.75** | **2** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE10 | DEVOPS AND MICROSERVICES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Operating Systems, Computer Networks, Software Engineering

**Course Objective:**

- To learn the basic concepts and terminology of DevOps
- To gain knowledge on Devops platform
- To understand building and deployment of code
- To be familiar with DevOps automation tools
- To learn basics of MLOps

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Software Engineering - traditional and Agile process models - DevOps -Definition - Practices - DevOps life cycle process - need for DevOps –Barriers.

**UNIT II DEVOPS PLATFORM AND SERVICES 9**

Cloud as a platform - IaaS, PaaS, SaaS - Virtualization - Containers –Supporting Multiple Data Centers - Operation Services - Hardware provisioning- software Provisioning - IT services - SLA - capacity planning - security - Service Transition - Service Operation Concepts.

**UNIT III BUILDING, TESTING AND DEPLOYMENT 9**

Microservices architecture - coordination model - building and testing - Deployment pipeline - Development and Pre-commit Testing -Build and Integration Testing - continuous integration - monitoring - security - Resources to Be Protected - Identity Management.

**UNIT IV DEVOPS AUTOMATION TOOLS 9**

Infrastructure Automation- Configuration Management - Deployment Automation – Performance Management - Log Management -Monitoring.

**UNIT V MLOPS 9**

MLOps - Definition - Challenges -Developing Models - Deploying to production - Model Governance - Real world examples.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Len Bass, Ingo Weber and Liming Zhu, ”DevOps: A Software Architect‘s Perspective”, Pearson Education, 2016 |
| 2 | Joakim Verona - “Practical DevOps” - Packet Publishing , 2016 |
| 3 | Viktor Farcic -”The DevOps 2.1 Toolkit: Docker Swarm” - Packet Publishing, 2017 |
| 4 | Mark Treveil, and the Dataiku Team-”Introducing MLOps” - O’Reilly Media- 2020 |


**Course Outcomes**

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

| CO | Course Outcome Statement | Knowledge Level |
|---|---|---|
| CO1 | Implement modern software Engineering process | Understand |
| CO2 | Implement with DevOps platform | Understand |
| CO3 | Explore build, test and deploy code | Apply |
| CO4 | Explore DevOps tools | Apply |
| CO5 | Correlate MLOps concepts with real time examples | Apply |

**Course Articulation Matrix**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 2 | 2 | 1 | 3 | 3 | 3 |
| **2** | 2 | - | 1 | 2 | 2 | 2 |
| **3** | 2 | 1 | 1 | 3 | 3 | 3 |
| **4** | 2 | 1 | 2 | 2 | 1 | 1 |
| **5** | 2 | - | - | 2 | 1 | 1 |
| **Average** | **2** | **1.3** | **1.25** | **2.4** | **2** | **2** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE11 | LARGE LANGUAGE MODEL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Programming in Python, Machine Learning Fundamentals

**Course Objective:**

- To Study about the principles, methods, and applications of generative models in artificial intelligence.
- To gain hands-on experience with state-of-the-art generative models such as GANs, VAEs, and autoregressive models.
- To addresses ethical considerations and emerging trends in Generative AI.

**Detailed Syllabus**

**UNIT I FUNDAMENTALS OF DEEP LEARNING 9**

Basics of neural networks, Activation functions, loss functions, and optimization techniques, Introduction to PyTorch/Tensor Flow tools.

**UNIT II INTRODUCTION TO GENERATIVE AI 9**

Overview of Generative AI, Types of generative models (implicit vs. explicit), Applications of generative models in various domains.

**UNIT-III TYPES OF GENERATIVE MODELS 9**

Variational Autoencoders (VAEs), Introduction to VAEs, Mathematical foundations (KL divergence, variational inference), Training and sampling from VAEs. Generative Adversarial Networks (GANs), Introduction to GANs, Architecture of GANs (Generator and Discriminator), Training challenges and solutions (e.g., mode collapse, Wasserstein GANs), Conditional GANs (cGANs), CycleGANs and image-to-image translation, StyleGANs and advanced GAN applications. Autoregressive Models, Introduction to autoregressive models (e.g.,PixelRNN, PixelCNN), Sequence generation with RNNs and Transformers.

**UNIT-IV DIFFUSION MODELS AND OTHER EMERGING TECHNIQUES 9**

Introduction to diffusion models, Overview of other emerging generative models, Comparisons and trade-offs among different generative models.

**UNIT-V APPLICATIONS AND ETHICS OF GENERATIVE AI 9**

Applications in healthcare, art, entertainment, and others, Ethical considerations in Generative AI (bias, misuse, deepfakes), Future trends and research directions.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st Edition, 2016, MIT Press. |
| 2 | Generative Deep Learning – David Foster, 2nd Edition, 2022, O'Reilly Media. |
| 3 | Pattern Recognition and Machine Learning – Christopher M. Bishop, 1st Edition, 2006, Springer. |
| 4 | Machine Learning: A Probabilistic Perspective – Kevin P. Murphy, 1st Edition, 2012, MIT Press. |
| 5 | Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron, 3rd Edition, 2022, O'Reilly Media. |


**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | implement the simple Neural Network model for the classification task with Deep Learning through Software tools. | Understand |
| CO2 | Know the Generative AI Models and its applications | Understand |
| CO3 | Design and Implement Generative Models VAE, GAN and Autoregressive models | Create |
| CO4 | Investigate and present an emerging generative model techniques | Apply |
| CO5 | Design a Solution for the real-world problem through Generative AI Models and Tool | Create |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 3 | 1 | 1 | 2 | 3 | 2 |
| **2** | 2 | 1 | 2 | 3 | 2 | 3 |
| **3** | 1 | 3 | 2 | 3 | 3 | 2 |
| **4** | 1 | 3 | 3 | 3 | 3 | 1 |
| **5** | 2 | 3 | 3 | 2 | 2 | 3 |
| **Average** | 1.8 | 2.2 | 2.2 | 2.2 | 2.6 | 2.2 |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE12 | COMPUTER VISION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Programming in Python / MATLAB , Data Structures and Algorithms

**Course Objective:**

- Articulate & apply standard computer vision concepts
- Implement standard image processing tasks
- Applying Clustering concept for Image Classification
- Identify practical constraints in computer vision application
- Architecture of an existing computer vision pipeline based on deep learning models

**Detailed Syllabus**

**UNIT I COMPUTER VISION 9**

About Computer Vision. Components of an Image Processing System. Image Resolution. Image Formats. Colour Spaces. Fundamental of Image Processing. Visual Inspection System. Biomedical Imaging Methods. Image Thresholding. Based Image Retrieval. Human Visual Inception. Image Formation. Geometric Properties. 3D Imaging. Stereo Images.

**UNIT II PIXEL-BASED MANIPULATIONS & TRANSFORMATION 9**

Visual properties. Pixel colour manipulation. Colour Change with Pixel Position. Colour Change with Pixel Distance. Colour Change with Trigonometric Functions. Randomness. Drawing with existing images. Blending multiple images. Image transformation. Image orientation. Image resizing. Affine transform. Known Affine Transformations. Unknown Affine Transformations. Perspective transform. Linear vs. polar coordinates. Three-dimensional space. General pixel mapping.

**UNIT III STRUCTURE IDENTIFICATION 9**

Image preparation. Conversion to grayscale. Conversion to a black-and-white image. Morphological operations (erode, dilate). Blur operations (smoothing)Edge detection. First Derivative Edge Detectors. Second Derivative Edge Detectors. Multispectral Edge Detection. Line detection. Circle detection. Contours processing. Finding the contours. Bounding box. Minimum area rectangle. Convex hull. Polygon approximation. Testing a point in contour. Checking intersection. Shape detection. Moravec Corner Detection. Harris Corner Detection. FAST Corner Detection. SIFT.

**UNIT IV CLUSTERING IMAGES & IMAGE RETRIEVAL 9**

About Transfer Learning. Extract features. SciPy Clustering Package. K-Means Clustering. Clustering Images. Principal Components. Clustering Pixels. Hierarchical Clustering. Spectral Clustering. Fast Fourier Transforms. -Based Image Retrieval. Indexing Images. Searching the Database for Images. Querying with an Image. Benchmarking and Plotting the Results. Ranking Results Using Geometry.

**UNIT V IMAGE CLASSIFICATION USING DEEP LEARNING 9**

Working with Image Datasets. k-NN: A Simple Classifier. K-NN Hyper parameters. Gradient Descent. Loss Functions. Stochastic Gradient Descent (SGD). Regularisation. The Perceptron Algorithm. Back propagation and Multi-layer Networks. Weight Initialization. Constant Initialization. Uniform and Normal Distributions. CNN Building Blocks. Image Classification.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Pro Processing for Images and Computer Vision with OpenCV, Bryan WC Chung, Apress, 2017 |
| 2 | Programming Computer Vision with Python, Jan Erik Solem, O'Reilly Media, 2012 |
| 3 | A Practical Introduction to Computer Vision with OPENCV, Kenneth Dawson-Howe, Wiley, 2014 |
| 4 | Practical Computer Vision Applications Using Deep Learning with CNNs: With Detailed Examples in Python Using TensorFlow and Kivy, Ahmed Fawzy Gad, Apress. 2018 |
| 5 | Computer Vision Principles, Algorithms, Applications, Learning E.R. Davies, Academic Press, 5th edition, 2017 |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand the basic knowledge, theories and methods of computer vision. | Understand |
| CO2 | Understand the essentials of image processing concepts through mathematical interpretation. | Understand |
| CO3 | Demonstrate a knowledge of a broad range of fundamental image processing and image analysis techniques | Apply |
| CO4 | Apply Clustering algorithms for clustering. | Apply |
| CO5 | Analyse cognitive tasks including image classification, recognition and detection through deep learning. | Analyse |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 3 | 3 | - | - | - | - |
| **2** | 2 | 2 | 2 | 3 | - | - |
| **3** | 2 | 2 | 3 | 3 | 3 | 2 |
| **4** | - | 3 | 3 | 2 | - | 3 |
| **5** | 2 | 2 | 2 | 3 | 3 | - |
| **Average** | **2.2** | **2.4** | **2.5** | **2.7** | **3** | **2.5** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSPE13 | ETHICS AND AI | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Basic knowledge of Artificial Intelligence, Understanding of social, ethical, and professional responsibilities

**Course Objective:**

- Study the morality and ethics in AI
- Learn about the Ethical initiatives in the field of artificial intelligence
- Study about AI standards and Regulations
- Study about social and ethical issues of Robot Ethics
- Study about AI and Ethics- challenges and opportunities

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust

**UNIT II ETHICAL INITIATIVES IN AI 9**

International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles, Warfare and weaponization.

**UNIT III AI STANDARDS AND REGULATION 9**

Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems.

**UNIT IV ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS 9**

Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology – Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy.

**UNIT V AI AND ETHICS- CHALLENGES AND OPPORTUNITIES 9**

Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,"The ethics of artificial intelligence: Issues and initiatives", EPRS \| European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020 |
| 2 | Patrick Lin, Keith Abney, George A Bekey," Robot Ethics: The Ethical and Social Implications of Robotics", The MIT Press- January 2014. |
| 3 | Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017 |
| 4 | Mark Coeckelbergh," AI Ethics", The MIT Press Essential Knowledge series, April 2020 |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Learn about morality and ethics in AI | Understand |
| CO2 | Acquire the knowledge of real time application ethics, issues and its challenges. | Understand |
| CO3 | Understand the ethical harms and ethical initiatives in AI | Understand |
| CO4 | Learn about AI standards and Regulations like AI Agent, Safe Design of Autonomous and Semi-Autonomous Systems | Understand |
| CO5 | Understand the concepts of Roboethics and Morality with professional responsibilities. | Understand |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 1 | 3 | 1 | 1 |
| **2** | 2 | 3 | 1 | 2 | - | - |
| **3** | 1 | 2 | 1 | 3 | 1 | 1 |
| **4** | 1 | 2 | 1 | 3 | 1 | 1 |
| **5** | 3 | 1 | 2 | 3 | - | - |
| **Avg** | **1.6** | **2** | **1.2** | **2.8** | **1** | **1** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

## AUDIT COURSES (AC)
**Registration for any of these courses is optional to students**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| THEORY COURSES | | | | | | | | | | |
| 1. | P26CSAC01 | Research Paper Writing | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |
| 2. | P26CSAC02 | Disaster Management | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |
| 3. | P26CSAC03 | AI Tools for Empowering Education | AC | 2 | 0 | 0 | 2 | 0 | 100 | - |

| P26CSAC01 | RESEARCH PAPER WRITING | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**Pre-requisite:** Basic proficiency in English, Fundamentals of Technical Communication / Professional English, Basic knowledge of academic writing and grammar

**Course Objective:**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT II PRESENTATION SKILLS 6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**UNIT III TITLE WRITING SKILLS 6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV RESULT WRITING SKILLS 6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V VERIFICATION SKILLS 6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

**Total Periods: 30**

**Learning Resources**

| | |
|---|---|
| 1 | Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011 |
| 2 | Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006 |
| 3 | Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006 |
| 4 | Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand that how to improve your writing skills and level of readability | Understand |
| CO2 | Learn about what to write in each section | Understand |
| CO3 | Understand the skills needed when writing a Title | Understand |
| CO4 | Understand the skills needed when writing the Conclusion | Understand |
| CO5 | Ensure the good quality of paper at very first-time submission | Apply |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 1 | 3 | 1 | 1 |
| **2** | 2 | 3 | 1 | 2 | - | - |
| **3** | 1 | 2 | 1 | 3 | 1 | 1 |
| **4** | 1 | 2 | 1 | 3 | 1 | 1 |
| **5** | 3 | 1 | 2 | 3 | - | - |
| **Average** | **1.6** | **2** | **1.2** | **2.8** | **1** | **1** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSAC02 | DISASTER MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**Pre-requisite:** Fundamentals of Information Technology, Basic Understanding of Teaching–Learning Processes

**Course Objective:**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**Detailed Syllabus**

**UNIT I INTRODUCTION 6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT III DISASTER PRONE AREAS IN INDIA 6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

**UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT V RISK ASSESSMENT6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

**Total Periods: 30**

**Learning Resources**


| | |
|---|---|
| 1 | Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009. |
| 2 | NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007. |
| 3 | Sahni, Pradeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Ability to summarize basics of disaster | Understand |
| CO2 | Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response. | Understand |
| CO3 | Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. | Understand |
| CO4 | Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. | Understand |
| CO5 | Ability to develop the strengths and weaknesses of disaster management approaches | Understand |

**Course Articulation Matrix**

| **CO** | **POs** | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 1 | 3 | 1 | 1 |
| **2** | 2 | 3 | 1 | 2 | - | - |
| **3** | 1 | 2 | 1 | 3 | 1 | 1 |
| **4** | 1 | 2 | 1 | 3 | 1 | 1 |
| **5** | 3 | 1 | 2 | 3 | - | - |
| **Average** | **1.6** | **2** | **1.2** | **2.8** | **1** | **1** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

| P26CSAC03 | AI TOOLS FOR EMPOWERING EDUCATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**Pre-requisite:** Fundamentals of Information Technology, Basic Understanding of Teaching–Learning Processes

**Course Objective:**

- Understand the fundamentals of AI and its applications in education.
- Explore various AI tools and technologies that can be used in educational settings.
- Develop skills to implement AI solutions for personalized learning, administrative efficiency, and data-driven decision-making.
- Analyze ethical considerations and challenges associated with AI in education.

**Detailed Syllabus**

| |
|---|
| **UNIT I INTRODUCTION TO AI IN EDUCATION 6**<br>Overview of AI: History, Concepts, and Impact, AI in Education: Current Trends and Future Prospects |
| **UNIT II AI TOOLS FOR PERSONALIZED LEARNING AND ADMINISTRATIVE EFFICIENCY 6**<br>Adaptive Learning Systems, Intelligent Tutoring Systems, AI in Student Information Systems, AI for Resource Management and Planning |
| **UNIT III DATA ANALYTICS IN EDUCATION & ENHANCING STUDENT ENGAGEMENT 6**<br>Educational Data Mining, Learning Analytics, Chatbots & Virtual Assistants, Gamification. |
| **UNIT IV AI IN ASSESSMENT AND EVALUATION 6**<br>Automated Grading Systems, AI for Formative and Summative Assessments |
| **UNIT V ETHICAL CONSIDERATIONS AND CHALLENGES 6**<br>Bias and Fairness in AI, Privacy and Security in AI Applications, Implementing AI in Educational Institutions. |
| **Total Periods: 30** |

**Learning Resources**

| | |
|---|---|
| 1 | Artificial Intelligence in Education" by Wayne Holmes, Maya Bialik, and Charles Fadel. |
| 2 | "Learning with AI: Big Data in Education" by Viktor Mayer-Schönberger and Kenneth Cukier |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand the fundamental concepts of AI and its application in education. | Understand |
| CO2 | Learn about various AI tools and technologies used in educational settings. | Understand |
| CO3 | Develop practical skills in implementing AI solutions for educational purposes. | Create |
| CO4 | Explore the ethical considerations and challenges of using AI in education. | Create |
| CO5 | Analyze case studies and current research trends in the field of AI in education | Analyse |

**Course Articulation Matrix**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **1** | 1 | 2 | 1 | 3 | 1 | 1 |
| **2** | 2 | 3 | 1 | 2 | - | - |
| **3** | 1 | 2 | 1 | 3 | 1 | 1 |
| **4** | 1 | 2 | 1 | 3 | 1 | 1 |
| **5** | 3 | 1 | 2 | 3 | - | - |
| **Average** | **1.6** | **2** | **1.2** | **2.8** | **1** | **1** |

**For CO-PO/PSO Mapping:** 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

## OPEN ELECTIVE COURSES (OEC)

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TP | CREDITS | ASSESSMENT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | CIA | ESE |
| THEORY COURSES | | | | | | | | | | |
| 1. | P26CSOE01 | Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 2. | P26CSOE02 | Environmental Impact Assessment | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 3. | P26CSOE03 | Ethical Management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 4. | P26CSOE04 | Smart Grid | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |
| 5. | P26CSOE05 | Medical Applications | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 |

| P26CSOE01 | INTEGRATED WATER RESOURCES MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Environmental Science / Environmental Engineering Fundamentals

**Course Objective:**

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

**Detailed Syllabus**

**UNIT I CONTEXT FOR IWRM 9**

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

**UNIT II WATER ECONOMICS 9**

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

**UNIT III LEGAL AND REGULATORY SETTINGS 9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework..

**UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

**UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9**

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

**Total Periods: 45**

**Learning Resources**

| | |
|---|---|
| 1 | Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003. |
| 2 | Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006. |
| 3 | Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002. |
| 4 | Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management. | Understand |
| CO2 | Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies. | Understand |
| CO3 | Apply law and governance in the context of IWRM. | Apply |
| CO4 | Discuss the linkages between water-health; develop a HIA framework. | Apply |
| CO5 | Analyse how the virtual water concept pave way to alternate policy options. | Analyze |

| **P26CSOE02** | **ENVIRONMENTAL IMPACT ASSESSMENT** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**Pre-requisite:** Environmental Science / Environmental Engineering Fundamentals

**Course Objective:**

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

**Detailed Syllabus**

**UNIT I INTRODUCTION 9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. Legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

**UNIT II IMPACT INDENTIFICATION AND 10**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological – cumulative impact assessment.

**UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8**

| |
|---|
| Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. Communities in transition-rehabilitation. |
| **UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9**<br>Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment. |
| **UNIT V CASE STUDIES 9**<br>Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects. |
| **Total Periods: 45** |

**Learning Resources**

| | |
|---|---|
| 1 | EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of Ind |
| 2 | Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India |
| 3 | Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996 |
| 4 | Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003 |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles | Understand |
| CO2 | Understand various impact identification methodologies, prediction techniques and model of impacts on various environments | Understand |
| CO3 | Understand relationship between social impacts and change in community due to development activities and rehabilitation methods | Understand |
| CO4 | Document the EIA findings and prepare environmental management and monitoring plan | Apply |
| CO5 | Identify, predict and assess impacts of similar projects based on case studies | Analyze |

| P26CSOE03 | ETHICAL MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Fundamentals of Management / Management Principles

**Course Objective:**

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

**Detailed Syllabus**

**UNIT I ETHICS AND SOCIETY 9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

**UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, and develop ethical management skills, knowledge, and competencies. Proactive crisis management.

**UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

**UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9**

Understanding individual variables in ethics, managerial ethics, and concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, and ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision- making and management.

**UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

**Total Periods: 45**

**Learning Resources**


| | |
|---|---|
| 1 | Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential Companion to leading your career and your company, 2016. |
| 2 | Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011. |
| 3 | Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020. |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Role modelling and influencing the ethical and cultural context. | Understand |
| CO2 | Respond to ethical crises and proactively address potential crises situations. | Understand |
| CO3 | Understand and implement stakeholder management decisions. | Understand |
| CO4 | Develop the ability, knowledge, and skills for ethical management. | Create |
| CO5 | Develop practical skills to navigate, resolve and thrive in management situations | Create |

| **P26CSOE04** | **SMART GRID** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**Pre-requisite:** Power Systems Engineering

**Course Objective:**

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

**Detailed Syllabus**

**UNIT I INTRODUCTION TO SMART GRID 9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

**UNIT II SMART GRID TECHNOLOGIES 9**

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

**UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

**UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

**UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9**

| |
|---|
| Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid. |
| **Total Periods: 45** |

**Learning Resources**

| | |
|---|---|
| 1 | Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012. |
| 2 | JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012. |
| 3 | Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press,<br>2015 |
| 4 | Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014 |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Relate with the smart resources, smart meters and other smart devices. | Understand |
| CO2 | Explain the function of Smart Grid. | Understand |
| CO3 | Experiment the issues of Power Quality in Smart Grid. | Understand |
| CO4 | Analyze the performance of Smart Grid. | Analyze |
| CO5 | Recommend suitable communication networks for smart grid applications | Analyze |

| **P26CSOE05** | **MEDICAL APPLICATION** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**Pre-requisite:** Basic Biology / Human Physiology, Computer Programming

**Course Objective:**

- To understand hardware and software for ARM processor.
- To understand ARM processor and Building Blocks of Embedded Systems
- To provide information about sensor interfacing with microcontroller boards
- To provide information about various protocols for IoT
- To familiarize the student with the various applications in healthcare using IOT

**Detailed Syllabus**

**UNIT I HARDWARE AND SOFTWARE OF ARM PROCESSOR 9**

ARM processor fundamentals, architecture, Instruction set, Memory system, Exception/ Interrupt handling. Cortex-M Processors, Embedded Software Development- Introduction to C language and C preprocessor.

**UNIT II DATA ACQUISITION SYSTEMS 10**

Analog signals: amplitude, bandwidth; Analog multiplexing, Anti-aliasing filters, Analog to Digital converter, Sensor interfacing, sampling theorem, Digital filters, UART to USB converters, Bluetooth, Zigbee and Wi-fi Communication protocols.

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|---|
| **UNIT III SENSOR INTERFACING WITH MICROCONTROLLER BOARDS 8**<br>Basics of hardware design, functions of passive components-sensors and actuators, Introduction to Arduino Due; Arduino integrated development environment and programming. |
| **UNIT IV AN INTRODUCTION IOT 9**<br>Networked Embedded System types and overview, Introduction to IOT , Application of IOT in health-care - Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness. |
| **UNIT V EMBEDDED WEB-SERVER/ IOT CLOUD SERVICES APPLICATION/ CASE STUDY 9**<br>Embedded web server: Basic introduction and its application in IOT. Case Study1: Wireless Patient Monitor system Case Study2: Wearable Fitness & Activity Monitor Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration, Design of single channel and multi-channel ECG and EMG amplifier systems incorporating analog, digital communication. |
| **Total Periods: 45** |

**Learning Resources**

| | |
|---|---|
| 1 | Andrew Sloss, Dominic Symes, Chris Wright, ARM system developer's guide: designing and optimizing system software, Morgan Kaufmann, 2004. |
| 2 | Getting Started with Internet of Things- CunoPfister, 2011 |
| 3 | S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, Vikas Publishing House, 2012. |
| 4 | Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010 24 Course |

**Course Outcomes**

| At the end of the course, the students will be able to | | |
|---|---|---|
| **CO** | **Course Outcome Statement** | **Knowledge Level** |
| CO1 | Develop hardware and software for ARM processor, Understand ARM processor and Building Blocks of Embedded Systems | Create |
| CO2 | Understand the data acquisition system. | Understand |
| CO3 | Acquire Knowledge on sensor interfacing with Arduino | Understand |
| CO4 | Analyze various protocols for IoT, | Analyze |
| CO5 | Build various applications in healthcare using IOT based approach and substantiate thesame with appropriate. | Analyze |