# PANIMALAR ENGINEERING COLLEGE

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**
**Bangalore Trunk Road, Varadharajapuram,**
**Poonamallee, Chennai – 600 123**

## Department of Computer Science and Engineering

**M.E- Computer Science and Engineering**

## Curriculum and Syllabus
## Regulation-2021

# Vision

To provide an academically conducive environment for individuals to develop as technologically superior, socially conscious and nationally responsible citizens.

# Mission

- To develop our department as a centre of excellence, imparting quality education, generating competent and skilled manpower.
- We prepare our students with high degree of credibility, integrity, ethical standards and social concern
- We train our students to devise and implement novel systems, based on Education and Research.

## PROGRAM EDUCATIONAL OBJECTIVES (PEO)

1. Apply the basic fundamental tools and profound knowledge of computer science & engineering to generate interest in newer areas of research and develop the students into successful professionals.
2. Develop innovative and advanced software systems by exploring multiple solutions to computational problems with efficient algorithms giving due consideration to the human context in which the systems would work.
3. Adapt to sustained learning and ever-changing technological and societal requirements which will enable them to attain a dynamic career in academics and research and industries.
4. Demonstrate and Practice professional and ethical code of conduct towards team work with societal responsibilities.
5. Engage in continued learning to keep pace with changing landscape of technologies and provide innovative solutions to real-life problems.

## PROGRAM OUTCOMES (POs)

| PO# | Graduate Attribute | Programme Outcomes |
|---|---|---|
| **1.** | Research Aptitude | An ability to independently carry out research Investigations, identify problems and develop solutions to solve practical problems. |
| **2.** | Technical documentation | An ability to write and present a substantial technical report/ document. |
| **3.** | Technical competence | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program |
| **4.** | Handle complex problems | Use research-based knowledge, methods, appropriate techniques, resources and tools to solve complex engineering issues with an understanding of the limitations. |
| **5.** | Environmental Sustainability and societal Ethics | Ensure development of socially relevant and eco-friendly indigenous products by applying technical knowledge, ethical principles and, sound engineering practices |
| **6.** | Life-long learning | Recognize the need for independent, life-long learning and engage in the broadest context of technological change. |

## PROGRAM SPECIFIC OUTCOMES (PSO)

1. To use mathematical, algorithmic and theoretical foundations in the study of computing systems.
2. To acquire in-depth knowledge and skills in core and emerging technologies of Computer Science and Engineering.
3. To develop and apply innovative solutions to real world problems using appropriate research techniques

## MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme educational objective and the outcomes is given in the following table

| PROGRAM EDUCATIONAL OBJECTIVES | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| 1. | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 2. | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 3. | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 4. | ✓ | | ✓ | ✓ | ✓ | ✓ |
| 5. | ✓ | | ✓ | ✓ | ✓ | ✓ |

| YEAR | SEMESTER | COURSE TITLE | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|
| YEAR 1 | SEM 1 | Advanced Mathematics for Scientific Computing | ✓ | | ✓ | ✓ | | |
| | | Data structures and Algorithms | ✓ | | ✓ | ✓ | | |
| | | Advance Database Technology and Design | ✓ | | ✓ | ✓ | | |
| | | Networking Technologies | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | | Research Methodology and IPR | ✓ | ✓ | ✓ | | ✓ | |
| | | Audit Course – I | | | | | | |
| | | Data Structures and Algorithms Laboratory | ✓ | | ✓ | ✓ | | |

| YEAR | SEMESTER | COURSE TITLE | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|
| | | Networking Technologies Laboratory | ✓ | | ✓ | ✓ | | |
| | SEM 2 | Cloud Infrastructure & Application Management | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | | Advanced System Software | ✓ | | ✓ | ✓ | | |
| | | Machine Learning Techniques | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | | Professional Elective I | | | | | | |
| | | Professional Elective II | | | | | | |
| | | Audit Course – II | | | | | | |
| | | Machine Learning Techniques Laboratory | ✓ | | ✓ | ✓ | | ✓ |
| YEAR 2 | SEM 3 | Professional Elective –III | | | | | | |
| | | Professional Elective –IV | | | | | | |
| | | Professional Elective –V | | | | | | |
| | | Open Elective | | | | | | |
| | | Industry Orientation and Technical Seminar | | | | | | |
| | | Project Work Phase- I | | | | | | |
| | SEM 4 | Project Work Phase- II | | | | | | |

# PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

**M.E- COMPUTER SCIENCE AND ENGINEERING**

**CHOICE BASED CREDIT SYSTEM**

## CURRICULA AND SYLLABI- R 2021

### SEMESTER I

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21MA2101 | Advanced Mathematics for Scientific Computing | FC | 4 | 4 | 0 | 0 | 4 |
| 2. | 21CS2101 | Data structures and Algorithms | PCC | 3 | 3 | 0 | 0 | 3 |
| 3. | 21CS2102 | Advance Database Technology and Design | PCC | 4 | 4 | 0 | 0 | 4 |
| 4. | 21CS2103 | Networking Technologies | PCC | 3 | 3 | 0 | 0 | 3 |
| 5. | 21RM2101 | Research Methodology and IPR | RMC | 2 | 2 | 0 | 0 | 2 |
| 6. | | Audit Course – I | AC | 2 | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| 7. | 21CS2111 | Data Structures and Algorithms Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |
| 8. | 21CS2112 | Networking Technologies Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **26** | **18** | **0** | **8** | **20** |

### SEMESTER II

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21CS2201 | Cloud Infrastructure & Application Management | PCC | 3 | 3 | 0 | 0 | 3 |
| 2. | 21CS2202 | Advanced System Software | PCC | 5 | 3 | 0 | 2 | 4 |
| 3. | 21CS2203 | Machine Learning Techniques | PCC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Professional Elective I | PEC | 5 | 3 | 0 | 2 | 4 |
| 5. | | Professional Elective II | PEC | 3 | 3 | 0 | 0 | 3 |
| 6. | | Audit Course – II | AC | 2 | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | | | | |
| 7. | 21CS2211 | Machine Learning Techniques Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **25** | **17** | **0** | **08** | **19** |

**SEMESTER III**

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | | Professional Elective –III | PEC | 5 | 3 | 0 | 2 | 4 |
| 2. | | Professional Elective –IV | PEC | 3 | 3 | 0 | 0 | 3 |
| 3. | | Professional Elective –V | PEC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Open Elective | OEC | 3 | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | | | | |
| 5. | 21CS2311 | Industry Orientation and Technical Seminar | EEC | 4 | 0 | 0 | 4 | 2 |
| 6. | 21CS2312 | Project Work Phase- I | EEC | 12 | 0 | 0 | 12 | 6 |
| | | | **TOTAL** | **30** | **12** | **0** | **18** | **21** |

**SEMESTER IV**

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **PRACTICALS** | | | | | | | | |
| 1. | 21CS2411 | Project Work Phase- II | EEC | 24 | 0 | 0 | 24 | 12 |
| | | | **TOTAL** | **24** | **0** | **0** | **24** | **12** |

**TOTAL NO. OF CREDITS: 72**

## FOUNDATION COURSES (FC)

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21MA2101 | Advanced Mathematics for Scientific Computing | FC | 4 | 4 | 0 | 0 | 4 |

## PROFESSIONAL CORE COURSES (PCC)

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21CS2101 | Data Structures and Algorithms | PCC | 3 | 3 | 0 | 0 | 3 |
| 2. | 21CS2102 | Advanced Database Technology and Design | PCC | 4 | 4 | 0 | 0 | 4 |
| 3. | 21CS2103 | Networking Technologies | PCC | 3 | 3 | 0 | 0 | 3 |
| 4. | 21CS2201 | Cloud Infrastructure & Application Management | PCC | 3 | 3 | 0 | 0 | 3 |
| 5. | 21CS2202 | Advanced System Software | PCC | 5 | 3 | 0 | 2 | 4 |
| 6. | 21CS2203 | Machine Learning Techniques | PCC | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 7. | 21CS2111 | Data Structures and Algorithms Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |
| 8. | 21CS2112 | Networking Technologies Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |
| 9. | 21CS2211 | Machine Learning Techniques Laboratory | PCC | 4 | 0 | 0 | 4 | 2 |

## EMPLOYABILITY ENHANCEMENT COURSE (EEC)

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **PRACTICALS** | | | | | | | | |
| 1. | 21CS2311 | Industry Orientation and Technical Seminar | EEC | 4 | 0 | 0 | 4 | 2 |
| 2. | 21CS2312 | Project Work Phase- I | EEC | 12 | 0 | 0 | 12 | 6 |
| 3. | 21CS2411 | Project Work Phase- II | EEC | 26 | 0 | 0 | 26 | 12 |

## RESEARCH METHODOLOGY AND IPR COURSE (RMC)

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21RM2101 | Research Methodology and IPR | RMC | 2 | 2 | 0 | 0 | 2 |

## AUDIT COURSE - I

**Registration for any of these courses is optional to students**

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21AC2101 | English for Research Paper Writing | AC | 2 | 2 | 0 | 0 | 0 |
| 2. | 21AC2102 | Disaster Management | AC | 2 | 2 | 0 | 0 | 0 |
| 3. | 21AC2103 | Sanskrit for Technical Knowledge | AC | 2 | 2 | 0 | 0 | 0 |
| 4. | 21AC2104 | Value Education | AC | 2 | 2 | 0 | 0 | 0 |

## AUDIT COURSE - II

**Registration for any of these courses is optional to students**

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 5. | 21AC2201 | Constitution of India | AC | 2 | 2 | 0 | 0 | 0 |
| 6. | 21AC2202 | Pedagogy Studies | AC | 2 | 2 | 0 | 0 | 0 |
| 7. | 21AC2203 | Stress Management by Yoga | AC | 2 | 2 | 0 | 0 | 0 |
| 8. | 21AC2204 | Personality Development Through Life Enlightenment Skills | AC | 2 | 2 | 0 | 0 | 0 |

## OPEN ELECTIVE COURSES (OEC)

***(out of 6 courses one course must be selected)**

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21OE2001 | Business Data Analytics | OEC | 3 | 3 | 0 | 0 | 3 |
| 2. | 21OE2002 | Industrial Safety | OEC | 3 | 3 | 0 | 0 | 3 |
| 3. | 21OE2003 | Operations Research | OEC | 3 | 3 | 0 | 0 | 3 |
| 4. | 21OE2004 | Cost Management of Engineering Projects | OEC | 3 | 3 | 0 | 0 | 3 |
| 5. | 21OE2005 | Composite Materials | OEC | 3 | 3 | 0 | 0 | 3 |
| 6. | 21OE2006 | Waste to Energy | OEC | 3 | 3 | 0 | 0 | 3 |

## LIST OF ELECTIVES

**PROFESSIONAL ELECTIVES (PE) -** Professional Elective – I & III

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY& LAB INTEGRATED** | | | | | | | | |
| 1. | 21CS2901 | Information Security | PEC | 5 | 3 | 0 | 2 | 4 |
| 2. | 21CS2902 | Deep Learning | PEC | 5 | 3 | 0 | 2 | 4 |
| 3. | 21CS2903 | Advanced Software Engineering | PEC | 5 | 3 | 0 | 2 | 4 |
| 4. | 21CS2904 | Adhoc And Wireless Sensor Networks | PEC | 5 | 3 | 0 | 2 | 4 |
| 5. | 21CS2905 | Computer Vision | PEC | 5 | 3 | 0 | 2 | 4 |
| 6. | 21CS2906 | Bio-Metric Systems | PEC | 5 | 3 | 0 | 2 | 4 |
| 7. | 21CS2907 | Data Engineering & Visualization | PEC | 5 | 3 | 0 | 2 | 4 |
| 8. | 21CS2908 | Agile Practices | PEC | 5 | 3 | 0 | 2 | 4 |
| 9. | 21CS2909 | Network Performance Analysis | PEC | 5 | 3 | 0 | 2 | 4 |
| 10. | 21CS2910 | Bio Informatics | PEC | 5 | 3 | 0 | 2 | 4 |

**PROFESSIONAL ELECTIVES (PE) -** Professional Elective –II, IV & V

| S. No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 21CS2911 | Block chain Technologies And Applications | PEC | 3 | 3 | 0 | 0 | 3 |
| 2. | 21CS2912 | IoT Architecture and Protocols | PEC | 3 | 3 | 0 | 0 | 3 |
| 3. | 21CS2913 | Software Testing And Quality Assurance | PEC | 3 | 3 | 0 | 0 | 3 |
| 4. | 21CS2914 | Next Generation Networks | PEC | 3 | 3 | 0 | 0 | 3 |
| 5. | 21CS2915 | Computational Intelligence | PEC | 3 | 3 | 0 | 0 | 3 |
| 6. | 21CS2916 | Cyber Physical Systems | PEC | 3 | 3 | 0 | 0 | 3 |
| 7. | 21CS2917 | Information Storage Management | PEC | 3 | 3 | 0 | 0 | 3 |
| 8. | 21CS2918 | Software Reliability Metrics And Models | PEC | 3 | 3 | 0 | 0 | 3 |
| 9. | 21CS2919 | Mobile Application Development | PEC | 3 | 3 | 0 | 0 | 3 |
| 10. | 21CS2920 | Natural Language Processing | PEC | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11. | 21CS2921 | Digital Forensics | PEC | 3 | 3 | 0 | 0 | 3 |
| 12. | 21CS2922 | Open Source Programming | PEC | 3 | 3 | 0 | 0 | 3 |
| 13. | 21CS2923 | Software Agents | PEC | 3 | 3 | 0 | 0 | 3 |
| 14. | 21CS2924 | High Performance Computing | PEC | 3 | 3 | 0 | 0 | 3 |
| 15. | 21CS2925 | E Learning Technologies | PEC | 3 | 3 | 0 | 0 | 3 |

## CREDIT DISTRIBUTION

| S.No | Subject Area | Credits Per Semester | | | | Credits Total | % |
|---|---|---|---|---|---|---|---|
| | Semester | I | II | III | IV | | |
| 1. | Professional Core (PCC) | 14 | 12 | - | - | 26 | 36 |
| 2. | Research Methodology And IPR Course (RMC) | 2 | - | - | - | 2 | 3 |
| 3. | Professional Electives (PEC) | - | 7 | 10 | - | 17 | 24 |
| 4. | Open Electives (OE) | - | - | 3 | - | 3 | 4 |
| 5. | Foundation Courses (FC) | 4 | - | - | - | 4 | 5 |
| 6. | Employability Enhancement Course (EEC) | - | - | 8 | 12 | 20 | 28 |
| 7. | Audit Courses (AC) | 0 | 0 | - | - | 0 | 0 |
| | **TOTAL** | **20** | **19** | **21** | **12** | **72** | **100** |

## SEMESTER I

| 21MA2101 | ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 4 | 0 | 0 | 4 |

**OBJECTIVES:**

1. To apply mathematical linear programming techniques to solve constrained problems.
2. To appreciate the use of simulation techniques.
3. To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives
4. To give an idea of testing the statistical hypothesis claimed based on a set of data points using standard sampling distributions.
5. To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

**UNIT I** **LINEAR PROGRAMMING** **12**

Formulation – Graphical solution – Simplex method – Two phase method –Transportation, Travelling Salesman Problem and Assignment Problems.

**UNIT II** **SIMULATION** **12**

Discrete Event Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to real time problems.

**UNIT III** **ESTIMATION THEORY** **12**

Estimators- Unbiasedness, consistency, efficiency, sufficiency – Method of moments – Maximum likelihood estimation.

**UNIT IV** **TESTING OF HYPOTHESIS** **12**

Sampling distributions – Estimation of parameters – Statistical hypothesis Tests based on Normal, t, Chi-square and F distributions for mean, variance and proportion, 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 : 60 PERIODS**

**OUTCOMES:**

1. Formulate and find optimal solution in the real life optimizing/allocation/assignment problems involving conditions and resource constraints.
2. Simulate appropriate application/distribution problems.
3. Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
4. Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.
5. Get exposure to the principal component analysis of random vectors and matrices

**REFERENCE BOOKS:**


1. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, Boston, 2016.
2. Johnson, R.A, Irwin Miller and John Freund., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, 9th Edition, New York, 2016.
3. Johnson, R.A., and Wichern, D.W., "Applied Multivariate Statistical Analysis", Pearson Education, Sixth Edition, New Delhi, 2013.
4. Ross. S.M., "Probability Models for Computer Science", Academic Press, SanDiego, 2002.
5. Taha H.A.,, "Operations Research: An Introduction", Prentice Hall of India Pvt. Ltd. 10th Edition, New Delhi, 2017. 6. Winston, W.L., "Operations Research", Thomson – Brooks/Cole, Fourth Edition, Belmont, 2003.
6. K.Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Wiley
7. V. Balakrishnan, Schaum's Outlines of Combinatorics, TMH
8. Mansih Sharma & Amit Gupta, The Practice of Business Statistics, KPH,New Delhi

| 21CS2101 | DATA STRUCTURES AND ALGORITHMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To enhance the students' understanding of algorithms and data structures.
2. To augment their proficiency in algorithmic analysis and algorithm design procedures.
3. To comprehend various types of search and heap structures.
4. To learn various types of geometric, randomized and approximation algorithms.
5. To infer and apply those algorithms and techniques to solve problems

**UNIT I** **FUNDAMENTALS** **9**

Properties of Big-oh Notation –Conditional Asymptotic Notation – Algorithm Analysis – Amortized Analysis – Introduction to NP-Completeness/NP-Hard – Recurrence Equations – Solving Recurrence Equations – Time-Space Trade off.

**UNIT II** **SEARCH STRUCTURES** **9**

Binary Search Trees – AVL Trees – Red-Black trees – Multi-way Search Trees –B-Trees – Splay Trees – Tries.

**UNIT III** **HEAP STRUCTURES** **9**

Min/Max heaps – Heaps – Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Skew Heaps – Lazy Binomial Heaps

**UNIT IV** **GEOMETRIC ALGORITHMS** **9**

Segment Trees – 1-Dimensional Range Searching – k-d Trees – Line Segment Intersection – Computing the Overlay of Two Subdivisions – Range Trees – Voronoi Diagram

**UNIT V** **ADVANCE TOPICS** **9**

Approximation Algorithms: Vertex Cover & Euclidean Travelling Salesperson Problem – Randomized Algorithms: Closest Pair Problem & Minimum Spanning Trees – Online Algorithm: Euclidean Spanning Tree.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Examine algorithms.
2. Define algorithm correctness
3. Choose appropriate data structures for the problems to be solved
4. Design algorithms for problems from different domains
5. Identify various research approaches on algorithmic design.

**REFERENCE BOOKS:**


1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", Second Edition, University Press, 2008.
2. Gilles Brassard, Paul Bratley, "Algorithmics: Theory and Practice", Prentice Hall, 1988.
3. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, "Computational Geometry Algorithms and Applications", Third Edition, Springer, 2008.
4. R.C.T Lee, S.S Tseng, R.C Chang and Y.T Tsai, "Introduction to the Design and Analysis of Algorithms", Tata McGraw-Hill Edition, 2012.
5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", MIT Press, 2009.


**WEB REFERENCES**

1. https://visualgo.net/en
2. http://cse01-iiith.vlabs.ac.in/

**ONLINE COURSES / RESOURCES:**

1. https://www.udemy.com/course/advanced-algorithms-python
2. https://onlinecourses.nptel.ac.in/noc21_cs21/preview

| 21CS2102 | ADVANCED DATABASE TECHNOLOGY AND DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 4 | 0 | 0 | 4 |

**OBJECTIVES:**

1. To comprehend the underlying principles of Relational Database Management System.
2. To develop database models using parallel and distributed databases.
3. To understand the concepts of XML and Web databases.
4. To apprehend the design and implementation of active temporal and deductive databases.
5. To develop applications based on NoSQL database.

**UNIT I RELATIONAL MODEL 12**

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language-Database Normalization – Transaction Management- Concurrency control – Recovery

**UNIT II CONTROL FLOW, STRINGS & FUNCTPARALLEL AND DISTRIBUTED DATABASES 12**

Parallel Databases– I/O Parallelism– Inter-Query and Intra-Query Parallelism– Inter-Operation and Intra-operation Parallelism – Performance evaluation for Parallel DB Systems – Distributed Database Architecture-Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Load balancing tools for DDB – DDB Security.

**UNIT III XML AND WEB DATABASES 12**

XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity-Java Database Connectivity–Accessing Relational database using PHP – User Driven Querying – Writing to Web Databases – Session Management.

**UNIT IV ACTIVE TEMPORAL AND DEDUCTIVE DATABASES 12**

Event Condition Action Model – Design and Implementation Issues for Active Databases – Termination, Confluence, Determination and Modularization – Temporal Databases –Interpreting Time in Relational Databases – Deductive Databases – Datalog Queries

**UNIT V NoSQL DATABASES 12**

NoSQL database vs traditional RDBMS database – Migrating from RDBMS to NoSQL– CRUD operations – Querying NoSQL stores – Indexing and Ordering Datasets – MongoDB-Database creation and Querying– Web Application development using MongoDB

**TOTAL : 60 PERIODS**

**OUTCOMES:**

1. Design and implement relational databases.
2. Design and implement parallel and distributed databases.
3. Design and implement XML databases, Active, Temporal and Deductive databases.
4. Implement the concept of database connectivity with the applications.
5. Design and implement NoSQL database.

**REFERENCE BOOKS:**


1. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Sixth Edition, McGraw Hill, 2011.
2. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, Pearson Education, 2007.
3. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Addison-Wesley, 2011.
4. Shashank Tiwari, "Professional NoSQL", Wiley, 2011.
5. Han, Jiawei, Jian Pei, and MichelineKamber. Data mining: Concepts and Techniques. 2011.
6. C. J. Date, A.Kannan and S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
7. V.S.Subramanian, "Principles of Multimedia Database Systems", Harcourt India Pvt. Ltd.,2001.
8. David Lane, Hugh.E.Williums, Web Database Applications with PHP and MySQL, O'Reilly Media; 2nd edition, 2004
9. Fundamentals of Database Management System, Learn Essential Concepts of Database Systems, Mukesh Negi ,2019
10. A Deep Dive Into NoSQL Databases: The Use Cases and Applications, Ganesh Chandra Deka, 2018


**WEB REFERENCES**

1. https://www.db-book.com
2. https://www.pearsoned.co.in/prc/book/thomas-m-connolly-database-systems-practical-approach-design-implementation-management-4e--4/9788131720257
3. https://www.wiley.com/en-us/Professional+NoSQL-p-9780470942246

**ONLINE COURSES / RESOURCES:**

1. https://www.udemy.com/course/advanced-mysql-database-administration-dba/
2. https://www.udemy.com/course/learn-mongodb-leading-nosql-database-from-scratch/
3. https://www.udemy.com/course/creating-and-querying-databases-with-nosql-and-sql/
4. https://nptel.ac.in/courses/106/106/106106095/

| 21CS2103 | NETWORKING TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To learn about integrated and differentiated services architectures and design implications.
2. To understand the working of wireless network protocols.
3. To study about network security applications.
4. To get familiarized with next generation networks.
5. To know the concepts behind software defined networks.

**UNIT I NETWORK ARCHITECTURE AND QoS 9**

Overview of TCP/IP Network Architecture – Integrated Services Architecture – Approach – Components – Services – Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services

**UNIT II WIRELESS NETWORKS 9**

IEEE 802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX – 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – LiFi – Protocol Stack – Security – Profiles.

**UNIT III CELLULAR NETWORKS 9**

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN – Core and Radio Network Mobility Management – UMTS Security

**UNIT IV 4G NETWORKS 9**

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks –Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) – 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G& XG networks..

**UNIT V SOFTWARE DEFINED NETWORKS 9**

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Identify the different features of integrated and differentiated services.
2. Demonstrate various protocols of wireless networks.
3. Analyze the use of next generation networks.
4. Provide solutions using SDN.
5. Design protocols for cellular networks

**REFERENCE BOOKS:**


1. William Stallings, "High Speed Networks and Internets: Performance and Quality of Service", Prentice Hall, Second Edition, 2002.
2. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2014.
3. Savo G Glisic, "Advanced Wireless Networks – 4G Technologies", John Wiley & Sons, 2007.
4. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
5. WiMAX, IMS, 4G Devices and the Mobile Web 2.0", Wiley, 2009.
6. Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, "Next-Generation Wireless
7. Technologies", Springer, 2013.
8. William Stallings, Network Security Essentials: Applications And Standards Fourth Edition Prentice Hall, ISBN 13: 978-0-13-610805-4
9. Software-Defined Networks: A Systems Approach Paperback –by Larry Peterson, Carmelo Cascone, Bruce Davie , 2021.


**WEB REFERENCES**

1. https://flylib.com/books/en/2.145.1/
2. https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML12163A047
3. https://nptel.ac.in/courses/10610503

**ONLINE COURSES / RESOURCES:**

1. https://www.coursera.org/specializations/computer-network-security
2. https://www.coursera.org/specializations/applied-crypto
3. https://www.coursera.org/learn/tcpip
4. https://www.coursera.org/learn/design-secure-networked-systems

| 21RM2101 | RESEARCH METHODOLOGY AND IPR | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**OBJECTIVES:**

1. To impart knowledge and skills required for research and IPR:
2. Problem formulation, analysis and solutions.
3. Technical paper writing / presentation without violating professional ethics
4. Patent drafting and filing patents.

**UNIT I** **RESEARCH PROBLEM FORMULATION** **6**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

**UNIT II** **LITERATURE REVIEW** **6**

Effective literature studies approaches, analysis, Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis-plagiarism, and research ethics

**UNIT III** **TECHNICAL WRITING** **6**

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes- Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

**UNIT IV** **INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)** **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**UNIT V** **INTELLECTUAL PROPERTY RIGHTS (IPR)** **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that the future belongs to those who evolve by ideas, concept, and creativity along with technology
5. Ability to understand about IPR and filing patents in R & D.

**REFERENCE BOOKS:**


1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd., 2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010
6. Research Methodology A Practical and Scientific Approach, Vinayak Bairagi, Mousami V. Munot 2019.
7. Research Methodology and Scientific Writing By C. George Thomas · 2021


**WEB REFERENCES**

**1.** https://www.wipo.int/patents/en/

**2.** https://ipindia.gov.in/patents.htm

| 21CS2111 | DATA STRUCTURES AND ALGORITHMS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

1. To acquire the knowledge of using data structures and algorithmic complexity analysis.
2. To learn the usage of heap structures.
3. To understand the usage of graph structures and spanning trees.

**List of experiments**

**Implement the following programs using C/ Python:**

1. Iterative and recursive algorithms and its complexity analysis.
2. Merge sort algorithm analysis using divide and conquer approach.
3. Quick sort algorithm using randomized algorithmic approach.
4. Matrix chain multiplication using dynamic programming approach.
5. Activity selection and Huffman coding using greedy approach.
6. Binary search tree and a Red-Black tree.
7. Basic heaps operations.
8. A spanning tree for a given graph using Prim's algorithm.
9. Shortest path of a given graph using Dijkstra's algorithm and Bellman Ford algorithm.
10. All pair shortest path of a given graph using Floyd Warshall's algorithm.

**TOTAL: 60 PERIODS**

**OUTCOMES**

1. Achieve programming skill to convert a problem to a programming logic.
2. Apply suitable data structure for the problem in hand.
3. Apply divide and conquer technique.
4. Apply Dynamic programming

| 21CS2112 | NETWORKING TECHNOLOGIES LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

1. To develop network utilities
2. To design and configure LANs
3. To study the various network-based tools for network monitoring and analysis .

**List of experiments**

1. Configure networks using:
    1. Distance Vector Routing protocol
    2. Link State Vector Routing protocol
2. Implement the congestion control using Leaky bucket algorithm.
3. Installation of NS3 and execution of TCL commands / scripts.
4. Implementation Point to Point network using duplex links between the nodes. Analyze the packet transfer by varying the queue size and bandwidth. (using simulator)
5. Implement the dynamic routing protocol by varying the CBR traffic for each node and use a flow monitor ( ) to monitor losses at nodes. (using simulator)
6. Create a wireless mobile ad-hoc network environment and implement the OLSR routing protocol. (using simulator)
7. Implement CDMA by assigning orthogonal code sequence for 5 stations, generate the CDMA code sequence and communicate between the stations using the generated code.
8. Create a GSM environment and implement inter and intra handover mechanisms. (using simulator)
9. In LTE environment implement Round Robin and Token Bank Fair Queue scheduler in MAC layer.
10. Write python script to create topology in Mininet and configure OpenFlow switches with POX controller to communicate between nodes

**TOTAL: 60 PERIODS**

**OUTCOMES:**

1. Judge the emerging wireless technology standards.
2. Configure functionalities of router and switches.
3. Assess the importance of wireless adhoc networks.
4. Compare and contrast various wireless technologies.
5. Explain and design the considerations for deploying wireless network infrastructure.

## SEMESTER II

| 21CS2201 | CLOUD INFRASTRUCTURE AND APPLICATION MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the concept of cloud and utility computing.
2. To familiarize themselves with the lead players in cloud.
3. To enable student to develop and launch applications in the cloud Environment.
4. To understand the various frameworks and APIs that can be used for developing cloud based applications.
5. To use Cloud application management and management tools are used to analyse digital service ecosystems and digital product life-cycles.

**UNIT I INTRODUCTION 9**

Introduction- Historical Development – Cloud Computing Architecture – The Cloud Reference Model – Cloud Characteristics –Cloud Deployment Models: Public, Private, Community, Hybrid Clouds- Cloud Delivery Models: IaaS, PaaS, SaaS – Open Source Private Cloud Software: Eucalyptus, Open Nebula, Open Stack.

**UNIT II VIRTUALIZATION 9**

Data Center Technology – Virtualization – Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques – Virtualization and Cloud Computing –Pros and Cons of Virtualization – Implementation Levels of Virtualization – Tools and Mechanisms: Xen, VMWare, Microsoft Hyper-V, KVM, Virtual Box.

**UNIT III CLOUD COMPUTING MECHANISM 9**

Cloud Infrastructure Mechanism: Cloud Storage, Cloud Usage Monitor, Resource Replication – Specialized Cloud Mechanism: Load Balancer, SLA Monitor, Pay-per-use Monitor, Audit Monitor, Failover System, Hypervisor, Resource Cluster, Multi Device Broker, State Management Database – Cloud Management Mechanism: Remote Administration System, Resource Management System, SLA Management System, Billing Management System.

**UNIT IV CLOUD SECURITY 9**

Basic Terms and Concepts – Threat Agents – Cloud Security Threats –Cloud Security Mechanism: Encryption, Hashing, Digital Signature, Public Key Infrastructure, Identity and Access Management, Single Sign-on, Cloud Based Security Groups, Hardened Virtual Server Images.

**UNIT V CLOUD APPLICATIONS DEVELOPMENT 9**

Best practices in architecture cloud applications in AWS cloud, Amazon Simple Queue Service (SQS), RabbitMQ, Amazon Simple Notification Service (Amazon SNS), multi-player online game hosting on cloud resources, Building content delivery networks using clouds. Service creation environments to develop cloud based applications. Development environments for service development; Amazon, Azure, Google App.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Design, Develop & Deploy real-world applications in the cloud computing platforms they have learnt.
2. Demonstrate the ability to access the various cloud platforms used.
3. Describe the standardization process of cloud platform and various API's
4. Describe the methods for managing the data in cloud and secure the data in the cloud platform.

**REFERENCE BOOKS:**


1. Thomas Erl, Zaigham Mahood, Ricardo Puttini, "Cloud Computing, Concept, Technology & Architecture", Prentice Hall, 2013.
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw-Hill,2013.
3. Toby Velte, Anthony Velte, Robert C. Elsenpeter, "Cloud Computing, A Practical Approach",Tata McGraw-Hill Edition, 2010.
4. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud (Theory in Practice)", O'Reilly, 2009.
5. ArshdeepBahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", Universities Press(India) Private Limited, 2014.
6. James E Smith and Ravi Nair, "Virtual Machines", Elsevier, 2005.
7. John Rittinghouse& James Ransome, "Cloud Computing, Implementation, Management and Strategy", CRC Press, 2010.
8. Barrie Sosinsky, " Cloud Computing Bible" John Wiley & Sons, 2010


**WEB REFERENCES**

1. https://cloud.google.com/appengine/docs
2. https://www.chef.io/solutions/cloud-management/
3. https://aws.amazon.com/documentation

**ONLINE COURSES / RESOURCES:**

1. https://dev.twitter.com/overview/documentation
2. https://developers.facebook.com/
3. https://www.cloudfoundry.org/

| 21CS2202 | ADVANCED SYSTEM SOFTWARE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To Learn the basic concepts of compilers and device drivers.
2. To Study symbol table structure and intermediate code optimization techniques.
3. To Understand memory optimization and code sharing.
4. To Understand virtual machine concept.
5. To Learn emulation techniques and binary translations.

**UNIT I INTRODUCTION TO ADVANCED SYSTEM SOFTWARE 9+6**

Basic Compiler Functions – Grammars – Lexical Analysis – Syntactic Analysis – Code Generation – Heap Management – Parameter Passing Methods – Semantics of Calls and Returns – Implementing Subprograms – Stack Dynamic Local Variables – Dynamic binding of method calls to methods – Overview of Memory Management, Virtual Memory, Process Creation – Overview of I/O Systems, Device Drivers, System Boot

**UNIT II SYMBOL TABLE MANAGEMENT AND INTERMEDIATE CODE 9+6**

Introduction and Overview – Symbol table structure – Local and Global Symbol table management Intermediate representation – Issues – High level, medium level, low level intermediate languages – MIR, HIR, LIR – ICAN for Intermediate code – Optimization – Early optimization – loop optimization

**UNIT III CODE OPTIMIZATION 9+6**

Procedure optimization – in-line expansion – leaf routine optimization and shrink wrapping –register allocation and assignment – graph coloring – data flow analysis – constant propagation – alias analysis – register allocation – global references – Optimization for memory hierarchy -Code Scheduling – Instruction scheduling – Speculative scheduling – Software pipelining –trace scheduling – Run-time support – Register usage – local stack frame – run-time stack –Code sharing – position–independent code

**UNIT IV VIRTUAL MACHINE 9+6**

Introduction to Virtual Machines (VM) – Pascal P-Code VM – Object-Oriented VMs – Java VM Architecture – Common Language Infrastructure – Dynamic Class Loading – Security –Garbage Collection – Optimization

**UNIT V EMULATION AND BINARY TRANSLATION 9+6**

Emulation – Interpretation and Binary Translation – Instruction Set Issues – Process Virtual Machines – Profiling – Migration – Grids – Examples of real world implementations of system software

**LIST OF EXERCISES**

1. Implementation of Token Separation.
2. Implementation of Symbol table Manipulation
3. Implementation of pass one of Two pass Assembler
4. Implementation of pass Two of Two pass Assembler
5. Implementation of one pass Assembler
6. Simulation of absolute loader
7. Simulation of Linking Loader
8. Implementation of Macro Substitution
9. Design of Editor
10. Write a program to create Dynamic Link Library for any mathematical operation and write an application program to test it. (Java Native Interface / Use VB or VC++).
11. Program to design a DFA(Deterministic Finite Automaton) for string generation
    **Software Requirements: Latest JDK., Eclipse / VB or VC++**

**TOTAL : 45+30 PERIODS**

**OUTCOMES:**

1. Explain fundamental concepts of compilers.
2. Construct symbol table.
3. Implement various optimization techniques.
4. Design Virtual machine
5. Develop small compiler and device drivers.

**REFERENCE BOOKS:**


1. Writing A Compiler In Go by Thorsten Ball July 2018
2. A Practical Approach to Compiler Construction (Undergraduate Topics in Computer Science) 1st ed. 2017 Edition by Des Watson
3. Notes on compiler design by Albert Desouza April 2017.
4. Compiler Design: by Knowledge flow Mar 31, 2015
5. Compiler Construction by K.V.N SUNITHA Jun 1, 2013
6. V. Raghavan, Principles of Compiler Design, McGrawHill, 2010
7. Robert W. Sebesta, "Concepts of Programming Languages", 8 th, Pearson Education, 2009.
8. Writing Compilers and Interpreters: A Software Engineering Approach 3rd Edition, by Ronald Mak


**ONLINE COURSES / RESOURCES:**

1. http://cis2.oc.ctc.edu/oc_apps/Westlund/xbook/xbook.php?UNIT=11&proc=book
2. http://tutorials.jenkov.com/java-reflection/dynamic-class-loading-reloading.html

| 21CS2203 | MACHINE LEARNING TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To grasp the fundamental concepts of Machine Learning.
2. To understand supervised learning and their applications.
3. To appreciate the concepts and algorithms of unsupervised learning.
4. To study applications of machine learning in real world domains

**UNIT I INTRODUCTION 9**

Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning-Probability theory – Probability Distributions – Decision Theory

**UNIT II SUPERVISED LEARNING 9**

Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines.

**UNIT III UNSUPERVISED LEARNING 9**

Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis

**UNIT IV ADVANCED LEARNING 9**

Sampling-Basic Sampling methods, Monte Carlo, Gibbs Sampling – Computational Learning Theory – Mistake Bound Analysis – Reinforcement learning – Markov Decision processes, Deterministic and Non-deterministic Rewards and Actions, Temporal Difference Learning Exploration.

**UNIT V APPLICATIONS 9**

Image fusion-object recognition-speech analysis-text document clustering-handwritten digit recognition-image segmentation-spam email classification

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Design a learning model appropriate to the application
2. Design a Neural Network for an application of your choice.
3. Use a tool to implement typical Clustering algorithms for different types of applications.
4. Identify applications suitable for different types of Machine Learning with suitable justification.

**REFERENCE BOOKS:**


1. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition, 2014.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
4. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
5. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.

| 21CS2211 | MACHINE LEARNING TECHNIQUESLABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

1. To apply the concepts of Machine Learning to solve real-world problems
2. To implement basic algorithms in clustering & classification applied to text & numeric data
3. To implement algorithms emphasizing the use of bagging & boosting in classification & regression
4. To implement algorithms related to dimensionality reduction

**List of experiments**

1. Solving Regression & Classification using Decision Trees
2. Root Node Attribute Selection for Decision Trees using Information Gain
3. Bayesian Inference in Gene Expression Analysis
4. Pattern Recognition Application using Bayesian Inference
5. Bagging, Boosting applications using Regression Trees
6. Data & Text Classification using Neural Networks
7. Using Weka tool for SVM classification for chosen domain application
8. Data & Text Clustering using K-means algorithm
9. Data & Text Clustering using Gaussian Mixture Models
10. Dimensionality Reduction Algorithms in Image Processing applications

**TOTAL: 60 PERIODS**

**OUTCOMES**

1. To learn to use Weka tool for implementing machine learning algorithms related to numeric data
2. To learn the application of machine learning algorithms for text data
3. To use dimensionality reduction algorithms for image processing applications
4. To use fundamental and advanced neural network algorithms for solving real-world data

| 21CS2311 | INDUSTRY ORIENTATION AND TECHNICAL SEMINAR | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

In this course, students will approach the industry and undergo training for a period of minimum four weeks and present a report. They will also develop their scientific and technical reading and writing skills that they need to understand and construct research articles individually. A research paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation
10. Publish their work in standard journals / conferences.

Based on the below mentioned concepts students will explore and perform critical analysis from various resources in the research domains and publish their work in standard journals / conferences.

**INTERNAL ASSESSMENT ONLY**

**TOTAL: 30 PERIODS**

## AUDIT COURSES

| 21AC2101 | ENGLISH FOR RESEARCH PAPER WRITING | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. Teach how to improve writing skills and level of readability
2. Tell about what to write in each section
3. Summarize the skills needed when writing a Title
4. Infer the skills needed when writing the Conclusion
5. Ensure the quality of paper at very first-time submission

**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 : 30 PERIODS**

**OUTCOMES:**

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title.
4. Understand the skills needed when writing the Conclusion.
5. Ensure the good quality of paper at very first-time submission.

**REFERENCE BOOKS:**


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 book1998

| 21AC2102 | DISASTER MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

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

**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 ASSESSMENT 6**

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 : 30 PERIODS**

**OUTCOMES:**

1. Ability to summarize basics of disaster.
2. Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3. Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4. Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
5. Ability to develop the strengths and weaknesses of disaster management approaches.

**REFERENCE BOOKS:**


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

| 21AC2103 | SANSKRIT FOR TECHNICAL KNOWLEDGE | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. Illustrate the basic sanskrit language.
2. Recognize sanskrit, the scientific language in the world.
3. Appraise learning of sanskrit to improve brain functioning.
4. Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
5. Extract huge knowledge from ancient literature.

**UNIT I** **ALPHABETS** **6**

Alphabets in Sanskrit

**UNIT II** **TENSES AND SENTENCES** **6**

Past/Present/Future Tense - Simple Sentences

**UNIT III** **ORDER AND ROOTS** **6**

Order - Introduction of roots

**UNIT IV** **SANSKRIT LITERATURE** **6**

Technical information about Sanskrit Literature

**UNIT V** **TECHNICAL CONCEPTS OF ENGINEERING** **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Understanding basic Sanskrit language.
2. Write sentences.
3. Know the order and roots of Sanskrit.
4. Know about technical information about Sanskrit literature.
5. Understand the technical concepts of Engineering

**REFERENCE BOOKS:**


1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

| 21AC2104 | VALUE EDUCATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. Understand value of education and self-development
2. Imbibe good values in students
3. Let the should know about the importance of character

**UNIT I** **SELF-DEVELOPMENT** **6**

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgments.

**UNIT II** **IMPORTANCE OF HUMAN VALUES** **6**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT III** **OVERALL PERSONALITY IMPROVEMENT** **6**

Personality and Behaviour Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship.

**UNIT IV** **BEHAVIOR DEVELOPMENT** **6**

Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature- Character and Competence–Holy books vs Blind faith.

**UNIT V** **DEVELOPING GOOD HEALTH** **6**

Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Knowledge of self-development.
2. Learn the importance of Human values..
3. Developing the overall personality
4. Developing the Behavior.
5. Developing Good health.

**REFERENCE BOOKS:**

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

| 21AC2201 | CONSTITUTION OF INDIA | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
3. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism
4. To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

**UNIT I** **HISTORY OF MAKING OF THE INDIAN CONSTITUTION AND PHILOSOPHY OF THE INDIAN CONSTITUTION** **6**

History, Drafting Committee, (Composition & Working) -Preamble, Salient Features.

**UNIT II** **CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES** **6**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT III** **ORGANS OF GOVERNANCE** **6**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT IV** **LOCAL ADMINISTRATION** **6**

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT V** **ELECTION COMMISSION** **6**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization
3. Learning of social reforms leading to revolution in India
4. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
5. Discuss the passage of the Hindu Code Bill of 1956.

**REFERENCE BOOKS:**


1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

| 21AC2202 | PEDAGOGY STUDIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. Review existing evidence on their view topic to inform program design and policy
2. Making under taken by the DfID, other agencies and researchers
3. Identify critical evidence gaps to guide the development.

**UNIT I INTRODUCTION AND METHODOLOGY 6**

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

**UNIT II THEMATIC OVERVIEW 6**

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

**UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 6**

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT IV PROFESSIONAL DEVELOPMENT 6**

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

**UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS 6**

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in
3. What conditions, and with what population of learners?
4. How can teacher education (curriculum and practicum) and the school
5. Curriculum and guidance materials best support effective pedagogy

**REFERENCE BOOKS:**


1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

| 21AC2203 | STRESS MANAGEMENT BY YOGA | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. To achieve overall health of body and mind
2. To overcome stress

**UNIT I ASHTANGA 10**

Definitions of Eight parts of yoga.(Ashtanga)

**UNIT II YAM AND NIYAM 10**

Yam and Niyam - Do`s and Don't's in life – Ahinsa, satya, astheya, bramhacharya and aparigraha, Ahinsa, satya, astheya, bramhacharya and aparigraha.

**UNIT III ASAN AND PRANAYAM 10**

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam.

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve Efficiency.

**REFERENCE BOOKS:**


1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

| 21AC2204 | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**OBJECTIVES:**

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination .
3. To awaken wisdom in students

**UNIT I NEETISATAKAM 10**

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

**UNIT II APPROACH TO DAY TO DAY WORK AND DUTIES 10**

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

**UNIT III STATEMENTS OF BASIC KNOWLEDGE 10**

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

**TOTAL : 30 PERIODS**

**OUTCOMES:**

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students

**REFERENCE BOOKS:**


1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010.
2. Swami Swarupananda, Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

## OPEN ELECTIVES

| 21OE2001 | BUSINESS DATA ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the basics of business analytics and its life cycle.
2. To gain knowledge about fundamental business analytics.
3. To learn modelling for uncertainty and statistical inference.
4. To understand analytics using Hadoop and Map Reduce frameworks.
5. To acquire insight on other analytical frameworks

**UNIT I OVERVIEW OF BUSINESS ANALYTICS 9**

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

**UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9**

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

**UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9**

Modelling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

**UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9**

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

**UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9**

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Identify the real world business problems and model with analytical solutions.
2. Solve analytical problem with relevant mathematics background knowledge.
3. Convert any real world decision making problem to hypothesis and apply suitable statistical testing
4. Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
5. Use open source frameworks for modelling and storing data.
6. Apply suitable visualization technique using R for visualizing voluminous data.

**REFERENCE BOOKS:**


1. VigneshPrajapati, "Big Data Analytics with R and Hadoop", Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, "Business Analytics Using R – A Practical Approach", Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, "Essentials of Business Analytics", Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley, 2017.
6. Ohri, "R for Business Analytics", Springer, 2012
7. Rui Miguel Forte, "Mastering Predictive Analytics with R", Packt Publication, 2015

| 21OE2002 | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Summarize basics of industrial safety
2. Describe fundamentals of maintenance engineering
3. Explain wear and corrosion
4. Illustrate fault tracing
5. Identify preventive and periodic maintenance

**UNIT I INTRODUCTION 9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods

**UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**UNIT IV FAULT TRACING 9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes

**UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Ability to summarize basics of industrial safety
2. Ability to describe fundamentals of maintenance engineering
3. Ability to explain wear and corrosion
4. Ability to illustrate fault tracing
5. Ability to identify preventive and periodic maintenance

**REFERENCE BOOKS:**


1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

| 21OE2003 | OPERATIONS RESEARCH | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Solve linear programming problem and solve using graphical method.
2. Solve LPP using simplex method
3. Solve transportation, assignment problems
4. Solve project management problems
5. Solve scheduling problems

**UNIT I LINEAR PROGRAMMING 9**

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

**UNIT II ADVANCES IN LINEAR PROGRAMMING 9**

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

**UNIT III NETWORK ANALYSIS – I 9**

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

**UNIT IV NETWORK ANALYSIS – II 9**

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

**UNIT V NETWORK ANALYSIS – III 9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. To formulate linear programming problem and solve using graphical method
2. To solve LPP using simplex method
3. To formulate and solve transportation, assignment problems
4. To solve project management problems
5. To solve scheduling problems

**REFERENCE BOOKS:**


1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

| 21OE2004 | COST MANAGEMENT OF ENGINEERING PROJECTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Summarize the costing concepts and their role in decision making
2. Infer the project management concepts and their various aspects in selection
3. Interpret costing concepts with project execution
4. Develop knowledge of costing techniques in service sector and various budgetary control techniques
5. Illustrate with quantitative techniques in cost management

**UNIT I INTRODUCTION TOCOSTINGCONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

**UNIT II INTRODUCTION TOPROJECTMANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

**UNIT III PROJECT EXECUTION ANDCOSTINGCONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETARY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity- Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Understand the costing concepts and their role in decision making.
2. Understand the project management concepts and their various aspects in selection
3. Interpret costing concepts with project execution
4. Gain knowledge of costing techniques in service sector and various budgetary control techniques
5. Become familiar with quantitative techniques in cost management

**REFERENCE BOOKS:**


1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A.H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting,1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi,2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting,2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd,2007

| 21OE2005 | COMPOSITE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
2. Identify the various reinforcements used in composite materials.
3. Compare the manufacturing process of metal matrix composites.
4. Understand the manufacturing processes of polymer matrix composites.
5. Analyze the strength of composite materials

**UNIT I INTRODUCTION 9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance

**UNIT II REINFORCEMENTS 9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

**UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications

**UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

**UNIT V STRENGTH 9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Know the characteristics of composite materials and effect of reinforcement in composite materials.
2. Know the various reinforcements used in composite materials.
3. Understand the manufacturing processes of metal matrix composites.
4. Understand the manufacturing processes of polymer matrix composites.
5. Analyze the strength of composite materials

**REFERENCE BOOKS:**


1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

| 21OE2006 | WASTE TO ENERGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Interpret the various types of wastes from which energy can be generated
2. Develop knowledge on biomass pyrolysis process and its applications
3. Develop knowledge on various types of biomass gasifiers and their operations
4. Invent knowledge on biomass combustors and its applications on generating energy
5. Summarize the principles of bio-energy systems and their features

**UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9**

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

**UNIT II BIOMASS PYROLYSIS 9**

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**UNIT III BIOMASS GASIFICATION 9**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT IV BIOMASS COMBUSTION 9**

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT V BIOENERGY 9**

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Understand the various types of wastes from which energy can be generated
2. Gain knowledge on biomass pyrolysis process and its applications
3. Develop knowledge on various types of biomass gasifiers and their operations
4. Gain knowledge on biomass combustors and its applications on generating energy
5. Understand the principles of bio-energy systems and their features

**REFERENCE BOOKS:**


1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd.,1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons,1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd.,1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd.,1990.

## ELECTIVE LIST

### PROFESSIONAL ELECTIVES I & III

| 21CS2901 | INFORMATION SECURITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To learn the core fundamentals of system security concepts
2. To identify the threats to the network of computers.
3. To understand the ways of sharing and storing of files in controlled manner.
4. To deploy the security essentials in the IT sectors.
5. To perform a detailed study of Storage security and related Issues.
6. To be exposed to the concept of database security.

**UNIT I SYSTEM SECURITY 9+6**

Building a secure organization- A Cryptography primer- detecting system Intrusion- Preventing system Intrusion- Fault tolerance and Resilience in cloud computing environments- Security web applications, services and servers

**UNIT II NETWORK SECURITY 9+6**

Internet Security - Botnet Problem- Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security- Optical Network Security- Optical wireless Security

**UNIT III OPERATING SYSTEM AND FILE SECURITY 9+6**

Process Protection. Controlling Files. The File System - Executable Files and Malware - Sharing and Protecting Files - Security Controls for Files - File Security Controls - Patching Security Flaws. Sharing Files. Controlled Sharing - File Permission Flags.

**UNIT IV SECURITY MANAGEMENT 9+6**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System - Intrusion and Detection and Prevention System

**UNIT V STORAGE SECURITY 9+6**

Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials. Issues in Database Security - Fundamentals of Access Control - Database Access Control - Using Views for Access Control - Security Logs and Audit Trails - Encryption - SQL Data Control Language - Security in Oracle - Statistical Database Security - SQL Injection -Database Security and the Internet.

**PRACTICAL EXERCISES**

1. Implement DES Encryption and Decryption
2. Implement the AES Encryption and decryption
3. Implement RSA Encryption Algorithm
4. Create a virtual private network over WAN
5. Implement ICMP PING
6. Implement SUBNETTING
7. Implement RIP routing protocol to create timed link failures and recoveries.
8. Implement OSPF for load balancing
9. Implement XSS and SQL injection attacks
10. implement Penetration testing, IDSs

- Use the OPEN SOURCE SOFTWARE/JAVA to implement the experiments

**TOTAL : 45 + 30 = 75 PERIODS**

**OUTCOMES:**

1. To explain the core fundamentals of system security concepts
2. To identify and mitigate the threats to the network of computers.
3. To discuss various the ways sharing and storing of files in controlled manner.
4. To deploy the security essentials in the IT sectors.
5. To solve the Storage security and related Issues.
6. To be explain the concept of database security

**REFERENCE BOOKS:**


1. John R.Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017.
2. "Elementary Information Security", Richard E. Smith, PhD, CISSP, Third Edition, Jones and Bartlett Learning, 2019
3. "Security Engineering":A Guide to building dependable Distributed Systems, Third Edition,Ross Anderson, Wiley,2020
4. "Network Security, Firewalls, and VPNs", Third Edition, J. Michael Stewart, Denise Kinsey , Jones & Bartlett Learning, 2020
5. Michael E. Whitman, Herbert J. Mattord, Principal of Information Security,6th edition, Cengage Learning, 2018

| 21CS2902 | DEEP LEARNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand the basic ideas and principles of Neural Networks
2. To understand the basic concepts of Big Data and Statistical Data Analysis
3. To familiarize the student with The Image Processing facilities like Tensorflow and Keras
4. To appreciate the use of Deep Learning Applications
5. To understand and implement Deep Learning Architectures

**UNIT I BASICS OF NEURAL NETWORKS 9+6**

Basic concept of Neurons – Perceptron Algorithm – Feed Forward and Back Propagation Networks.

**UNIT II INTRODUCTION TO DEEP LEARNING 9+6**

Feed Forward Neural Networks – Gradient Descent – Back Propagation Algorithm – Vanishing Gradient problem – Mitigation – RelU Heuristics for Avoiding Bad Local Minima – Heuristics for Faster Training – Nestors Accelerated Gradient Descent – Regularization – Dropout.

**UNIT III CONVOLUTIONAL NEURAL NETWORKS 9+6**

CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning

**UNIT IV MORE DEEP LEARNING ARCHITECTURES 9+6**

LSTM, GRU, Encoder/Decoder Architectures – Autoencoders – Standard- Sparse – Denoising – Contractive- Variational Autoencoders – Adversarial Generative Networks – Autoencoder and DBM

**UNIT V APPLICATIONS OF DEEP LEARNING 9+6**

Image Segmentation – Object Detection – Automatic Image Captioning – Image generation with Generative Adversarial Networks – Video to Text with LSTM Models – Attention Models for Computer Vision – Case Study: Named Entity Recognition – Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks – Sentence Classification using Convolutional Neural Networks – Dialogue Generation with LSTMs.

**PRACTICAL EXERCISES**

1. Implement Simple Programs like vector addition in TensorFlow.
2. Implement a simple problem like regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Implement a Transfer Learning concept in Image Classification.
7. Implement an Autoencoder in TensorFlow/Keras.

8. Implement a Simple LSTM using TensorFlow/Keras.
9. Implement an Opinion Mining in Recurrent Neural network.
10. Implement an Object Detection using CNN.

**TOTAL : 45 + 30 = 75 PERIODS**

**OUTCOMES:**

1. Understand the role of Deep learning in Machine Learning Applications.
2. To get familiar with the use of TensorFlow/Keras in Deep Learning Applications.
3. To design and implement Deep Learning Applications.
4. Critically Analyse Different Deep Learning Models in Image Related Projects.
5. To design and implement Convolutional Neural Networks.
6. To know about applications of Deep Learning in NLP and Image Processing.

**REFERENCE BOOKS:**


1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
2. Francois Chollet, "Deep Learning with Python", Manning Publications, 2018.
3. Phil Kim, "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress , 2017.
4. Ragav Venkatesan, Baoxin Li, "Convolutional Neural Networks in Visual Computing", CRC Press, 2018.
5. Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
6. Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications, 2016.

| 21CS2903 | ADVANCED SOFTWARE ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand Software Engineering Lifecycle Models
2. To do project management and cost estimation
3. To gain knowledge of the System Analysis and Design concepts.
4. To understand software testing approaches
5. To be familiar with DevOps practices.

**UNIT I INTRODUCTION 9 + 6**

Software engineering concepts – Development activities – Software lifecycle models - Classical waterfall - Iterative waterfall – Prototyping – Evolutionary - Spiral – Software project management – Project planning – Estimation – Scheduling – Risk management – Software configuration management. Introduction to software Reliability.

**UNIT II SOFTWARE REQUIREMENT SPECIFICATION 9 + 6**

Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modeling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modeling – Data Flow Diagram.

**UNIT III ARCHITECTURE AND DESIGN 9 + 6**

Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client- server - Tiered - Pipe and filter.- User interface design

**UNIT IV TESTING 9 + 6**

Testing – UNIT testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking

**UNIT V DEVOPS 9 + 6**

DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline: Overall Architecture - Building and Testing-Deployment- Case study: Migrating to Microservices.

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF EXERCISES**

**Tool Required:** Argo UML, Tortoises SVN Subversion Client, Eclipse , MySQL

1. Identify the suitable lifecycle models for a suggested system and also suitable estimation technique to estimate the cost of a particular software project
2. Do Project Planning using Gantt Chat for a suggested system
3. Develop Software Requirements Specification(SRS) for a given problem in IEEE template
4. Create Structured design for the developed DFD model, Develop DFD model (level-0, level-1 DFD and Data dictionary) of the suggested system
5. Perform the user‘s view analysis for the suggested system: Use case diagram, Activity diagram
6. Develop UML Interaction diagram , State chart for the suggested system
7. To perform various testing using the testing tool UNIT testing, integration testing for a sample code of the suggested system.
8. Identify To carry out the integration testing, which among the following is necessary? (The coding and UNIT testing of all other modules, sub modules and UNITs of suggested system are completed. The top-down integration is in progress for the suggested model software. The bottom-up integration is to be started for the suggested model software. Mention any stub or driver needed to carry out the integration testing? )
9. Version control using Subversion
10. DevOps provides integration with popular open source and third-party tools and services—across the entire DevOps workflow. Use the tools and languages you know. Spend less time integrating and more time delivering higher-quality software, faster – case study DevOps provides integration with popular open source and third-party tools and services—across the entire DevOps workflow. Use the tools and languages you know. Spend less time integrating and more time delivering higher-quality software, faster – case study

**OUTCOMES:**

1. Understand the advantages of various Software Development Lifecycle Models
2. Gain knowledge on project management approaches as well as cost and schedule estimation strategies
3. Perform formal analysis on specifications
4. Use UML diagrams for analysis and design Architect and design using architectural styles and design patterns
5. Understand software testing approaches Understand the advantages of DevOps practices

**REFERENCE BOOKS:**


1. Bernd Bruegge, Alan H Dutoit, Object-Oriented Software Engineering, 2 nd edition, Pearson Education, 2004.
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2 nd edition, PHI Learning Pvt. Ltd., 2010.
3. CraigLarman, Applying UML and Patterns, 3rd ed, Pearson Education, 2005.
4. Len Bass, Ingo Weber and Liming Zhu, ―DevOps: A Software Architect‘s Perspective‖, Pearson Education, 2016
5. Rajib Mall, Fundamentals of Software Engineering, 3 rd edition, PHI Learning Pvt. Ltd., 2009.

6. StephenSchach, Software Engineering 7th ed, McGraw-Hill, 2007.
7. John D. Musa, Anthony Iannino and KazuhiraOkumoto, “Software Reliability, Measurement, Prediction, Application, Series in Software Engineering and Technology”, McGraw Hill, 1987.
8. John D. Musa, “Software Reliability Engineering”, Tata McGraw Hill, 1999.

| 21CS2904 | ADHOC AND WIRELESS SENSOR NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To learn about the issues in the design of wireless ad hoc networks.
2. To understand the working of protocols in different layers of mobile ad hoc and sensor networks.
3. To expose the students to different aspects in sensor networks.
4. To understand various traffic generators and models for sensor networks.
5. To understand various security issues in ad hoc and sensor networks and solutions to the issues.

**UNIT I FUNDAMENTALS AND ROUTING PROTOCOLS OF WIRELESS ADHOC NETWORKS 9 + 6**

Introduction – Applications of Mobile Ad Hoc Networks (MANETs) – Medium Access Control Layer – Topology Control – Routing Protocols – Broadcasting – Multicasting – Internet Connectivity for MANETs – Security in MANETs - Scenario Based Performance Analysis of Various Routing Protocols in MANETs

**UNIT II MOBILITY MODELS AND OVERHEAD CONTROL MECHANISMS IN MANETS 9 + 6**

Description of Various Mobility Models – Simulation and Analysis of Various Mobility Models – Overhead Analysis in Hierarchical Routing Scheme – Overhead Minimization Techniques – Energy Models.

**UNIT III WIRELESS SENSOR NETWORKS (WSN) 9 + 6**

Applications of WSNs – Hardware and Software Issues in WSN – Design Issues of MAC Protocols – Deployment – Localization – Synchronization – Calibration – Network Layer Issues – Classification of Routing Protocols – Transport Layer Issues – Data Aggregation and Dissemination – Database Centric and Querying

**UNIT IV SENSOR NETWORK SECURITY 9 + 6**

Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks.

**UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9 + 6**

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF LABORATORY EXERCISES:**

1. Simple design of network using NS2 simulator
2. Nodes creation with MAC layer using NS2
3. Simulating a WSN using Network Simulator 2
4. Study on Mannasim Simulator
5. Error detection using LEACH Protocol
6. DoS Detection using Omnet+ simulator
7. Performance Evaluation of WSN using LEACH protocol

**OUTCOMES:**

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

1. Identifying suitable routing protocols for various scenarios of ad hoc networks.
2. To explore various mobility models for MANETs.
3. Identify different issues in wireless sensor networks.
4. Analyse the performance of IEEE 802.15.4.
5. Identify and critique security issues in ad hoc and sensor networks.

**REFERENCE BOOKS:**


1. 1.Subir Kumar Sarkar, “Wireless Sensor and Ad Hoc Networks Under Diversified Network
2. Scenarios”, Auerbach Publications, 2012.
3. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Pearson Education, 2008.
4. Labiod. H, “Wireless Adhoc and Sensor Networks”, Wiley, 2008.
5. Li, X, “Wireless ad -hoc and sensor Networks: theory and applications”, Cambridge University Press, 2008.
6. Holger Karl , Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, John wiley publication, Jan 2006.
7. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks: Theory and Applications”, World Scientific Publishing, Second Edition, 2011.

| 21CS2905 | COMPUTER VISION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To review image processing techniques for computer vision
2. To understand shape and region analysis
3. To understand Hough Transform and its applications to detect lines, circles, ellipses
4. To understand the models for stereo vision
5. To study some applications of computer vision algorithms.

**UNIT I LOW-LEVEL VISION 9+6**

Images and Imaging Operations- Basic Image Filtering Operations – The role of Thresholding - Edge Detection - Corner and Interest Point Detection - Textures Analysis.

**UNIT II INTERMEDIATE-LEVEL VISION 9+6**

Binary Shape Analysis - Boundary Pattern Analysis - Line, Circle and Ellipse Detection- The Generalised Hough Transform.

**UNIT III HIGH-LEVEL VISION 9+6**

Image Stitching- Motion Models, Global Alignment, Compositing; Depth estimation: Epi polar geometry- Sparse correspondence- Dense correspondence- Local methods- Global optimization; multi-view stereo - 3D reconstruction.

**UNIT IV 3-D VISION AND MOTION 9+6**

The Three-Dimensional World: Tackling the Perspective n-point Problem - Invariants and Perspective - Image Transformations and Camera Calibration – Motion.

**UNIT V PUTTING COMPUTER VISION TO WORK 9+6**

Face Detection and Recognition: the impact of deep learning - In Vehicle vision system.

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF EXERCISES (Use MATLAB/ OpenCV)**

1. Implement image pre-processing and Edge detection
2. Implement camera calibration methods
3. Implement Segmentation methods
4. Construct 3D model from defocus image
5. Construct 3D model from Images
6. Implement optical flow method
7. Implement object detection and tracking from video using AdaBoost in OpenCV
8. Face detection and Recognition using OpenCV
9. Object detection from dynamic Background for Surveillance

**OUTCOMES:**

1. Implement fundamental image processing techniques required for computer vision
2. Perform shape analysis and Implement boundary tracking techniques
3. Apply 3D vision techniques
4. Develop applications using computer vision techniques
5. Familiar with the use of MATLAB / OpenCV environment

**REFERENCE BOOKS:**


1. Davies E R, Computer & Machine Vision, Academic Press, Fifth Edition, 2018.
2. Szeliski R, Computer Vision: Algorithms and Applications, Springer 2021.
3. Adrian Rosebrock, Deep Learning for Computer Vision with Python Starter Bundle, Pyimagesearch, First Edition, 2017
4. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education, Third Edition, 2008.
5. Mark Nixon and Alberto S Aquado, Feature Extraction & Image Processing for Computer Vision, Academic Press, Third Edition, 2012.
6. John C Russ, The Image Processing Handbook, CRC Press, 2007.
7. Baggio D L et al., Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing, 2012.

| 21CS2906 | BIO-METRIC SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand the basic ideas and principles in biometrics.
2. To understand the basic concepts of statistical data analysis for validating the biometrics projects.
3. To familiarize the student with the image processing facilities in Matlab and its equivalent open source tools like OpenCV.
4. To appreciate the use of biometrics Industrial applications and to understand the role of biometrics in modern security environment.
5. To understand the role of multi-biometrics

**UNIT I BIOMETRICS FUNDAMENTALS 9+6**

Introduction to Biometrics – Benefits of Biometric Security – Types of Biometric Traits – Physiological and Behavioral Biometrics – General Architecture of Biometrics – Biometric Error and Performance Measures –Accuracy – False match rate – False non – match rate – Failure to Enrolment rate – Derived metrics – Applications of Biometrics.

**UNIT II FINGERPRINT AND FACIAL SCAN 9+6**

Finger Scan – Features – Components – Operation Steps – Competing Finger Scan Technologies Strength and Weakness – Types of Algorithms Used for Interpretation. Facial Scan – Features Components – Operation Steps – Competing Facial Scan Technologies – Strength – Weakness.

**UNIT III ADDITIONAL PHYSIOLOGICAL BIOMETRICS 9+6**

Retina Biometrics – Iris Scan – Features – Components – Competing Iris Scan Technologies – Strength and Weakness – Vein Pattern of Palm – Basics of Hand Geometry – Sign Language.

**UNIT IV BEHAVIOR BIOMETRICS 9+6**

Behavior Biometrics – Signature Scan – Keystrokes – Multimodality and Combining Biometrics for Improving Performance – Voice Scan-Features – Components – Operation Steps–Competing Voice Scan Technologies–Strength and Weakness.

**UNIT V BIOMETRICS APPLICATION DEVELOPMENT 9+6**

Biometrics – Standard Development Organizations – Information Security and Biometric Standards – BioAPI Consortium - Privacy Issues – Comparing Privacy Factor of Different Biometrics Technologies – Designing Privacy Sympathetic Biometric Systems.

**PRACTICAL EXERCISES**

1. Reading and writing of a biometric image like fingerprint or face.
2. Image Enhancement of biometric image by removing blur and noise.
3. Implementation of finger localization in OpenCV.
4. Implementation of face localizations in OpenCV .

5. Implementation of simple fingerprint and face identification.
6. Extraction of IRIS features in Matlab/OpenCV.
7. Implementation of voice acquisition in Matlab.
8. Implementation of fusion of biometrics in Matlab/OpenCV.
9. Extraction of features of signature in Matlab/Octave.
10. Develop an authentication system using keyboard strokes in Matlab/Octave.

**TOTAL : 45+30=75 PERIODS**

**OUTCOMES:**

1. Implement basic biometrics related algorithms.
2. Familiar with the types of Physiological and Behavioral Biometrics.
3. Design and implement an industrial application that incorporates different concepts of biometrics.
4. Critically analyze different approaches of Biometrics to implement mini projects in industrial environment and in security related projects.
5. Know the Biometric standards.
6. Know the Biometrics Application development.

**REFERENCE BOOKS:**


1. Anil K. Jain, Arun A. Rossand, Karthik Nandakumar, “Introduction to Biometrics”, Springer, 2011.
2. G. R. Sinha, Sandeep B. Patil, “Biometrics: Concepts and Applications”, Wiley, 2013.
3. James L. Wayman, Anil K. Jain, Davide Maltoni, Dario Maio, “Biometric Systems: Technology, Design and Performance Evaluation”, Springer, 2004.
4. Samir Nanavati, Michael Thieme, Raj Nanavati, “Biometrics: Identity Verification in a Networked World”, John WILEY, 2002.

| 21CS2907 | DATA ENGINEERING AND VISUALIZATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand the fundamentals of data visualization.
2. To know the working principles of various information visualization tools.
3. To acquire knowledge about the issues in data representation.
4. To visualize the complex engineering design.
5. To gain skill in designing real time interactive information visualization system
6. Understanding complex social cues.

**UNIT I INTRODUCTION 9+6**

Introduction – Visualization Stages – Computational Support – Issues – Different Types of Tasks – Data representation – Limitation: Display Space, Rendering Time, Navigation Link.

**UNIT II DATA REPRESENTATION 9+6**

Human Factors – Foundation for a Science of Data Visualization – Environment- Optics – Optimal Display – Overview about Lightness, Brightness, Contrast, Constancy, Color –Visual Attention that Pops Out – Types of Data – Data Complexity – The Encoding of Values – Encoding of Relation – Relation and Connection – Alternative Canvass.

**UNIT III DATA PRESENTATION 9+6**

Human Vision – Space Limitation – Time Limitations – Design – Exploration of Complex Information Space – Figure Caption in Visual Interface – Visual Objects and Data Objects – Space Perception and Data in Space – Images, Narrative and Gestures for Explanation.

**UNIT IV COLOR PROCESSING 9+6**

Color. Color Processing. Color Spaces. Color Aesthetics. Colors for Visualization-Cognition. Looking vs. Seeing. Image Gist. Gestalt Principles. Visual Attention. Visual Working & Long-Term Memory.

**UNIT V DATA VISUALISATION SYSTEM 9+6**

Visual Story Telling. Messaging. Effective Presentations. Design for Information Visualization and Arts, Visualization Systems- Database Visualization

**PRACTICAL EXERCISES**

1. Creating Interoperable Web Visualization Components using Candela tool.
2. Implementing Line and Stacked charts with Labels and Notes using Datawrapper tool.
3. Creating Interactive Charts using Google Chart tool.
4. Use Myheatmap tool to View Geographic Data Interactively.
5. Visualizing TSV, CSV, DSV data using Rawgraph.
6. Working with animation using Chartist.js tool.

7. Visualizing Image data using Matlab.
8. Visualizing Complex Historical Data using Palladio tool.
9. Creating Mobile Friendly Interactive Maps using Leaflet tool.
10. Implementing a Real Time Application using VTK tool as mini project.

**TOTAL : 45 + 30 = 75 PERIODS**

**OUTCOMES:**

1. Critically evaluate visualizations and suggest improvements and refinements
2. Use standalone visualization applications to quickly explore data
3. Apply a structured design process to create effective visualizations
4. Conceptualize ideas and interaction techniques using sketching
5. Create web-based interactive visualizations using JavaScript and D3

**REFERENCE BOOKS:**


1. Robert Spence, "Information Visualization An Introduction", Third Edition, Pearson Education, 2014.
2. Colin Ware, "Information Visualization Perception for Design", Third edition, Margon Kaufmann Publishers, 2012.
3. Robert Spence, "Information Visualization Design for Interaction", Second Edition, Pearson Education, 2006.
4. Benjamin B. Bederson and Ben shneiderman, "The Craft of Information Visualization", Morgan Kaufmann Publishers, 2003.
5. Thomas strothotte, "Computational Visualization: Graphics, Abstraction and Interactivity", Springer, 1998.
6. Matthew O. Ward, George Grinstein, Daniel Keim, "Interactive Data Visualization: Foundation, Techniques and Applications", Second Edition, A. K. Peters/CRC Press, 2015.
7. Joerg Osarek, "Virtual Reality Analytics", Gordon's Arcade, 2016

| 21CS2908 | AGILE PRACTICES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand the theoretical as well as practical understanding of agile software development practices.
2. To provide a good understanding of software design and a set of software technologies and APIs.
3. To do a detailed examination and demonstration of Agile development and testing techniques.
4. To understand the benefits and pitfalls of working in an Agile team.
5. To understand Agile development and testing

**UNIT I AGILE METHODOLOGY 9+6**

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model – Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams – Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values-Agile team building activity/game

**UNIT II AGILE PROCESSES 9+6**

Lean Production – SCRUM, Crystal, and Feature Driven Development- Adaptive Software Development – Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices- XP and Scrum scenarios to choose between two.

**UNIT III AGILITY AND KNOWLEDGE MANAGEMENT 9+6**

Agile Information Systems – Agile Decision Making – Earl S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment , Leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM)- story card maturity model for given scenario.

**UNIT IV AGILITY AND REQUIREMENTS ENGINEERING 9+6**

Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – requirement prioritization using different techniques- Agile Requirements Modelling and Generation – Concurrency in Agile Requirements Generation.

**UNIT V AGILITY QUALITY ASSURANCE AND DevOps 9+6**

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance – Test Driven Development – Agile Approach in Global Software Development- DevOps– Continuous Integration and Continuous Delivery CI/CD: Jenkins Creating pipelines, Setting up runners Containers and container orchestration (Dockers and Kubernetes) for application development and deployment; Checking build status; Fully Automated Deployment; Continuous monitoring with Nagios.

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF EXERCISES**

**TOOLS REQUIRED**

Jenkins , Dockers and Kubernetes , Nagios **(All open sources**)

1. Create a team building activity that covers the Agile principles and benefits
2. Identifying the business requirement for given scenario and document the epic and features.
3. Identify the user stories for the features created in UNIT 1 and prioritize the stories with story points.
4. Establish the scrum roles and document the sprint meeting outcomes. (creation of sprint backlog, scrum board, daily stand up notes, retrospective notes, review feedback)
5. Design some scenarios where XP OR Scrum can be chosen.
6. Framing the evaluation cycle for an e commerce portal. (Example Amazon / flip kart)
7. For the story backlog created UNIT 2 frame the story card maturity model.
8. Design the unstable requirements and the impact faced by the same in previous UNITs.
9. Given two scenarios with user stories. Assigning the priority for the requirements using different techniques (MoSCoW , level , numeric etc.)
10. Create a burn down and burn up chart for the story completed in previous UNITs
11. Calculate the velocity of the forthcoming sprint based on completed sprints
12. Write a simple program for registration page creation using java script and commit the same using git.
13. Configure a Jenkins pipeline for pulling the code changes from GitHub and deploy the same.

**OUTCOMES:**

1. Realize the importance of interacting with business stakeholders in determining the requirements for a software system.
2. Perform iterative software development processes: how to plan them, how to execute them.
3. Point out the impact of social aspects on software development success.
4. Develop techniques and tools for improving team collaboration and software quality.
5. Perform Software process improvement as an on-going task for development teams and show how agile approaches can be scaled up to the enterprise level.

**REFERENCE BOOKS:**


1. Craig Larman, ―Agile and Iterative Development: A manager_s Guide‖, Addison-Wesley, 2004
2. David J. Anderson; Eli Schragenheim, ―Agile Management for Software Engineering: Applying
3. the Theory of Constraints for Business Results‖, Prentice Hall, 2003
4. Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ―Agile Software Development, Current
5. Research and Future Directions‖, Springer-Verlag Berlin Heidelberg, 2010
6. Hazza& Dubinsky, ―Agile Software Engineering, Series: Undergraduate Topics in Computer
7. Science‖, Springer, VIII edition, 2009
8. Kevin C. Desouza, ―Agile information systems: conceptualization, construction, and
9. management‖, Butterworth-Heinemann, 2007.
10. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, By Andrew Stellman, Jennifer Greene, 2015, O Reilly
11. DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive ... By SricharanVadapalli, Packt, 2018

12. DevOps For Beginners: A Step-By-Step Guide To DevOps Best Practices – Liam Foster-2017
13. The Phoenix Project: DevOps For Everyone – Gene Kim, Kevin behr, and George Spafford-2013.
14. More Agile Testing: Learning Journeys for the Whole Team By Janet Gregory, Lisa Crispin, Addison Wesley, 2015.

| 21CS2909 | NETWORK PERFORMANCE ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To understand the mathematical basis for analyzing the performance of networks.
2. To understand queuing theory and queuing models.
3. To analytically model traffic control protocols, and error control protocols using these concepts.
4. To model performance of wired and wireless MAC such as 802.3, 802.11 and 802.16.
5. To model network traffic and study the performance of different packet scheduling algorithms.

**UNIT I MARKOV CHAINS BASICS** 9 +6

An overview of performance evaluation, Types of workloads and workload election, Work load characterization. Overview of Random Processes, Markov Chains – Markov matrices, State transition matrix, Markov chains at equilibrium – steady state distribution vector.

**UNIT II REDUCIBLE AND PERIODIC MARKOV CHAINS 9 +6**

Reducible Markov chain – Transition matrix, Reducible Composite Markov chain, Transient analysis, Steady state, Periodic Markov chain – Transition matrix, canonical form, Strongly and weakly periodic Markov chains, Analysis of Single Queue: Birth-Death Processes; M/M/1 Queue, M/M/m Queue, M/M/1/B queues, D/M/1/B queues, performance, communicating Markov chains, Advanced Markovian Queueing Models (M[X]/M/1), (M/M[Y ]/1), Queuing Networks: Open and Closed Queuing Networks.

**UNIT III TRAFFIC CONTROL, ERROR CONTROL AND MAC MODELING 9 +6**

Modeling traffic control protocols – Modeling leaky bucket and token bucket algorithms, Modeling Error control protocols - Stop and wait and GBN ARQ performance, Modeling media access control protocols – 802.1p, ALOHA, 802.3.

**UNIT IV NETWORK TRAFFIC AND SCHEDULING 9 + 6**

Modeling network traffic – Flow traffic models – Continuous time modeling, Discrete time modeling, Pareto traffic distribution, Destination traffic. Scheduling algorithms – Analysis.

**UNIT V PERFORMANCE ANALYZER TOOLS AND CASE STUDY 9 + 6**

Other aspects of Performance analysis on networks (random walk on graph, dynamics on network) – Network Performance Analyzer Tools. Case study of performance evaluation of some real-world applications (such as BitTorrent simulation and evaluation, Internet worm modeling and simulation).

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF EXERCISES**

1. Basics of Network Simulation
2. Simulating a Local Area Network
3. Measuring Network Performance
4. Evaluation using NS-2
5. Simulation of Queues in NS2 - Simulation of various queues in NS2 and analyzing their
6. performances on various performance metrics such as throughput, average delay and packet loss
7. 6.Simulation of various queue Scheduling Algorithms

8. Simulating a Wi-Fi Network
9. Simulating a WiMAX Network

**OUTCOMES:**

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

1. Apply markov chain models and analyse the behavior of network systems
2. Perform queuing theory based analysis of various L2 layer functions, such as flow control, error control, and MAC
3. Build network traffic models
4. Analyse QoS functions such as scheduling and traffic control

**REFERENCE BOOKS:**


1. Anurag Kumar, D. Manjunath, Joy Kuri, Communication Networking: An analytical Approach, Elsevier, 2004.
2. Bertsekas D and Gallager R, Data Networks, 2nd Edition, Prentice-Hall, 1992.
3. Fayez Gebali, Analysis of computer networks, 2nd Edition, Springer, 2015.
4. Harrison P G and Patel N M, Performance Modelling of Communication Networks and Computer Architectures, Addison-Wesley, 1993.
5. Robertazzi T G, Computer Networks and Systems: Queuing Theory and Performance Evaluation, 2nd, Edition, Springer-Verlag, 1994.
6. Performance Analysis of Communications Networks and Systems , Piet Van Mieghem, Technische Universiteit Delft, The Netherlands
7. Raj Jain, The Art of Computer Systems Performance Analysis, John Wiley & Sons, 1991.
8. Fundamentals of Queueing Theory, 4th Edition Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris
9. Raj Jain ,The Art of Computer Systems Performance Analysis
10. 10. Performance Evaluation by Simulation and Analysis with Applications to Computer Networks, Ken Chen, 2015

| 21CS2910 | BIOINFORMATICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**OBJECTIVES:**

1. To get exposed to Bioinformatics Technologies.
2. To solve various problems in biological sciences- sequence analysis.
3. To solve various problems in gene expression analysis, biomedical image analysis.
4. To solve various problems in metabolic pathway analysis.
5. To be familiar with working of bioinformatics models in MATLAB

**UNIT I INTRODUCTION 9+6**

Need for Bioinformatics Technologies – Overview of Bioinformatics Technologies – Structural Bioinformatics – Data Format and Processing – Secondary Resources and Applications – Role of Structural Bioinformatics – Biological Data Integration System.

**UNIT II BIOINFORMATICS TOOL BOX 9+6**

Sequence Analysis – NGS – Graph Theory – Gene Ontology – Importing Data and Deploying.

**UNIT III BIOLOGICAL DATA ANALYSIS 9+6**

Microarray Data Analysis – Mass Spectrometry Data Analysis – Statistical Classification of Biological Data.

**UNIT IV IMAGE PROCESSING 9+6**

Key Features of Image Processing – Importing and Exporting Images – Image File Formats and Format Conversion – Pre and Post Processing Images – Spatial Transformations and Image Registration – Microarray Image Analysis.

**UNIT V SYSTEMS BIOLOGY 9+6**

Basics of Enzyme Kinetics – Kinetic Laws – Modeling Biological System: Simulation, Sensitivity Analysis, Parameter Estimation using Simbiology – Pharmacokinetic Modeling: Simulation, Population Study – Model of the Yeast Heterotrimeric G Protein Cycle and Glycolysis

**TOTAL : 45 + 30 = 75 PERIODS**

**LIST OF EXERCISES (Use MATLAB/OpenCV)**

1. MATLAB basic commands.
2. Sequence analysis tools including functions for pairwise, MSA and phylogenetic tree construction.
3. Microarray data import from GEO and affymetrix and expression analysis and normalization.
4. Microarray image analysis.
5. Gene expression data analysis from gene ontology.
6. Mass spectrometry data import and base line correction and normalization.
7. Model creation and simulation using simbiology.
8. Node knock out of model generated in simbiology using graph theory.
9. Pharmakokinetic model building. 10. Pharmakokinetic population fitting.

**OUTCOMES:**

1. Develop models for Biological Data.
2. Implement Image Processing Techniques to Bioinformatics Data.
3. Implement Micro Array analysis over Genome Expression.
4. Understand the study of Symbiology.
5. Understand the Pharmacokinetic Modeling
6. Understand the working model of Biological Data in MATLAB.

**REFERENCE BOOKS:**


1. Gautam B. Singhm "Fundamentals of Bioinformatics and Computational Biology: Methods and Exercises in MATLAB", Springer International Publishing, 2015
2. Michael R. King, Nipa A. Mody, "Numerical and Statistical Methods for Bioengineering: Applications in MATLAB", Cambridge University Press, 2011.
3. G. Alterovitz, M. F. Ramoni, "Systems Bioinformatics: An Engineering Case-Based Approach", Artech House, 2007.
4. John L. Semmlow, "Biosignal and Medical Image Processing", CRC Press, 2004.
5. Frank C. Hoppensteadt, Charles S. Peskin, "Modeling and Simulation in Medicine and Life Sciences", Springer, 2010.
6. C. Gibas, Per Jambeck, "Developing bioinformatics computer skills", O'Reilly Media, 2001.

**PROFESSIONAL ELECTIVE - II, IV and V**

| 21CS2911 | BLOCK CHAIN TECHNOLOGIES AND APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To learn the fundamentals of Block chain.
   To explain the details of Bitcoin and its different components.
2. To incorporate the consensus of Block chain
3. To understand the Ethereum development environment
4. To learn the applications of Block chain

**UNIT I INTRODUCTION 9**

Block chain history, basics, architectures, Types of block chain ,Basic Cryptographic primitives used in Block chain –Secure- Collision Resistant hash functions - Digital signature - Public key cryptosystems – Zero knowledge proof systems - Need for Distributed Record Keeping - Modelling faults and adversaries- Byzantine Generals problem - Consensus algorithms and their scalability problems - Why Nakamoto Came up with Block chain based crypto currency.

**UNIT II BITCOIN 9**

Fundamentals, aspects of bit coins, properties of bit coins, Digital Keys and Addresses – Transactions, life cycle, data structure, types – Structure of the block chain – Mining – Bitcoin Networks and Payments – Wallets – Alternative coins – Smart Contracts – Definition – Recardian contracts.

**UNIT III BITCOIN CONSENSUS 9**

Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases, Design issues for Permissioned Blockchains, Execute contracts- Consensus models for permissioned blockchain-Distributed consensus in closed environment Paxos.

**UNIT IV ETHEREUM 9**

Setting up Ethereum development tools – Solidity language. – Ethereum accounts, key pairs, working with Externally Owned Accounts (EOA), contract accounts – Smart contracts, structure, setting up and interaction, examples – Decentralised applications, implementation, case studies – Whisper protocol – Swarm architecture and concepts.

**UNIT V APPLICATIONS (ANNA) 9**

Applications of block chain in cyber security- integrity of information- E-Governance, Finance, Internet of things, Health and other contract enforcement mechanisms.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Define and Explain the fundamentals of Blockchain
2. Explain the different steps in the use of Bitcoins.
3. Describe the consensus of Blockchain
4. Analyze and demonstrate the Ethereum
5. Analyze various applications of Block chain.

**REFERENCE BOOKS:**


1. S.Shukla,n M.Dhawan, S.Sharma, S. Venkatesan “Blockchain Technology: Cryptocurrency and Applications” ,Oxford University Press 2019 .
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, ”Bitcoin and cryptocurrency technologies: a comprehensive introduction”,Princeton University Press,2016.
3. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
4. Alex Leverington, “Ethereum Programming” Packt Publishing Limited, 2017.
5. Arshdeep Bahga and Vijay Madisetti, “Blockchain Applications : A Hands-On Approach”, 2017

| 21CS2912 | IoT ARCHITECTURE AND PROTOCOLS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To Understand the Architectural Overview of IoT
2. To Understand the IoT Reference Architecture and Real World Design Constraints
3. To Understand the various IoT Protocols ( Datalink, Network, Transport, Session, Service)

**UNIT I OVERVIEW 9**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

**UNIT II REFERENCE ARCHITECTURE 9**

IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

**UNIT III IoT DATA LINK LAYER & NETWORK LAYER PROTOCOLS 9**

Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations-Key-Value Databases-What Is a Key-Value Store, Key-Value Store Features-Suitable Use Cases-Storing Session Information-User Profiles- Preference-Shopping Cart Data- When Not to Use.

**UNIT IV IoT TRANSPORT & SESSION LAYER PROTOCOLS 9**

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session LayerHTTP, CoAP, XMPP, AMQP, MQTT

**UNIT V SERVICE LAYER PROTOCOLS & SECURITY 9**

Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Comprehend the essentials of IoT and its applications
2. Understand the concepts of IoT Architecture Reference model and IoT reference architecture
3. Analyze various IoT Application layer Protocols
4. Apply IP based protocols and Authentication Protocols for IoT
5. Design IoT-based systems for real-world problems.

**REFERENCE BOOKS:**


1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2. Peter Waher, “Learning Internet of Things”, PACKT publishing, BIRMINGHAM – MUMBAI
3. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications.
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on Approach)”, 1 st Edition, VPT, 2014.


**WEB REFERENCES**


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2. https://www.packtpub.com/product/data-engineering-with-python/9781839214189
3. https://www.amazon.in/Data-Engineering-Python-datasets-pipelines-ebook/dp/B08DSLVFNR

| 21CS2913 | SOFTWARE TESTING AND QUALITY ASSURANCE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the basics of testing, test planning & design and test team organization.
2. To study the various types of test in the life cycle of the software product.
3. To build design concepts for system testing ,execution and usage of automation tools
4. To learn the software quality assurance, metrics, defect prevention techniques.
5. To learn the techniques for quality assurance and applying for applications.

**UNIT I SOFTWARE TESTING - CONCEPTS, ISSUES, AND TECHNIQUES 9**

Quality Revolution, Verification and Validation, Failure, Error, Fault, and Defect, Objectives of Testing, Testing Activities, Test Case Selection White-Box and Black ,test Planning and design, Test Tools and Automation, . Power of Test. Test Team Organization and Management-Test Groups, Software Quality Assurance Group ,System Test Team Hierarchy, Team Building

**UNIT II SYSTEM TESTING 9**

System Testing - System Integration Techniques-Incremental, Top Down Bottom Up Sandwich and Big Bang, Software and Hardware Integration, Hardware Design Verification Tests, Hardware and Software Compatibility Matrix Test Plan for System Integration. Built- in Testing. functional testing - Testing a Function in Context. Boundary Value Analysis, Decision Tables. acceptance testing - Selection of Acceptance Criteria, Acceptance Test Plan, Test Execution Test. software reliability - Fault and Failure, Factors Influencing Software, Reliability Models

**UNIT III SYSTEM TEST CATEGORIES AND TOOLS 9**

System test categories Taxonomy of System Tests, Interface Tests Functionality Tests. GUI Tests, Security Tests Feature Tests, Robustness Tests, Boundary Value Tests Power Cycling Tests Interoperability Tests, Scalability Tests, Stress Tests, Load and Stability Tests, Reliability Tests, Regression Tests , Regulatory Tests . Test Generation from FSM models- State-Oriented Model. Finite-State Machine Transition Tour Method, Testing with State Verification. Test Architectures-Local, distributed, Coordinated, Remote. System test design- Test Design Factors Requirement Identification, modeling a Test Design Process Test Design Preparedness, Metrics, Test Case Design Effectiveness. system test execution- Modeling Defects, Metrics for Monitoring Test Execution .Defect Reports, Defect Causal Analysis, Beta testing, measuring Test Effectiveness. Software Testing tools- Automation and Testing Tools –JMetra, JUNIT and Cactus.

**UNIT IV SOFTWARE QUALITY 9**

Software quality - People‘s Quality Expectations, Frameworks and ISO-9126, McCall‘s Quality Factors and Criteria – Relationship. Quality Metrics. Quality Characteristics ISO 9000:2000 Software Quality Standard. Maturity models- Test Process Improvement ,Testing Maturity Model.

**UNIT V SOFTWARE QUALITY ASSURANCE 9**

Quality Assurance - Root Cause Analysis, modelling, technologies, standards and methodologies for defect prevention. Fault Tolerance and Failure Containment - Safety Assurance and Damage Control, Hazard analysis using fault-trees and event-trees. Comparing Quality Assurance Techniques and Activities. QA Monitoring and Measurement, Risk Identification for Quantifiable Quality Improvement. Case Study: FSM-Based Testing of Web-Based Applications.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Perform functional and nonfunctional tests in the life cycle of the software product.
2. Understand system testing and test execution process.
3. Identity defect prevention techniques and software quality assurance metrics
4. Understand software testing and Automation tools
5. Apply techniques of quality assurance for typical applications.

**REFERENCE BOOKS:**


1. Software Testing And Quality Assurance-Theory and Practice, Kshirasagar Nak Priyadarshi Tripathy, John Wiley & Sons Inc,2008
2. Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement, Jeff Tian, John Wiley & Sons, Inc., Hoboken, New Jersey. 2005.
3. Software Quality Assurance - From Theory to Implementation, Daniel Galin, Pearson Education Ltd UK, 2004
4. Software Quality Assurance, Milind Limaye, TMH ,New Delhi, 2011
5. Software Automation Testing Tools for Beginners, Rahul Shende, Shroff Publishers and Distributors, 2012.
6. Software Testing Tools, K.V.K.K. Prasad, Dream Tech Press, 2008
7. Software Testing Concepts and Tools, Nageswara Rao Pusuluri, Dream Tech press, 2007.

| 21CS2914 | NEXT GENERATION NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To learn the technical, economic and service advantages of next generation networks
2. To learn the evolution of technologies of 4G and beyond.
3. To learn Software defined Mobile Network issues and integrating challenges with LTE.
4. To explore the NGN framework catering the services of end user with QoS provisioning.
5. To learn about the NGM management and standards.

**UNIT I INTRODUCTION 9**

Evolution of public mobile services -motivations for IP based services, Wireless IP network architecture –3GPP packet data network architecture. Introduction to next generation networks - Changes, Opportunities and Challenges, Technologies, Networks, and Services, Next Generation Society, future Trends.

**UNIT II 4G and BEYOND 9**

Introduction to LTE-A –Requirements and Challenges, network architectures –EPC, E-UTRAN architecture-mobility management, resource management, services, channel -logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure. Overview of Potential 5G Communications System Architecture – 5G wireless communication systems, Massive MIMO, cognitive radio networks, and device-to-device communications. Security Issues and Challenges in 5G Communications Systems.

**UNIT III SDMN-LTE INTEGRATION 9**

SDN paradigm and applications, SDN for wireless-challenges, Leveraging SDN for 5G networks ubiquitous connectivity-mobile cloud-cooperative cellular network-restructuring mobile networks to SDN-SDN/LTE integration benefits.

**UNIT IV MULTI SERVICE NETWORKS 9**

Origin of multi service ATM, Next Generation Multi service Networks, Next Generation Multi service ATM switching, Multiprotocol Label switching, Networks, Frame Based MPLS, Cell based MPLS, MPLS services and their benefits, multi service provisioning platforms (MSPP) & Multi service switching platform (MSSP).

**UNIT V NGN MANAGEMENT AND STANDARDIZATION 9**

Evolution towards NGN-Technology requirements, NGN functional architecture- Transport stratum, service stratum, service/ content layer and customer terminal equipment function. NGN entities, Network and Service evolution -fixed, mobile, cable and internet evolution towards NGN. NGN Applications, UTMS, WAP, WiMAX-Security and directory Enabled networks.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

1. To be able to understand the issues and challenges of wireless domain in future generation network design.
2. To be able to explore the LTE concepts and technologies.
3. To be able to understand the integration of SDN with LTE.
4. To be able to understand the NGN management and standardizations.
5. To be able to learn and understand Multi service networks

**REFERENCE BOOKS:**


1. Jingming Li Salina, Pascal Salina "Next Generation Networks-perspectives and potentials" Wiley, January 2008.
2. Madhusanga Liyanage, Andrei Gurtov, Mika Ylianttila, "Software Defined Mobile Networks beyond LTE Network Architecture", Wiley, June 2015.
3. Martin Sauter,"3G,4G and Beyond bringing networks, devices and web together", Wiley, 2nd edition-2013.
4. Savo G Glisic," Advanced Wireless Networks- Technology and Business models", Wiley, 3rd edition- 2016.
5. Thomas Plavyk, ―Next generation Telecommunication Networks, Services and Management‖, Wiley & IEEE Press Publications, 2010.
6. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.

| 1CS2915 | COMPUTATIONAL INTELLIGENCE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To provide a strong foundation on fundamental concepts in Computational Intelligence.
2. To enable Problem-solving through Genetic Algorithms.
3. To provide basic techniques, theory and computational models of Fuzzy systems.
4. To apply neural networks to design classification problems.
5. To apply Computational Intelligence techniques primarily for machine learning.

**UNIT I INTRODUCTION 9**

Artificial Intelligence – a brief review – Pitfalls of traditional AI -Introduction to CI- History of CI- Basic techniques and applications of CI- Introduction to Machine learning.

**UNIT II EVOLUTIONARY COMPUTING 9**

Introduction to Genetic Algorithms (GA) – Applications of GA - Building block hypothesis Representation– Fitness Measures – Genetic Operators-. GA based Machine Learning.

**UNIT III FUZZY SYSTEMS 9**

Fuzzy Logic: Fuzzy sets, properties, membership functions, fuzzy operations - Fuzzy logic and fuzzy inference and applications - Evolutionary Computation - constituent algorithms - Swarm intelligence algorithms - Overview of other bio-inspired algorithms - Hybrid Intelligent systems (Rough fuzzy hybridization & Reinforcement learning).

**UNIT IV NEURAL NETWORKS 9**

Neural Networks-Neuro-fuzzy Inference- Biological and artificial neuron, neural networks, supervised and unsupervised learning. Single layer Perceptron, Multilayer Perceptron – Back propagation learning. Neural networks as associative memories - Hopfield networks, Bidirectional Associative Memory. Topologically organized neural networks – competitive learning, kohonen maps.

**UNIT V PROBLEM SOVING 9**

Adversial Search- Game Playing Cycle- A simple Game Tree- MINMAX Procedure- Additional pruning of game tree- Illustration of alpha beta cut off- Additional refinements- Horizon effect- Iterative deepening.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Provide a basic exposition to the goals and methods of Computational Intelligence.
2. Apply Genetic Algorithms to design intelligent computational systems.
3. Apply fuzzy principles and thinking to deal with vulnerability and tackle real-time issues.
4. Apply neural networks to design classification problems.
5. Improve problem solving skills using the acquired knowledge in the areas of, reasoning, natural language understanding, gaming and machine learning.

**REFERENCE BOOKS:**


1. Russell Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, 2020. Pearson Education
2. A classical approach to Artificial Intelligence, Munesh Chandra Trivedi, Khanna Publications,2020
3. Machine Learning, Rajiv Chopra, Khanna Publishing House, 2020.
4. Michael Negnevitsky ,Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition,2020
5. Introduction to Artificial Intelligence and Expert Systems, Dan W. Patterson, Pearson Education, 2015.
6. Neural Networks and Learning Machines, Simon Haykin, Pearson Education, 3rd Edition,2016.
7. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Jyh-Shing Roger Jang, 1st Edition, 2015, Pearson Education.
8. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2008
9. Meta-heuristic and Evolutionary Algorithms for Engineering Optimization, Omid Bozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga,wiley publishers, 2017
10. 10. Rajashekaran S and Vijayalakshmi Pai G A, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.

| 21CS2916 | CYBER PHYSICAL SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To learn about design of cyber-physical systems
- Introduce modeling of CPS
- Introduce ability to analyze and simulate CPS systems
- To learn about CPS implementation issues
- To learn about secure deployment of CPS

**UNIT I** **Introduction** **9**

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS, Principles of Dynamical Systems: Dynamical Systems and Stability Controller Design Techniques Performance under Packet drop and Noise.

**UNIT II** **CPS - Platform components** **9**

CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet Scheduling Real Time CPS tasks

**UNIT III** **CPS implementation issues** **9**

From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion Building real-time networks for CPS.

**UNIT IV** **Intelligent CPS** **9**

Safe Reinforcement Learning, Robot motion control, Autonomous Vehicle control, Gaussian Process Learning, Smart Grid Demand Response, Building Automation

**UNIT V** **Secure Deployment of CPS** **9**

Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study: Vehicle ABS hacking, Power Distribution Case study : Attacks on Smart Grids.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Understand the core principles behind CPS
2. Identify safety specifications and critical properties
3. Understand abstraction in system designs
4. Express pre- and post-conditions and invariants for CPS models
5. To analyze CPS by with holistic models of cyber and physical components.

**REFERENCE BOOKS:**


1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. R. Rajkumar, D. de. Niz and M. Klein, (2017), Cyber Physical Systems, Addision-Wesely.
3. E.A.Lee and S A Shesia, (2018), Embedded system Design: A Cyber-Physical Approach,
4. Second Edition, MIT Press.
5. André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics., Springer, 2010. 426 pages,ISBN 978-3-642-14508-7.
6. Jean J. Labrosse, Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C, The publisher, Paul Temme, 2011.


**Web references**


1. A.Platzer, (2017), Logical Foundations of Cyber Physical Systems, Springer.

| 21CS2917 | INFORMATION STORAGE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the storage architecture and available technologies
2. To learn to establish & manage data center
3. To learn security aspects of storage & data center.
4. To study how to manage data in various application domains
5. To study about various visualization techniques

**UNIT I STORAGE TECHNOLOGY 9**

Review data creation and the amount of data being created and understand the value of data to a business, challenges in data storage and data management, Solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities.

**UNIT II STORAGE SYSTEMS ARCHITECTURE 9**

Hardware and software components of the host environment, Key protocols and concepts used by each component ,Physical and logical components of a connectivity environment ,Major physical components of a disk drive and their function, logical constructs of a physical disk, access characteristics, and performance Implications, Concept of RAID and its components, Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6, Compare and contrast integrated and modular storage systems ,High-level architecture and working of an intelligent storage system.

**UNIT III INTRODUCTION TO NETWORKED STORAGE 9**

Evolution of networked storage, Architecture, components, and topologies of FC-SAN, NAS, and IP-SAN, Benefits of the different networked storage options, understand the need for long-term archiving solutions and describe how CAS full fill the need, understand the appropriateness of the different networked storage options for different application environments

**UNIT IV INFORMATION AVAILABILITY, MONITORING & MANAGING DATACENTERS 9**

List reasons for planned/unplanned outages and the impact of downtime, Impact of downtime -Business continuity (BC) and disaster recovery (DR) ,RTO and RPO, Identify single points of failure in a storage infrastructure and list solutions to mitigate these failures, architecture of backup/recovery and the different backup/ recovery topologies, replication technologies and their role in ensuring information availability and business continuity, Remote replication technologies and their role in providing disaster recovery and business continuity capabilities. Identify key areas to monitor in a data center, Industry standards for data center monitoring and management, Key metrics to monitor for different components in a storage infrastructure, Key management tasks in a data center.

**UNIT V SECURING STORAGE AND STORAGE VIRTUALIZATION 9**

Information security, Critical security attributes for information systems, Storage security domains, List and analyzes the common threats in each domain, Virtualization technologies, block-level and file-level virtualization technologies and processes.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Select from various storage technologies to suit for required application.
2. Apply security measures to safeguard storage & farm
3. Analyse QoS on Storage.
4. To know about various backup and recovery technologies
5. Gain knowledge about various threats in different domains

**REFERENCE BOOKS:**


1. EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010
2. Marc Farley, ―Building Storage Networks‖, Tata McGraw Hill , Osborne, 2001.
3. Robert Spalding, ―Storage Networks: The Complete Reference―, Tata McGraw Hill, Osborne, 2003.


**WEB REFERENCES**

1. https://www.db-book.com
2. https://www.pearsoned.co.in/prc/book/thomas-m-connolly-database-systems-practical-approach-design-implementation-management-4e--4/9788131720257
3. https://www.wiley.com/en-us/Professional+NoSQL-p-9780470942246

**ONLINE COURSES / RESOURCES:**

1. https://www.my-mooc.com
2. Introduction to Data Storage and Management Technologies | My Mooc (my-mooc.com)
3. http://www.ictacademy.in/pages/Information-Storage-and-Management.aspx
4. https://www.classcentral.com

| 21CS2918 | SOFTWARE RELIABILITY METRICS & MODELS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To learn about the software reliability fundamentals & to measure the reliability of software systems.
2. To learn about basics of Software Reliability Modeling.
3. To Learn the concepts of Comparison Criteria
4. To Learn software metrics & Understand the concepts of Measurements in Software Engineering.
5. To Understand the Measurement of Internet Product Attributes and Quality Management Models.

**UNIT I SOFTWARE RELIABILITY FUNDAMENTALS 9**

Basic Concepts – Failure and Faults – Environment – Availability –Modeling –uses – requirements reliability metrics – design & code reliability metrics – testing reliability metrics. Computation of software reliability, Functional and Operational Profile.

**UNIT II SOFTWARE RELIABILITY MODELING 9**

Concepts – General Model Characteristic – Historical Development of models – Model Classification scheme – Markovian models – General concepts – General Poisson Type Models – Binomial Type Models – Poisson Type models – Fault reduction factor for Poisson Type models. Software Reliability Modeling: A general procedure for reliability modelling

**UNIT III COMPARISON OF SOFTWARE RELIABILITY MODELS 9**

Comparison Criteria – Failure Data – Comparison of Predictive Validity of Model Groups – Recommended Models – Comparison of Time Domains – Calendar Time Modeling – Limiting Resource Concept – Resource Usage model – Resource Utilization – Calendar Time Estimation and confidence Intervals

**UNIT IV MEASUREMENTS THEORY 9**

Measurements in Software Engineering – Scope of Software metrics – Measurements theory – Goal based Framework – Software Measurement Validation

**UNIT V MEASURING SOFTWARE PRODUCT 9**

Measurement of Internet Product Attributes – Size and Structure – External Product Attributes – Measurement of Quality – Software Reliability: Measurement and Prediction.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Evaluate the reliability of any given software product
2. Compare and select the right reliability model for evaluating the software
3. Design reliability models for software systems
4. Perform some simple statistical analysis relevant to software measurement data.
5. Understand from practical examples both the benefits and limitations of software metrics for quality control and assurance

**REFERENCE BOOKS:**


1. John D. Musa, ―Software Reliability Engineering‖, Tata McGraw Hill, 1999
2. John D. Musa, Anthony Iannino, KazuhiraOkumoto, ―Software Reliability – Measurement, Prediction, Application, Series in Software Engineering and Technology‖, McGraw Hill, 1987
3. Norman Fenton, James Bieman, ―Software Metrics: A Rigorous and Practical Approach‖, 3rd edition, CRC Press, 2015
4. H. Pham, Software Reliability, Springer Verlag, New York , 2000
5. Patric D. T.O Connor, Practical Reliability Engineering, 4th Edition, John Wesley & Sons , 2003
6. D. Reled, Software Reliability Methods, Springer Verlag, New York , 2001

| 21CS2919 | MOBILE APPLICATION DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the need and characteristics of mobile applications.
2. To design the right user interface for mobile application.
3. To understand the design issues in the development of mobile applications.
4. To understand the development procedures for mobile application.
5. To develop mobile applications using various tools and platforms.

**UNIT I INTRODUCTION** 9

Mobile applications – Characteristics and Benefits – Application Model – Infrastructure and Managing Resources – Mobile Device Profiles – Frameworks and Tools- Introduction to Android.

**UNIT II USER INTERFACE 9**

Generic UI development – Designing the right UI – Multimodal and Multichannel UI – Gesture based UI – Screen Elements and Layouts – Voice XML.

**UNIT III APPLICATION DESIGN 9**

Memory Management – Design Patterns for Limited Memory – Work Flow for Application Development – Java API – Dynamic Linking – Plug-ins and Rule of Thumb for using DLLs – Concurrency and Resource Management.

**UNIT IV APPLICATION DEVELOPMENT I 9**

Mobile OS: Android, Ios – Android Application Architecture – Android basic Components – Intents and Services – Storing and Retrieving data – Packaging and Deployment – Security and Hacking-Testing and publishing android applications.

**UNIT V APPLICATION DEVELOPMENT II 9**

Communication via the Web – Notification and Alarms – Graphics and Multimedia: Layer animation, Event Handling and Graphics Services – Telephony – Location Based Services.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

1. Design the right user interface for mobile application.
2. Implement mobile application using UI toolkits and frameworks
3. Design a mobile application that is aware of the resource constraints of mobile devices.
4. Develop web based mobile application that accesses internet and location data.
5. Implement android application to use telephony for SMS communication.

**REFERENCE BOOKS:**


1. Reto Meier, “Professional Android 4 Application Development”, Wiley, 2012.
2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, “Programming Android”, O’Reilly, 2011.
3. Alasdair Allan, “iPhone Programming”, O’Reilly, 2010.

| 21CS2920 | NATURAL LANGUAGE PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Learn the techniques in natural language processing.
2. Be familiar with the natural language generation.
3. Be exposed to machine translation.
4. Understand the information retrieval techniques

**UNIT I OVERVIEW AND LANGUAGE MODELING 8**

Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages-NLP Applications-Information Retrieval. Language Modelling: Various Grammar- based Language Models-Statistical Language Model

**UNIT II WORD LEVEL AND SYNTACTIC ANALYSIS 9**

Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word Classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing.

**UNIT III SEMANTIC ANALYSIS AND DISCOURSE PROCESSING 10**

Semantic Analysis: Meaning Representation-Lexical Semantics- Ambiguity-Word Sense Disambiguation. Discourse Processing: cohesion-Reference Resolution- Discourse Coherence and Structure

**UNIT IV NATURAL LANGUAGE GENERATION AND MACHINE TRANSLATION 9**

Natural Language Generation: Architecture of NLG Systems- Generation Tasks and Representations Application of NLG. Machine Translation: Problems in Machine Translation- Characteristics of Indian Languages- Machine Translation Approaches-Translation involving Indian Language

**UNIT V INFORMATION RETRIEVAL AND LEXICAL RESOURCES 9**

Information Retrieval: Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame Net Stemmers-POS Tagger- Research Corpora. Applications: Automatic Text Summarization, Question-Answering System

**TOTAL: 45 PERIODS**

**OUTCOMES:**

1. To tag a given text with basic Language features
2. To design an innovative application using NLP components
3. To implement a rule-based system to tackle morphology/syntax of a language
4. To design a tag set to be used for statistical processing for real-time applications
5. To compare and contrast the use of different statistical approaches for different types of NLP applications.

**REFERENCE BOOKS:**


1. Introduction to Natural Language Processing (Adaptive Computation and Machine Learning series), Eisenstein, Jacob, MIT Press, 2019
2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
3. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition",2 nd Edition, Prentice Hall, 2008
4. James Allen, "Natural Language Understanding", 2nd edition, Benjamin /Cummings publishing company, 1995

| 21CS2921 | DIGITAL FORENSICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices
2. To understand how to examine digital evidences such as the data acquisition, identification analysis
3. Students will learn different techniques and procedures that enable them to perform a digital investigation
4. Perform the analysis of physical storage media and volume analysis.
5.

**UNIT I FUNDAMENTALS OF COMPUTER FORENSICS 9**

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

**UNIT II FORENSICS ACQUISITION TOOLS 9**

Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

**UNIT III INVESTIGATION 9**

Introduction to Cyber Crime Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Hands on Case Studies. Encryption and Decryption Methods, Search and Seizure of Computers, Recovering Deleted Evidences, Password Cracking

**UNIT IV DIGITAL FORENSICS 9**

Introduction to Digital Forensics, Open Source Examination Platform - Using Linux and Windows as the Host, Disk and File System Analysis, Media Analysis Concepts , Sleuth Kit, Partitioning and Disk Layouts, Special Containers, Hashing, Forensic Imaging, Internet Artifacts, Browser & Mail Artifacts, File Analysis, Image, Audio, Video, Archives, Documents, Graphical Investigation Environments, PyFLAG, Fiwalk, Forensic Ballistics and Photography, Face, Iris and Fingerprint Recognition

**UNIT V LAWS AND ACTS 9**

Laws and Ethics, Digital Evidence Controls, Evidence Handling Procedures, Basics of Indian Evidence ACT IPC and CrPC , Electronic Communication Privacy ACT, Legal Policies

**TOTAL: 45 PERIODS**

**OUTCOMES:**

1. Knowledge about Forensics Acquisition Tools.
2. Analysis about investigation, Encryption and Decryption Methods.
3. Familiarity in Open source Digital Forensics Platform and tools.

**REFERENCE BOOKS:**


1. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5.
3. Bernadette H Schell, Clemens Martin, ―Cybercrime‖, ABC – CLIO Inc, California, 2004. Understanding Forensics in IT ―, NIIT Ltd, 2005
4. Understanding Forensics in IT ―, NIIT Ltd, 2005 Cory Altheide and Harlan Carvey, ―Digital Forensics with Open Source Tools‖ Elsevier publication, April 2011
5. Kevin Mandia, Chris Prosise, Matt Pepe, ―Incident Response and Computer Forensics ―, TataMcGraw -Hill, New Delhi, 2006.
6. Nelson Phillips and Enfinger Steuart, ―Computer Forensics and Investigations‖, Cengage Learning, New Delhi, 2009.
7. Robert M Slade,‖ Software Forensics‖, Tata McGraw - Hill, New Delhi, 2005

| 21CS2922 | OPEN SOURCE PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Open source community easy to adoption and use in creating (and running) much of the modern internet.
2. Allow anyone to modify, enhance or re-engineer a program's code
3. Understand about open source products on the Internet by using a search engine
4. Understand about Free open source content-management system
   Understanding about web security applications

**UNIT I INTRODUCTION 9**

Introduction to open source programming languages, advantages and drawbacks of open source programming, threats and vulnerabilities in open source languages, Operating System – Ubuntu Linux – Introduction to shell programming.

**UNIT II PHP 9**

Language Basics, Functions - calling a function, variable function, and anonymous function, Strings - cleaning, encoding and escaping, and comparing strings, Arrays – storing data in arrays, extracting multiple values, traversing, and sorting arrays, Objects – creation, introspection, and serialization, Web Techniques – processing forms and maintaining state.

**UNIT III WEB DATABASE APPLICATIONS 9**

Three-tier architecture, Introduction to Object oriented programming with PHP 5, Database basics, MYSQL - querying web databases, writing to web databases, validation with JavaScript, Form based authentication, protecting data on the web.

**UNIT IV PERL, TCL, AND PYTHON 9**

Numbers and Strings, Control Statements, Lists and Arrays, Files, Pattern matching, Hashes, Functions. Introduction to TCL/TK, Introduction to Python.

**UNIT V SECURITY IN WEB APPLICATIONS 9**

Recognizing web application security threats, Code Grinder, Building functional and secure web applications, Security problems with JavaScript, vulnerable GCI scripts, Code Auditing and Reverse Engineering, types of security used in applications.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Implement various applications using build systems
2. Understand the installation of various packages in open source operating systems
3. Create simple GUI applications using php, mysql
4. To understand the concept of Scripting language like JavaScript and GCI
5. Learn Scripting language like JavaScript

**TEXT BOOKS:**


1. Kevin Tatroe, Peter MacIntyre, RasmusLerdorf, “Programming PHP”, O’Reilly Media, 2012.
2. Michael Cross, “Developer’s Guide to Web Application Security”, Syngress Publishers, 2007.
3. Hugh E. Williams, David Lane, “Web Database applications with PHP and MYSQL”, Second Edition, O’Reilly Media, 2004.CSE

| 21CS2923 | SOFTWARE AGENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. Have an overview of the agent system and Software agent
2. To provide a good understanding of software process, threads, Daemons and Java agents
3. Design and Build multi agent system
4. Have a basic understanding about software agent technology and to be familiar with some of the communicating languages, standardization and applications
5. To implements Software Agents and Security.

**UNIT I AGENTS – OVERVIEW 9**

Agent Definition – Agent Programming Paradigms – Agent Vs Object – Aglet – Mobile Agents – Agent Frameworks – Agent Reasoning.

**UNIT II JAVA AGENTS 9**

Processes – Threads – Daemons – Components – Java Beans – ActiveX – Sockets – RPCs – Distributed Computing –Aglets Programming – Jini Architecture – Actors and Agents – Typed and Proactive Messages-Agent Programming.

**UNIT III MULTIAGENT SYSTEMS 9**

Interaction between Agents – Reactive Agents – Cognitive Agents – Interaction Protocols – Agent Coordination – Agent negotiation – Agent Cooperation – Agent Organization – Self-Interested Agents in Electronic Commerce Application.

**UNIT IV INTELLIGENT SOFTWARE AGENT 9**

Interface Agents – Agent Communication Languages – Agent Knowledge Representation – Agent Adaptability – Belief Desire Intension – Mobile Agent Applications

**UNIT V AGENTS AND SECURITY 9**

Agent Security Issues – Mobile Agents Security – Protecting Agents against Malicious Hosts – Untrusted Agent – Black Box Security – Authentication for Agents – Security Issues for Aglets-Multi Agent System in E Health Territorial Emergency.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Understanding the fundamentals of agents and agent programming paradigms
2. Discussing the basics of java agents
3. Learning the concepts of multi agent systems
4. Understanding the concepts of intelligent software agents
5. Understand the agents and security

**REFERENCE BOOKS:**


1. Bigus & Bigus, “Constructing Intelligent agents with Java”, Wiley, 2010.
2. Bradshaw, “Software Agents”, MIT Press, 2012.
3. Russel & Norvig, “Artificial Intelligence a modern approach”, Prentice Hall, 1994.
4. Richard Murch and Tony Johnson, “Intelligent Software Agents”, Prentice Hall, 2000.’
5. Michael Wooldridge, “An Introduction to Multi Agent Systems”, John Wiley, 2002.

| 21CS2924 | HIGH PERFORMANCE COMPUTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To understand the basics of high performance computer architecture.
2. To understand the concept of parallel execution within computer systems through modern parallel architectures.
3. To understand the concept memory allocation and management in high performance computer.
4. To introduce various High-performance computing environments and implementation issues.

**UNIT I INTRODUCTION TO PARALLEL COMPUTING** 9

Introduction — Computational Demands — Two real-time needs — Parallel Processing Terminology — Data, Temporal and Control Parallelisms — Flynn's Taxonomy — Processor arrays, Multiprocessors, Multi computers- Fundamental Algorithms — Broadcasting and All-prefix-sums Criteria for Complexity Analyses- Introduction to Heterogeneous Parallel Computing. GPU architecture. Thread hierarchy. GPU Memory Hierarchy.

**UNIT II MEMORY HIERARCHIES 9**

Memory Hierarchies, Multi-core Processors: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose-built

**UNIT III PARALLEL ALGORITHMS 9**

Parallel algorithms on various models with complexity analyses for selection, merging sorting and searching problems. Introduction to Parallel Programming Languages — CS and Sequent C - Comparison of Parallel Computing with Supercomputing and Distributed Computing

**UNIT IV GRID COMPUTING 9**

Introduction — Definition, Evolution and Elements — Current Perspective — Definition, block Diagram, Grid Computing Business areas and Applications - Grid Computing Infrastructure and vulnerability — security Issues — Resource Management.

**UNIT V CLUSTER COMPUTING 9**

Introduction - Cluster Computer and its Architecture, Parallel Applications and Their Development - Strategies for Developing Parallel Applications - Code Granularity and Levels of Parallelism - Parallel Programming Models and Tools - Parallel Languages, Message Passing, Virtual Shared Memory, Parallel Object-Oriented Programming, Programming Skeletons - Methodical Design of Parallel Algorithms - Partitioning, Communication, Agglomeration, Mapping- Restructuring applications for deep memory hierarchies.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

1. Understand the HPC platforms and parallel programming models.
2. Able to measure, analyse and assess the performance of HPC applications and their supporting hardware.
3. Management in an HPC environment, with particular reference to Grid and Cluster Computing.

**REFERENCE BOOKS:**


1. A.Y.Zomaya, "Parallel and Distributed Computing Handbook", 1995. McGrawHill Professional.
2. Michael J.Quinn, "Parallel Computing: Theory and Practice", Second Edition, 1994, Tata McGrawHill, Inc
3. Joshy Joseph, CreigFellenstein, "Grid Computing", 2003, PHI.
4. Kai Hwang, "Scalable Parallel Computing", McGraw Hill 1998.
5. Introduction to Parallel Computing, AnanthGrama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Welsey, 2003.
6. RajkumarBuyya, "High Performance Cluster Computing: Architectures and Systems", Vol. I, 1999, PH Inc.
7. RajkumarBuyya, "High Performance Cluster Computing: Programming and Applications", Vol. 2, 1999, PH Inc..
8. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, 2007.
9. Victor Eijkhout, Edmond Chow, Robert van de Geijn, Introduction to High Performance Scientific Computing, 2nd edition, revision 2016.

| 21CS2925 | E-LEARNING TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

1. To learn the various E-learning approaches and Components.
2. To understand the key elements of Design Thinking.
3. To explore the models for E-learning courseware development.
4. To design E-learning courses using Authoring tools.
5. To analyze various E-learning solutions for design and development
6. Develop an evaluation plan for the E-Learning
7.

**UNIT I INTRODUCTION 9**

Introduction to E- Learning - Need for E-Learning – Types of E-Learning – Strategies of E-Learning Components of ELearning– Synchronous and Asynchronous Modes of Learning – Quality of E-Learning – Blended Learning: Activities, Team and Technology – Work Flow to Produce and Deliver E-Learning Content. Design Thinking: Introduction – Actionable Strategy – Act to Learn – Leading Teams to Win.

**UNIT II DESIGNING E-LEARNING CONTENT / COURSE 9**

Design Models of E-Learning – Identifying and Organizing E-Learning Course Content: Needs Analysis –Analyzing the Target Audience – Identifying Course Content - Defining Learning Objectives – Defining the Course Sequence – Defining Instructional Methods – Defining Evaluation and Delivery Strategies – Case Study.

**UNIT III CREATING INTERACTIVE E- CONTENT 9**

Preparing content: Tips for Content Development and Language Style – Creating storyboards: Structure of an interactive Multimedia E-lesson – Techniques for presenting Multimedia content – Integrating multimedia elements -Developing Practice and Assessment Tests – Courseware Development – Authoring tools – Types of Authoring Tools – Selecting an Authoring Tool.

**UNIT IV LEARNING PLATFORMS 9**

Types of Learning Platforms – Proprietary vs. Open – Introduction Learning Management System (LMS) – Content management System – CMS vs LMS – LMS solutions – Functional Areas of LMS.

**UNIT V COURSE DELIVERY AND EVALUATION 9**

Components of an Instructor Led or Facilitated Course – Planning and Documenting Activities – Facilitating Learners Activities – E-learning Methods and Delivery Formats – Using Communication Tools for E-learning – Course Evaluation -Developing Evaluation Instruments – Evaluating E-Learning Development – Evaluating E-Learning Course

**TOTAL : 45 PERIODS**

**OUTCOMES:**

1. Distinguish the phases of activities in models of E-learning
2. Identify appropriate E-Learning instructional methods and delivery strategies
3. Choose appropriate E-learning Authoring tools
4. Create interactive E-Learning courseware
5. Evaluate the E-learning courseware
6. Determine the quality, effectiveness, and continuous improvement of the e- Learning

**REFERENCE BOOKS:**


1. Clark, R. C., & Mayer, R. E. (2016). E-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. John Wiley & Sons.
2. Means, B., Toyama, Y., Murphy, R, "Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies", 2010.
3. Crews, T. B., Sheth, S. N., Horne, T. M, "Understanding the Learning Personalities of Successful Online Students. Educause Review", 2014.
4. Johnny Schneider, "Understanding Design Thinking, Lean and Agile", 2017.
5. Horton William, e-Learning by Design, Publisher: Pfeiffer, 2011.
6. Madhuri Dubey, "Effective E-learning Design, Development and Delivery", University Press 2011.
7. Arshavskiy, M. Instructional design for Elearning: Essential guide to creating successful Elearning courses. CreateSpace.,2013