**ANNA UNIVERSITY, CHENNAI**
**UNIVERSITY DEPARTMENTS**
**M.TECH. INFORMATION TECHNOLOGY**
**REGULATIONS - 2019**
**CHOICE BASED CREDIT SYSTEM**

## DEPARTMENT OF INFORMATION SCIENCE AND TECHNOLOGY

### VISION OF THE DEPARTMENT:

To educate students with conceptual knowledge and technical skills in the field of Information Technology with moral and ethical values to achieve excellence in academic, industry and research centric environments.

### MISSION OF THE DEPARTMENT:

1. To inculcate in students a firm foundation in theory and practice of IT skills coupled with the thought process for disruptive innovation and research methodologies, to keep pace with emerging technologies.
2. To provide a conducive environment for all academic, administrative and interdisciplinary research activities using state-of-the-art technologies.
3. To stimulate the growth of graduates and doctorates, who will enter the workforce as productive IT engineers, researchers and entrepreneurs with necessary soft skills, and continue higher professional education with competence in the global market.
4. To enable seamless collaboration with the IT industry and Government for consultancy and sponsored research.
5. To cater to cross-cultural, multinational and demographic diversity of students.
6. To educate the students on the social, ethical, and moral values needed to make significant contributions to society.

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## 1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students to excel in research or to succeed in Information Technology Profession by adapting to the rapid advances in new emerging technologies through rigorous graduate education.
II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to provide IT solutions to real-world problems of Industries, Businesses and Society.
III. To train students with good computer science and engineering knowledge so as to comprehend, analyze, design and create novel products and novel IT services.
IV. To inculcate students in solving real-time problems through IT knowledge and with attention to team work, effective communication skills and critical thinking.
V. To provide student with an academic environment aware of excellence, leadership, ethical codes and guidelines, learning and teamwork for a successful professional career.

## 2. PROGRAMME OUTCOMES (POs):

On successful completion of the programme, the students will acquire the following:

| PO # | Programme Outcome |
|---|---|
| 1 | An ability to independently carry out research /investigation and development work to solve practical problems. |
| 2 | An ability to write and present a substantial technical report/document. |
| 3 | A degree of mastery over the field of Information Technology. |
| 4 | An ability to comprehend, select and adopt appropriate and emerging computing and communication technologies to solve the challenging problems of this information era. |
| 5 | An ability to recognize the need for applying efficient software and hardware based solutions to improve the quality of life. |
| 6 | An ability to function effectively as an individual and a team member, in project and product development and to follow professional ethics in the career. |

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### 3. PEO / PO Mapping:

| Programme Educational Objectives | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| PE01 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| PE02 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| PE03 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PE04 | | ✓ | | | | ✓ |
| PE05 | ✓ | | | ✓ | ✓ | ✓ |

### 4. Mapping of Course Outcome and Programme Outcome

| Year | Semester | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|
| YEAR 1 | SEM 1 | Probability and Statistical Methods | | | | | | |
| | | Advanced Data Structures and Algorithmics | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Web Technologies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Advanced Networks | ✓ | | ✓ | ✓ | ✓ | |
| | | Research Methodology and IPR | ✓ | | | | | ✓ |
| | | Audit Course I | ✓ | | | | | ✓ |
| | | Advanced Data Structures and Algorithms Laboratory | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | | Web Technologies Laboratory | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Software Design Methodologies | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | Advances in Operating Systems | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | Data Engineering Laboratory | | | | | | |
| | | Program Elective I | | | | | | |
| | | Program Elective II | | | | | | |
| | | Audit Course II | | | | | | |
| YEAR 2 | SEM 3 | Program Elective III | | | | | | |
| | | Program Elective IV | | | | | | |
| | | Program Elective V | | | | | | |
| | | Mini Project with Seminar | | | | | | |
| | | Dissertation I | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | SEM 4 | Dissertation II | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

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**M.TECH. INFORMATION TECHNOLOGY**
**REGULATIONS - 2019**
**CHOICE BASED CREDIT SYSTEM**
**I – IV CURRICULA AND SYLLABI**
**SEMESTER I**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA5156 | Probability and Statistical Methods | FC | 3 | 1 | 0 | 4 | 4 |
| 2. | IF5151 | Advanced Data Structures and Algorithmics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | IF5152 | Web Technologies | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | IF5101 | Advanced Networks | PCC | 3 | 0 | 2 | 5 | 4 |
| 5. | RM5151 | Research Methodology and IPR | MC | 2 | 0 | 0 | 2 | 2 |
| 6. | | Audit Course – I* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 7. | IF5161 | Advanced Data Structures and Algorithms Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 8. | IF5162 | Web Technologies Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **16** | **1** | **10** | **27** | **20** |

*Audit course is optional

**SEMESTER II**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | IF5201 | Software Design Methodologies | PCC | 3 | 0 | 2 | 5 | 4 |
| 2. | IF5202 | Advances in Operating Systems | PCC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Program Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Program Elective II | PEC | 3 | 0 | 2 | 5 | 4 |
| 5. | | Open Elective | OE | 3 | 0 | 0 | 3 | 3 |
| 6. | | Audit Course –II* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 7. | IF5261 | Data Engineering Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |
| 8. | IF5211 | Mini Project with Seminar | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **17** | **0** | **10** | **27** | **20** |

*Audit course is optional

## SEMESTER III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Program Elective III | PEC | 3 | 0 | 2 | 5 | 4 |
| 2. | | Program Elective IV | PEC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Program Elective V | PEC | 3 | 0 | 2 | 5 | 4 |
| **PRACTICALS** | | | | | | | | |
| 4. | IF5311 | Dissertation I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **9** | **0** | **16** | **25** | **17** |

## SEMESTER IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1 | IF5411 | Dissertation II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL NO. OF CREDITS: 70**



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**UNIVERSITY DEPARTMENTS**
**M.TECH. INFORMATION TECHNOLOGY (PART-TIME)**
**REGULATIONS - 2019**
**CHOICE BASED CREDIT SYSTEM**
**I - VI SEMESTER CURRICULA AND SYLLABI**

**SEMESTER I**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA5156 | Probability and Statistical Methods | PCC | 3 | 1 | 0 | 4 | 4 |
| 2. | IF5151 | Advanced Data Structures and Algorithmics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | RM5151 | Research Methodology and IPR | AC | 2 | 0 | 0 | 2 | 2 |
| **PRACTICALS** | | | | | | | | |
| 4. | IF5161 | Advanced Data Structures and Algorithms Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **8** | **1** | **4** | **13** | **11** |

**SEMESTER II**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | IF5201 | Software Design Methodologies | PCC | 3 | 0 | 2 | 5 | 4 |
| 2. | IF5202 | Advances in Operating Systems | PCC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Open Elective I | OE | 3 | 0 | 0 | 3 | 3 |
| 4. | | Audit Course - I* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 5. | IF5211 | Mini Project with Seminar | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **11** | **0** | **6** | **17** | **12** |

*Audit course is optional

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## SEMESTER III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | IF5152 | Web Technologies | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | IF5101 | Advanced Networks | PCC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Audit Course –II* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 4. | IF5162 | Web Technologies Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **8** | **0** | **6** | **14** | **9** |

*Audit course is optional

## SEMESTER IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Program Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Program Elective II | PEC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Program Elective III | PEC | 3 | 0 | 2 | 5 | 4 |
| | | | **TOTAL** | **9** | **0** | **4** | **13** | **11** |

## SEMESTER V

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Program Elective IV | PEC | 3 | 0 | 2 | 5 | 4 |
| 2. | | Program Elective V | PEC | 3 | 0 | 2 | 5 | 4 |
| **PRACTICALS** | | | | | | | | |
| 3. | IF5311 | Dissertation I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **6** | **0** | **16** | **22** | **14** |

## SEMESTER VI

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | IF5411 | Dissertation II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL NO. OF CREDITS: 70**

## FOUNDATION COURSE (FC)

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 9. | MA5156 | Probability and Statistical Methods | FC | 3 | 1 | 0 | 4 | 4 |

## PROGRAM CORE COURSE (PCC)

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | IF5151 | Advanced Data Structures and Algorithmics | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | IF5152 | Web Technologies | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | IF5101 | Advanced Networks | PCC | 3 | 0 | 2 | 5 | 4 |
| 4. | IF5161 | Advanced Data Structures and Algorithms Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 5. | IF5162 | Web Technologies Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 6. | IF5201 | Software Design Methodologies | PCC | 3 | 0 | 2 | 5 | 4 |
| 7. | IF5202 | Advances in Operating Systems | PCC | 3 | 0 | 2 | 5 | 4 |
| 8. | IF5261 | Data Engineering Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |

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## PROGRAM ELECTIVE COURSE (PEC)

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **ELECTIVES I** | | | | | | | | |
| 1. | IF5086 | Virtualization | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | IF5089 | Unix Internals | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | IF5082 | Next Generation Wireless Networks | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | IF5091 | Wireless Sensor Networks and Protocols | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | IF5084 | Software Architecture and Principles | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | IF5072 | Artificial Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | IF5071 | Advanced Computer Architecture | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | IF5001 | Reasoning Methods in Computer Science | PEC | 3 | 0 | 0 | 3 | 3 |
| **ELECTIVES II** | | | | | | | | |
| 1. | IF5078 | Distributed and Cloud Computing | PEC | 3 | 0 | 2 | 5 | 4 |
| 2. | IF5074 | Building Internet of Things | PEC | 3 | 0 | 2 | 5 | 4 |
| 3. | IF5081 | Information Retrieval | PEC | 3 | 0 | 2 | 5 | 4 |
| 4. | IF5092 | Analysis of Social Networks | PEC | 3 | 0 | 2 | 5 | 4 |
| 5. | IF5077 | Digital Image Processing Techniques | PEC | 3 | 0 | 2 | 5 | 4 |
| 6. | IF5075 | Computer Vision | PEC | 3 | 0 | 2 | 5 | 4 |
| 7. | IF5076 | Deep Learning | PEC | 3 | 0 | 2 | 5 | 4 |
| 8. | IF5080 | Human Computer Interaction Techniques | PEC | 3 | 0 | 2 | 5 | 4 |
| 9. | IF5083 | Pattern Recognition | PEC | 3 | 0 | 2 | 5 | 4 |
| 10. | IF5073 | Autonomous Ground Vehicle Systems | PEC | 3 | 0 | 2 | 5 | 4 |
| **S. NO.** | **COURSE CODE** | **COURSE TITLE** | **CATE GORY** | **PERIODS PER WEEK** | | | **TOTAL CONTACT PERIODS** | **CREDITS** |
| | | | | **L** | **T** | **P** | | |
| **ELECTIVES III, IV, V** | | | | | | | | |
| 11. | IF5002 | Open Source Technologies | PEC | 3 | 0 | 2 | 5 | 4 |
| 12. | IF5079 | GPU Architecture and Programming | PEC | 3 | 0 | 2 | 5 | 4 |
| 13. | IF5003 | Service Oriented Architecture and Microservices | PEC | 3 | 0 | 2 | 5 | 4 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 14. | IF5004 | Cryptography and Information Security | PEC | 3 | 0 | 2 | 5 | 4 |
| 15. | IF5005 | Software Quality Assurance and Testing | PEC | 3 | 0 | 2 | 5 | 4 |
| 16. | IF5006 | Soft Computing and Its Applications | PEC | 3 | 0 | 2 | 5 | 4 |
| 17. | IF5007 | Machine Learning Techniques | PEC | 3 | 0 | 2 | 5 | 4 |
| 18. | IF5090 | Semantic Web | PEC | 3 | 0 | 2 | 5 | 4 |
| 19. | IF5008 | Text Mining | PEC | 3 | 0 | 2 | 5 | 4 |
| 20. | IF5009 | E-Learning Techniques | PEC | 3 | 0 | 2 | 5 | 4 |
| 21. | IF5010 | Data Warehousing and Data Mining | PEC | 3 | 0 | 2 | 5 | 4 |
| 22. | IF5011 | Bioinformatics | PEC | 3 | 0 | 2 | 5 | 4 |
| 23. | IF5012 | Compiler Engineering | PEC | 3 | 0 | 2 | 5 | 4 |
| 24. | IF5088 | Mobile Application Development | PEC | 3 | 0 | 2 | 5 | 4 |
| 25. | IF5013 | Cyber Forensics | PEC | 3 | 0 | 2 | 5 | 4 |
| 26. | IF5014 | Biometrics | PEC | 3 | 0 | 2 | 5 | 4 |
| 27. | IF5015 | Blockchain Technologies | PEC | 3 | 0 | 2 | 5 | 4 |
| 28. | IF5016 | Multimedia Technologies | PEC | 3 | 0 | 2 | 5 | 4 |
| 29. | IF5017 | Advanced Database Systems | PEC | 3 | 0 | 2 | 5 | 4 |
| 30. | IF5018 | Linked Open Data | PEC | 3 | 0 | 2 | 5 | 4 |
| 31. | IF5085 | Video Processing and Analytics | PEC | 3 | 0 | 2 | 5 | 4 |
| 32. | MM5072 | Mixed Reality | PEC | 3 | 0 | 2 | 5 | 4 |
| 33. | IF5087 | Visualization Techniques | PEC | 3 | 0 | 2 | 5 | 4 |
| 34. | MM5071 | Advanced Computer Graphics and Animations | PEC | 3 | 0 | 2 | 5 | 4 |
| 35. | MM5073 | Multimedia Coding Techniques | PEC | 3 | 0 | 2 | 5 | 4 |

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## OPEN ELECTIVE COURSES (OEC)

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

| SI. NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OE5091 | Business Data Analytics | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OE5092 | Industrial Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OE5093 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OE5094 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OE5095 | Composite Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OE5096 | Waste to Energy | OEC | 3 | 0 | 0 | 3 | 3 |

## AUDIT COURSES (AC)

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

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | Lecture | Tutorial | Practical | |
| 1. | AX5091 | English for Research Paper Writing | 2 | 0 | 0 | 0 |
| 2. | AX5092 | Disaster Management | 2 | 0 | 0 | 0 |
| 3. | AX5093 | Sanskrit for Technical Knowledge | 2 | 0 | 0 | 0 |
| 4. | AX5094 | Value Education | 2 | 0 | 0 | 0 |
| 5. | AX5095 | Constitution of India | 2 | 0 | 0 | 0 |
| 6. | AX5096 | Pedagogy Studies | 2 | 0 | 0 | 0 |
| 7. | AX5097 | Stress Management by Yoga | 2 | 0 | 0 | 0 |
| 8. | AX5098 | Personality Development Through Life Enlightenment Skills | 2 | 0 | 0 | 0 |
| 9. | AX5099 | Unnat Bharat Abhiyan | 2 | 0 | 0 | 0 |
| | | | | | TOTAL CREDITS | 0 |

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## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S. NO. | CODE NO. | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IF5211 | Mini Project with Seminar | EEC | 0 | 0 | 2 | 2 | 1 |
| 2. | IF5311 | Dissertation I | EEC | 0 | 0 | 12 | 12 | 6 |
| 3. | IF5411 | Dissertation II | EEC | 0 | 0 | 24 | 24 | 12 |



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**MA5156 PROBABILITY AND STATISTICAL METHODS L T P C**
**3 1 0 4**

**OBJECTIVES:**

I. This course provides a sound and rigorous treatment of the basic principles for a proper understanding of the subject matter and for confidence in applying these principles to practical problem solving
II. This course provides a solid undergraduate foundation in both probability theory and mathematical statistics and at the same time provides an indication of the relevance and importance of the theory in solving problems in the real world
III. To introduce the basic concepts of one dimensional and two dimensional Random Variables
IV. To provide information about Estimation theory, Correlation, Regression and Testing of hypothesis
V. To enable the students to use the concepts of multivariate normal distribution and principal components analysis

**UNIT I ONE DIMENSIONAL RANDOM VARIABLES 12**

Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

**UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12**

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

**UNIT III ESTIMATION THEORY 12**

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.

**UNIT IV TESTING OF HYPOTHESES 12**

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

**UNIT V MULTIVARIATE ANALYSIS 12**

Random Vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

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

- Use the appropriate and relevant, fundamental and applied mathematical and statistics knowledge and methodologies in solving practical problem.
- Bring together and flexibly apply knowledge to characterize, analyse and solve a wide range of problems.
- Understand the balance between the complexity/accuracy of the mathematical/statistical models used and the timeliness of the delivery of the solution.
- Steeped in research methods and rigor.
- Develop critical thinking based on empirical evidence and the scientific approach to knowledge development.

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**REFERENCES:**


1. Dallas E Johnson , “Applied multivariate methods for data analysis”, Thomson and Duxbury press, Singapore, 1998.
2. Gupta S.C. and Kapoor V.K. “Fundamentals of Mathematical Statistics”, Sultan and Sons, 11th Edition, Reprint, New Delhi, 2019.
3. Jay L. Devore, “Probability and statistics for Engineering and Sciences”, Thomson and Duxbury, 9th Edition, Singapore, Boston, 2016.
4. Krishnaiah K. and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI, New Delhi, 2012.
5. Richard A. Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
6. Richard Johnson. ”Miller & Freund‟s Probability and Statistics for Engineer”, Prentice Hall of India Private Ltd., 8th Edition, New Delhi, 2011.


**IF5151 ADVANCED DATA STRUCTURES AND ALGORITHMICS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the usage of algorithms in computing.
- To understand and learn the algorithm design techniques.
- To learn and use hierarchical data structures and its operations.
- To learn the usage of graphs and its applications.
- To study about NP Completeness of problems.

**UNIT I ALGORITHMS IN COMPUTING 9**

Algorithms – Iterative and Recursive Algorithms – Insertion Sort – Analyzing Algorithms – Designing Algorithms – Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions – Recurrences: The Substitution Method – The Recursion – Tree Method – Randomized Algorithms – Quick Sort.

**Suggested Activities:**

- Flipped classroom on divide & conquer strategy (Merge Sort, Quick Sort).
- External learning – Solving recurrence relations using Master’s method.
- Formulation of recurrence relations for various recursive algorithms (such as Tower of Hanoi, Staircase problem).
- Assignment on finding order of growth for exponent and logarithmic time algorithms.

**Suggested Evaluation Methods:**

- Assignments on formulation of recurrence relations, Master’s method, finding order of growth for algorithms.
- Quizzes on divide and conquer strategy.

**UNIT II ALGORITHM DESIGN TECHNIQUES 8**

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

**Suggested Activities:**

- Flipped classroom on basics of algorithm design strategies.
- External learning – String edit distance and Knapsack problem.
- Assignment on applying suitable algorithm design technique for solving real time problems/scenario such as Checker Board/Sequence Alignment/Puzzle Solving/Data Compression.
- Assignment on analysis of time complexity for memorization algorithms and Huffman Coding.

**Suggested Evaluation Methods:**

- Assignments on Knapsack problems.
- Quizzes on algorithm design strategies.
- Demonstration for practical learning.

**UNIT III HIERARCHICAL DATA STRUCTURES 10**

Binary Search Trees: Basics – Querying a Binary Search Tree – Insertion and Deletion – Red-Black Trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion – Definition of B-trees – Basic Operations on B-Trees – Deleting a Key from a B-Tree – Min Max Heaps – Leftist Heaps – Binomial Heaps: Structure – Mergeable-Heap Operations.

**Suggested Activities:**

- Flipped classroom on AVL trees and binary heap concepts.
- External learning – Fibonacci heap operations.
- Assignment on choosing and apply a suitable tree/heap structure for solving a given real time problem/scenario such as the implementation of trees/heaps/PDF document creation.
- Assignment on analysis of time complexity for B-Trees and Binomial Heaps.

**Suggested Evaluation Methods:**

- Assignments on binomial heap operations.
- Quizzes on AVL trees, binary heaps, time complexity of trees.
- Demonstration of practical learning.

**UNIT IV GRAPH ALGORITHMS 9**

Graphs: Representations of Graphs – Topological Sort – Strongly Connected Components – Minimum Spanning Trees: Kruskal and Prim – Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths in Directed Acyclic Graphs, Dijkstra's Algorithm – All- Pairs Shortest Paths: The Floyd-Warshall Algorithm.

**Suggested Activities:**

- Flipped classroom on basics of graphs and graph operations.
- External learning – Applications of graphs and DFS.
- Analysis of time complexity for Dijkstra's algorithm and Floyd Warshall algorithm.
- Practical – To choose and apply a suitable graph algorithms for solving a real time problem/scenario such as network routing/shortest path updation in maps/relationship mining in graphs.

**Suggested Evaluation Methods:**

- Assignments on analysis of time complexity for Dijkstra's algorithm and Floyd Warshall algorithm.
- Quizzes on graph operations.
- Demonstration of practical learning.

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**UNIT V NP-COMPLETE AND NP –HARD 9**

NP-Completeness – Polynomial Time – Polynomial-Time Verification – NP Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems – Clique Problem – The Hamiltonian Cycle Problem – Approximation Algorithms – Vertex Cover Problem.

**Suggested Activities:**

- Flipped classroom on basics of approximation algorithms.
- External learning – Subset sum problem.
- Assignments on solving traveling salesman problem using approximation technique.
- Exploration of any two NP-complete problems with proofs.

**Suggested Evaluation Methods:**

- Assignments on NP-complete problems with proofs, traveling salesman problem using approximation techniques.
- Quizzes on approximation algorithms.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Apply suitable algorithms in real time computing.
2. Apply suitable design strategies to solve problems in an efficient manner.
3. Apply suitable hierarchical data structures to solve practical problems.
4. Design algorithms using graph structures to solve real-life problems.
5. Solve NP Complete problems efficiently.
6. Design data structures and algorithms that are appropriate for real time problems.

**REFERENCES:**


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2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, 2006.
3. Robert Sedgewick, Kevin Wayne, “Algorithms”, Fourth Edition, Pearson Education. 2011.
4. S. Sridhar, “Design and Analysis of Algorithms”, Second Edition, Oxford University Press, 2014.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO6** | 3 | 2 | 3 | 3 | 3 | 3 |

**IF5152** **WEB TECHNOLOGIES** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the object oriented concepts of Java and learn GUI based application development and network programming.
- To learn client side scripting languages to create dynamic web pages.
- To build dynamic web sites using databases and server side technologies.
- To understand the importance of advanced frameworks.
- To integrate all the features of web technologies for application development.

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

Overview of Java – Object Oriented Concepts: Classes and methods, Inheritance, Polymorphism, Interfaces, packages: JAR files and Annotation – GUI Development – I/O – Files, Streams and Object Serialization – Multithreading – Networking – Generic Collections – Generic Classes and Methods.

**Suggested Activities:**

- Flipped classroom on basics of Java.
- Learning and implementation of the following topics:
  - Java frame and applet based application development.
  - Java I/O streams for text and binary data operations to read from and write to files.
  - Java based thread implementation using thread priorities.
  - Java networking applications using sockets and datagrams.
  - Java applications using generic collections.

**Suggested Evaluation Methods:**

- Quiz on Java fundamentals.
- Tutorial – Advanced Java features.

**UNIT II WEB AND SCRIPTING** **9**

Overview of HTML5 – Cascading Style Sheets – Overview of JavaScript – Events Handling –Regular Expressions – HTML DOM, Web Browser BOM, AJAX, JSON – Dynamic Web Pages – Jquery – Overview of Angular JS.

**Suggested Activities:**

- Learning and implementation of the following topics
  - Developing complex web forms using HTML5 and validating using Javascript.
  - Enhancing website appearance with style sheets.
  - Validating sting data using regular expressions.
  - Traversal of HTML5 document using HTML DOM.
- External learning – Usage of Angular JS in simple web applications.

**Suggested Evaluation Methods:**

- Quizzes on HTML5 features and Java scripts.
- Presentation on Jquery and Angular JS features.

**UNIT III WEB APPLICATION DEVELOPMENT** **9**

Database Connectivity – JDBC Drivers – Servlets – Servlet API – Servlet Configuration – Running Servlet with Database Connectivity – Basics of JSP – Java Server Faces – MVC Architecture of JSF Apps – JSF Components – Session Tracking – Accessing Databases in Web Apps – Developing Dynamic Data Driven Websites.

**Suggested Activities:**

- Learning and Implementation of the following topics
  - Develop a database application using JDBC.
  - Develop a servlet program that illustrates the usage of cookies and sessions.
  - Create a shopping cart application and guest book web apps using JSF.
  - Validate user input of an application such as singing contest using JSP.
- Flipped classroom on MVC architecture.
- External learning – Development of dynamic web applications.

**Suggested Evaluation Methods:**

- Quiz on JDBC.
- Quiz on cookies, JSF and Java Beans.
- Demonstration of web applications developed using servlets, JSP and JSF.

**UNIT IV DISTRIBUTED OBJECTS 9**

Distributed Objects – RMI Programming Model – Java Beans Component – Java Beans API –XML – Java XML API – XML – RPC – WSDL – SOAP – Overview of Java Web Services – JAX-WS – RESTful Web Services.

**Suggested Activities:**

- Learning and implementation of the following topics
  - Create XML schema for specifying and validating the structure of an XML document.
  - Retrieve and manipulate XML data programmatically.
- External learning – Creation of an AJAX-enabled version of the feedback form with appropriate fields.
- External learning – Creation of a SOAP and RESTful web services.

**Suggested Evaluation Methods:**

- Quiz on RMI, XML and web services.
- Demonstration of RMI, XML and web services implementation.

**UNIT V ADVANCED FRAMEWORKS 9**

Hibernate Architecture – Overview of HQL – O/R Mapping – Working with Hibernate – MVC Architecture – Struts – Understanding Actions – Dependency Injection and Inversion of Control – Spring 3.0 – Dependency Injection – Spring Library – Developing Applications – Case Studies – Current Trends.

**Suggested Activities:**

Learning and Implementation of the following topics

- Create a simple application using struts.
- Hibernate framework based O/R mapping.
- To create simple applications using Spring framework.

**Suggested Evaluation Methods:**

- Demonstration of Hibernate, Struts and Spring framework based application.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Have knowledge on Java based implementation of object oriented features.
2. Develop dynamic websites using client side technologies.
3. Develop dynamic web applications with database connectivity using server side technologies.
4. Create distributed applications using RMI and web services.

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5. Design and develop applications using advanced frameworks.
6. Apply client and server side technologies for developing web applications with distributed objects and advanced framework features.

**REFERENCES:**


1. "Core and Advanced Java, Black Book", Dreamtech Press, 2018.
2. Paul J. Deitel and Harvey Deitel, "Java How to Program", Eleventh Edition, Pearson Education, 2017.
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4. Cay S. Horstmann, "Core Java" Volume I & II, Pearson Education, 2018
5. Marty Hall and Larry Brown, "Core Servlets And Javaserver Pages", Second Edition, Pearson Education, 2008.
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| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 2 | 2 | 2 |

**IF5101 ADVANCED NETWORKS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn about the principles and practices of advanced computer networking concepts.
- To understand the importance of Quality of Service in IP networks.
- To explore the need for Ipv6 and manage the MPLS technology in networks.
- To learn about SDN architecture and OpenFlow for network virtualization.
- To gain an in-depth knowledge of Network Virtualization Function.

**UNIT I INTRODUCTION 9**

Switched Networks and Shared Media Networks – Circuit Switching, Packet Switching and Virtual Circuits – Flow Control and Congestion Control – TCP/IP Reference Model –Network Externalities – Service Integration – Elastic and Inelastic Traffic – Playback Applications – Additional Requirements for Inelastic Traffic – Core Networks and Access/Edge.

**Suggested Activities:**

- Flipped classroom on network externalities and economies of scale.
- External learning – Inter-continental backbone network and Autonomous Systems model of the Internet.
- Computing the playout time of packets.

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**Suggested Evaluation Methods:**

- Quiz and discussion on network externalities and economies of scale.
- Assignments on inter-continental backbone network and autonomous systems.

**UNIT II QUALITY OF SERVICE 9**

Queuing – Queuing Model – Single Server – Multi-server – Integrated Service Architecture – Internet Traffic – ISA Services QoS Architectural framework – Quality of Service and Metrics – Integrated Services Architecture – Approach, Components, Services – Queuing Discipline: FQ, PS, BRFQ, GPS, WFQ – Traffic Shaping Algorithms – Random Early Detection – Differentiated Services – Class of Service – IP Precedence – Type of Service – Per-Hop Behavior – RSVP: Goals, Characteristics, Operations and Mechanisms.

**Suggested Activities:**

- Design the network topology and the appropriate traffic characteristics using simulators such as Riverbed.
- Experiment with various parameters and compute the throughput across the link.

**Suggested Evaluation Methods:**

- Assess the computation of the QoS parameters theoretically.
- Compare with the simulated parameters.

**UNIT III Ipv6 and MPLS 9**

Ipv6 Addressing Scheme – Ipv6 Header – Address Auto Configuration – Ipv6 Enhancements MPLS Architecture – MPLS: Operations, Label Stacking, Protocol Details – Label Distribution – Traffic Engineering with MPLS – Quality of Service with MPLS Technology – Network Recovery and Restoration with MPLS Technology.

**Suggested Activities:**

- Configure MPLS network GNS3 / any open-source tools.
- Identify how ping and traceroute work in MPLS network.
- Practical – Simulate network recovery and restoration scenarios.

**Suggested Evaluation Methods:**

- Assessment on different network topology.
- Evaluation of the practical.

**UNITIV SOFTWARE DEFINED NETWORKING 9**

Evolution of SDN – Characteristics of SDN – Control Plane – Control and data plane separation – SDN Data Plane – SDN Control Plane – OpenFlow Architecture – SDN Controller – VxLAN.

**Suggested Activities:**

- Configure OpenFlow switches.
- View switch configuration and capability using dpctl command in mininet.

**Suggested Evaluation Methods:**

- Evaluate some basic SDN applications using various open-sourced SDN controllers.
- Evaluate for various commands.

**UNIT V NETWORK FUNCTION VIRTUALIZATION 9**

NFV Concepts and Architecture – Virtualization and Data Plane I/O – Service Locations and Chaining – Functionality – Management – Use Cases of SDNs: Data Centers, Overlays, Big Data.

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**Suggested Activities:**

- Create and manipulate software defined components.
- Developing SDN in a big data application (application-driven network control).

**Suggested Evaluation Methods:**

- Evaluating the manipulations for different scenarios.
- Assessing the effect of big data application in SDN.

**PRACTICAL EXERCISES: 30**

1. Generate network traffic with a Web Browser. Using Wireshark capture the traffic flow for various protocols.
2. Build a simple network in Packet Tracer and observe how data flows in the network.
3. Analyze traffic flows statistics during network tests.
4. Start capturing packets and use telnet to login and enter the password. Use Wireshark and capture in order to identify and reassemble the password from the captured network traffic.
5. Configure MPLS LDP sessions between two directly connected routers.
6. Write a simple monitoring module that counts all packets going to or leaving host (mininet/ryu).
7. Configure Openflow switches with dpctl command.
8. Create a simple_switch application that keeps track of where the host with each MAC address is located and accordingly sends packets towards the destination and not flood all ports.
9. Develop a Ryu SDN switch application with load balancing. Implement a round robin mechanism for deciding the forwarding port when installing the flows in the switch.
10. Write a simple firewalling module that blocks traffic between 2 hosts.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

**On completion of the course, the student will be able to:**

- Explain the advancements in Ethernet Technologies.
- Configure and manage different concepts of QoS polices in IP networks.
- Configure and manage the Ipv6 addressing based network.
- Design a MPLS based network and able to provide QoS, TE services.
- Implement the SDN concepts and manage SDN controller.
- Explain network function virtualization techniques and apply the emerging technologies for various case studies.

**REFERENCES:**


1. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Elsevier/Morgan Kaufmann Publishers, 2011.
2. Bruce S. Davie, Adrian Farrel, “MPLS: Next Steps”, Morgan Kaufmann Publishers, 2011.
3. Paul Goransson, Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publisher, June 2014.
4. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O’Reilly Media, August 2013.
5. William Stallings, “Foundations of Modern Networking – SDN, NFC, QoE, IoT and Cloud” Third Edition, Pearson Education, 2019.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO2** | 3 | 1 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 1 | 2 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 1 | 2 |
| **CO6** | 3 | 2 | 3 | 2 | 1 | 2 |

**RM5151 RESEARCH METHODOLOGY AND IPR LT P C**
**2 0 0 2**

**OBJECTIVES:**
To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- 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, plagiarism, and research ethics.

**UNIT III TECHNICALWRITING /PRESENTATION 6**
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

**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 Case Studies, IPR and IITs.

**TOTAL: 30 PERIODS**

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**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 today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | | | | | | |
| CO2 | ✓ | | | | | | | | | | | |
| CO3 | ✓ | | | | | | | ✓ | | | | |
| CO4 | ✓ | | | | ✓ | | | | | | | |
| CO5 | ✓ | | | | | ✓ | | | | | | ✓ |

**REFERENCES:**


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


**IF5161 ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY L T P C**
**0 0 4 2**

**OBJECTIVES:**

- To learn the design strategies of various algorithms.
- To learn how to analyze the complexities of algorithms.
- To learn and understand the usage of advanced tree structures.
- To familiarize with the usage of heap structures.
- 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. Binomial heap operations.
9. Representation of graphs and graph traversals
10. A spanning tree for a given graph using Prim's algorithm.
11. Shortest path of a given graph using Dijkstra's algorithm and Bellman Ford algorithm.
12. All pair shortest path of a given graph using Floyd Warshall's algorithm.

**TOTAL: 60 PERIODS**

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**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Design and implement iterative and recursive algorithms with minimum complexity.
2. Design and develop efficient algorithms for practical problems by adopting suitable algorithm design strategies.
3. Design and implement basic and advanced data structures extensively.
4. Apply suitable hierarchical data structures based on real time problems.
5. Design algorithms using graph structures.
6. Implement real world applications by proper usage of data structures and algorithms.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 1 | 3 | 3 | 3 | 2 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 3 |

**IF5162** **WEB TECHNOLOGIES LABORATORY** **L T P C**
**0 0 4 2**

**OBJECTIVES:**

- To develop simple Java programs using object orientation concepts.
- To program using files and threads for concurrent operations.
- To design attractive GUI using framework.
- To create more dynamic web pages using CSS, JavaScript and AJAX.
- To develop mobile based web applications in cloud environment.

**LIST OF EXPERIMENTS:**

1. Simple Java programs using arrays and lists.
2. Object orientation program using inheritance and polymorphism.
3. Simple association using objects (pass & return by reference).
4. Simple GUI application development using applet and SWING.
5. Implement multithread program for concurrent operations.
6. Develop program to set priority and synchronize java threads.
7. Input and Output manipulation on files (Read/Write).
8. Java programs on generic and collections.
9. Client Server network application using java sockets.
10. Dynamic web page creation using Javascript, Jquery and AJAX.
11. Develop servlet and JSF application with JDBC access.
12. Manage sessions in JSP using cookies.
13. Create simple Node Javascript functions for server.
14. Android application for location based service.
15. Develop cloud based web application.

**TOTAL: 60 PERIODS**

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**OUTCOMES:**

On completion of the course, the students will be able to:

1. Implement object oriented concepts using Java language
2. Develop GUI application by including I/O streams and threads.
3. Create web pages with proper client-side features
4. Design dynamic web pages with server-side and other technologies
5. Develop simple android based mobile application
6. Deploy web applications in a cloud based environment.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 2 | 2 | 2 | 2 | 2 |

**IF5201 SOFTWARE DESIGN METHODOLOGIES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To gain knowledge about various software development lifecycle (SDLC) models, software development techniques and its application in real world context.
- To understand process, process improvement, requirements engineering and requirements management.
- To be aware of designing a software considering the various perspectives of end user. To learn to develop a software component using coding standards and facilitate code reuse.
- To use advanced software testing techniques.
- To analyze the software using metrics and measurement and predict the complexity and the risk associated with projects.

**UNIT I INTRODUCTION AND FORMAL METHODS 9**

Software and Software Engineering – Software Process Models – Process Activities – The Rational Unified Process – Agile Development – Agile Software – Process Improvement – Software Quality Methodologies.

**Suggested Activities:**

- Identify and propose ways to build quality software to stop deterioration due to change.
- Assignments like the following: Giving reasons for your answer based on the type of system being developed, suggest the most appropriate generic software process model that might be used as a basis for managing the development of the following systems (not limited to):
  - A system to control anti-lock braking in a car.
  - A virtual reality system to support software maintenance.
  - A university accounting system that replaces an existing system.

- An interactive travel planning system that helps users plan journeys with the lowest environment impact.
- Using the FDD feature template, define a feature set for a web browser.

**Suggested Evaluation Methods:**

- Assignments on the selection of suitable software process models for a given software specification.
- Tutorial – Identification of sample application for each process model and justification of the same stating reasons.

**UNIT II REQUIREMENTS ENGINEERING AND MANAGEMENT 9**

Requirements Engineering – Requirements Elicitation – Analysis and Negotiation – Requirements Modeling and Specification – Requirements Validation and Management – Requirements Engineering Process Models.

**Suggested Activities:**

- External Learning – Using open-source tools for RE to understand the requirements traceability and interdependency among the functionalities provided by the software project.
- External Learning – Requirements elicitation mechanisms and selection of an appropriate strategy.

**Suggested Evaluation Methods:**

- Tutorial on various Requirements elicitation mechanisms and selection of an appropriate strategy.
- Assignment on requirements categorization (considering contradicting, omission, commission of requirements) in a software project.
- Assignment on Selection of suitable software process models for a given software specification.

**UNIT III SOFTWARE DESIGN AND SOFTWARE IMPLEMENTATION 9**

Objectives – Overview of Software Design Process – Component based and Model-driven Development – Design Methods: Procedural and Structural Design Methods, Object Oriented Design Method, Unified Modeling Language Overview, Static and Dynamic Modeling – Advance Use Case: Class, State, Sequence Diagrams.

**Suggested Activities:**

- Design and model for any project (Software Project Categories – Php Projects, Data Mining, Android Projects, Smart Card/ Biometrics, Dotnet Projects, Web Based Projects, Information Security, Ios Projects, Artificial Intelligence, Embedded Projects).
- Draw the activity network representation of the tasks.
- Determine ES, EF, and LS, LF for every task.
- Develop the Gantt chart representation for the project.

**Suggested Evaluation Methods:**

- Assignments on software design and modeling.
- Tutorial problems on UML Modeling.
- Quiz on software design methods and its implementation.

**UNIT IV SOFTWARE PRACTICES, PROCESSES AND ARCHITECTURE 9**

Software Engineering Practices – Essence – Core Principles – Communication Practice – Planning Practice – General Structure of a Process – Process Framework – Process Improvements – Software Development Methodologies – Object Oriented Development Process – Unified Process – RAD Model – Software Testing.

**Suggested Activities:**

- In-class activity on application specific product and process view.
- Develop a complete process framework for any project like healthcare system.
- A class project may be given as follows: Develop a debugging plan that will provide language and system oriented hints that have been learnt. Begin with the outline of topics that will be revived by the class and your instructor. Publish the debugging plan for others in your local environment.

**Suggested Evaluation Methods:**

- Assignment on testing sample application and understand the differences in selecting of test cases from the test suite.
- Tutorial problems on software development methodologies.
- Quiz on software development methodologies and software engineering practices.

**UNIT V SOFTWARE PROJECT MANAGEMENT 9**

Real-time Software Design – Real-time Requirement specification – Design Guidelines for Real-time Software – Scheduling Concepts – Testing Real-time Software, Risk Management, Planning and Scheduling – Configuration Management – Software Quality Management – Software Metrics.

**Suggested Activities:**

- Perform software project management for any project like automobile in which the driver commands the steering wheel and provides vision.
- Develop a schedule timeline.
- Develop Mini projects (Software Project Categories – PHP Projects, Data Mining, Android Projects, Smart Card/ Biometrics, Dotnet Projects, Web Based Projects, Information Security, IOS Projects, Artificial Intelligence, Embedded Projects)

**Suggested Evaluation Methods:**

- Assignment on testing sample application and understanding the differences in the selection of test cases from the test suite.
- Tutorial problems on risk management, configuration management, quality management, planning and scheduling.
- Quiz on risk management, configuration management, quality management, planning and scheduling.

**PRACTICAL EXERCISES: 30**

Design, develop, implement and test any one of the following projects:

1. Data Mining.
2. Embedded Projects, Smart Card/Biometrics.
3. Web Based Projects.
4. Information Security.
5. Artificial Intelligence.

The road map for the project will be the following:

- Identify and propose ways to build quality software for the chosen project.
- Identify, justify and develop an appropriate generic software process model for the

chosen project.

- Using the FDD feature template, define a feature set for the chosen project.
- Perform requirements elicitation mechanisms on the selected project and justify the selection of an appropriate strategy.
- Categorize the requirements (considering contradicting, omission, commission of requirements) in a software project.
- Perform analysis.
- Develop a complete process framework.
- Design and model for the chosen project.
- Draw the activity network representation of the tasks for the chosen project.
- Determine ES, EF, and LS, LF for every task.
- Develop the Gantt chart representation for the project.
- Perform software project management tasks.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

- Analytically apply general principles of software development in the development of complex software and software- intensive systems.
- Understand methods and techniques for advanced software development and also be able to use these in various development situations.
- Apply testing techniques for object oriented software and web-based systems.
- Familiarize with the basic concepts of Software design and implementation.
- Apply various software metrics on software quality products.
- Apply various skills on real-time projects.

**REFERENCES:**


1. Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Seventh Edition, Tata McGraw-Hill, 2009.
2. Ian Sommerville, “Software engineering”, Ninth Edition, Pearson Education, 2010.
3. S. A. Kelkar, “Software Engineering A Concise Study”, PHI Learning, 2010.
4. Ali Behforooz, Frederick J. Hudson, “Software Engineering Fundamentals”, Oxford University, 1996.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO2** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO3** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO4** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO5** | 3 | 1 | 3 | 2 | 3 | 1 |
| **CO6** | 3 | 1 | 3 | 2 | 3 | 1 |

**IF5202** **ADVANCES IN OPERATING SYSTEMS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To expose students to real-world systems artifacts in operating systems.
- To understand the solutions for critical problems of an Operating system.
- To gain knowledge on Distributed operating system concepts that includes architecture, Mutual exclusion algorithms, Deadlock detection algorithms and agreement protocols.
- To gain insight on to the distributed resource management components viz. the algorithms for implementation of distributed shared memory, recovery and commit protocols.
- To know the components and management aspects of Real time, Mobile operating systems.

**UNIT I OPERATING SYSTEM BASICS 6**

Overview – Synchronization Mechanisms – Process and Threads– Critical Section Problem – Synchronization Problems: Dining Philosophers, Producer consumer – Language Mechanism for Synchronization: Monitors, Serializers, Path Expressions, Communicating Sequential Processes – Process Deadlocks – Deadlock Detection – Deadlock Prevention – Recovery – Models of Resources.

**Suggested Activities:**

- Practical – Solution to producer consumer problem in communicating sequential processes.
- Assignment on deadlock prevention.
- External learning – Models of deadlock and resources.

**Suggested Evaluation Methods:**

- Verifying the correctness of the solution for the given problem.
- Quiz on synchronization problems.

**UNIT II DISTRIBUTED OPERATING SYSTEM 11**

Issues in Distributed Operating System – Communication Primitives – Lamport‟s Logical clocks – Vector Clocks – Causal Ordering of Messages – Distributed Mutual Exclusion Algorithms: Lamport’s Algorithm – The Ricart-Agarwala Algorithm – Maekawa’s Algorithm – Centralized and Distributed Deadlock Detection Algorithms.

**Suggested Activities:**

- Practical – Write a program in any language for clock synchronization of events occur during chat based on time stamp and a logical counter.
- Practical – Write a program to enforce causal ordering of messages of a system with multiple processes.
- External learning – Global state recording algorithm to identify deadlocks in distributed systems.

**Suggested Evaluation Methods:**

- Evaluation of the order of events based on clock and counter values in the practical exercise.
- Evaluation of the delivery of messages from one process to other with the justification for the order of delivery in the practical exercise.
- Quiz on distributed deadlock detection.

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**UNIT III DISTRIBUTEDRESOURCE MANAGEMENT 11**

Distributed File System – Design Issues – Distributed Shared Memory – Algorithms for Implementing Distributed Shared memory–Issues in Load Distributing – Load Distributing Algorithms – Failure Recovery: Synchronous and Asynchronous Check Pointing and Recovery – Fault Tolerance: Two-Phase Commit Protocol – Non-blocking Commit Protocol – Security and Protection.

**Suggested Activities:**

- Practical – Implementing a system for resource management in distributed environment with appropriate modules to access files from a remote system using any programming language. Use multithreading concept and ensure provisions for new user registration and authentication of existing users.
- Practical – Create a file in FreeBSD and perform read and write operations.
- Study the following files in FreeBSD: file.c, sysfile.c [file creation, reading and writing]

**Suggested Evaluation Methods:**

- Evaluation of the understanding of the file concepts in FreeBSD.
- Implementation evaluation of small file problem in FreeBSD.
- Quiz on FreeBSD study files and other parts of the module.

**UNIT IV REAL TIME & MOBILE OPERATINGSYSTEMS 8**

Basic Model of Real Time Systems – Characteristics– Applications of Real Time Systems – Real Time Task Scheduling – Handling Resource Sharing – Mobile Operating Systems – Micro Kernel Design – Client Server Resource Access – Processes and Threads – Memory Management – File system-Android.

**Suggested Activities:**

- Mini project (group) for developing real time application.
- Assignments on file systems.

**Suggested Evaluation Methods:**

- Evaluation of the mini project.
- Quiz on file system.

**UNIT V CASE STUDIES 9**

The FreeBSD System: Design principle – Interface – Process Management– Memory Management – File System – Interprocess Communication – iphone Ios4: Architecture and SDK Framework – Media Layer – Services Layer – Core OS Layer – File System.

**Suggested Activities:**

- External learning – Process start up and disk partion in FreeBSD
- Study of the following files in FreeBSD:
    - proc.c[set up first user process, create new process, allocating process, exit of process, process states and scheduling], swtch.S [context switch]
    - proc.h [per-CPU state and per-process state],
    - vectors.S [trap handler]-> trapasm.S [build trap frame]->trap.c[Interrupt Descriptor Table] -> traps.h[Interrupt constants] -> syscall.c [system call handler]
- Write a user program to check and print the state of a process (current/all/specified) in FreeBSD.

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**SUGGESTED EVALUATION METHODS:**

- Quiz on FreeBSD study files and other parts of the Module.

**PRACTICAL EXERCISES**: **30**

1. Introduction to Linux and shell programming. (4 hours)
2. Write a program to implement a distributed chat server using TCP socket.
3. Write a program to implement client server RPC and client server based program using RMI.
4. Write a multi threaded client server program.
5. Write a program to simulate the functioning of lamports logical clock and lamports vector clock.
6. Write a program to implement Christian's algorithm and Berkeley algorithm.
7. Write a program to check grep and pipe commands in FreeBSD.
8. Write a program to do file permission and directory file permission in free BSD.
9. Write a program to building multi-threaded and multi-process application.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Articulate the main concepts, key ideas, strengths and limitations of operating systems.
2. Analyze the structure and basic architectural components of OS.
3. Have an understanding of high-level OS kernel structure.
4. Used gained insight into hardware-software interactions for compute and I/O.
5. Acquire practical skills in system tracing and performance analysis.
6. Explore research ideas in system structure and behaviour.

**REFERENCES:**


1. Mukesh Singhal, Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill, 2001.
2. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", Ninth Edition, John Wiley, 2012.
3. Andrew S. Tanenbaum, "Modern Operating System", Third Edition, Prentice Hall, 2008.
4. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education, 2006.
5. H. M. Deitel, P. J. Deitel, D. R. Choffnes, "Operating Systems", Pearson Education, 2004.
6. Neil Smyth, "iPhone Ios 4 Development Essentials – Xcode", Fourth Edition, Payload Media, 2011.
7. Neil Smyth, "Android 4.4 for App Development Essentials", Payload Media, 2014.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 2 |
| **CO2** | 1 | 2 | 3 | 1 | 1 | 1 |
| **CO3** | 2 | 2 | 3 | 1 | 1 | 1 |
| **CO4** | 1 | 2 | 3 | 2 | 1 | 1 |
| **CO5** | 1 | 2 | 2 | 3 | 1 | 1 |
| **CO6** | 3 | 2 | 3 | 3 | 2 | 1 |

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**IF5261** **DATA ENGINEERING LABORATORY** **L T P C**
**0 0 2 1**

**OBJECTIVES:**

- To provide a hands-on experience in R and Weka tool.
- To use the R packages for performing data preprocessing.
- To learn using Weka tool for data preprocessing.
- To familiarize the usage of R commands for visualizing data.
- To write and deploy simple algorithms as Map-Reduce tasks.

**LIST OF EXPERIEMNTS:**

1. Install standalone R. Install and configure Hadoop. Finally install Rhadoop.
2. Use R tool to explore various commands for descriptive data analytics using bench mark datasets.
3. Explore various variable and row filters in R for cleaning data.
4. Use R commands for probability distributions and probability statistics.
5. Formulate real business problems scenarios to hypothesis and solve using R statistical testing features.
6. Apply various plot features in R on sample data sets and visualize.
7. Write and execute word count, word search and pattern search problems from large text files using Map Reduce programs.
8. Write simple Map Reduce functions for sorting, grouping, joining, projecting, and filtering bench mark data sets.
9. Implement Relational Algebra Operations, Grouping and Aggregation as Map-Reduce tasks.
10. Install Weka tool and explore various data preprocessing options using bench mark data sets.

**TOTAL: 30 PERIODS**

**OUTCOME:**

On completion of the course, the students will be able to:

1. Learn to install and use R.
2. Write and execute various data preprocessing experiments in the R platform.
3. Execute data cleaning processes on voluminous data sets.
4. Develop, implement and deploy simple data handling algorithms such as Map Reduce functions.
5. Learn to apply R functions on various applications.
6. Learn to install and use Weka tool.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 3 | 1 | 1 | 2 | 2 | 1 |
| **CO2** | 2 | 3 | 2 | 3 | 2 | 1 |
| **CO3** | 1 | 2 | 3 | 3 | 3 | 1 |
| **CO4** | 2 | 1 | 1 | 3 | 2 | 1 |
| **CO5** | 2 | 1 | 2 | 3 | 3 | 2 |
| **CO6** | 1 | 1 | 1 | 2 | 2 | 2 |

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**IF5086** **VIRTUALIZATION** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the concept of virtualization.
- To understand the various issues in virtualization.
- To familiarize themselves with the types of virtualization.
- To compare and analyze various virtual machines.
- To explore the virtualization tools and products.

**UNIT INTRODUCTION TO VIRTUALIZATION 9**

System Architectures – Virtual Machine Basics – Process virtual machines – System virtual Machines – Taxonomy of virtual machines – Emulation: Basic Interpretation – Threaded Interpretation – Pre-coded & Direct Interpretation – Binary translation – Full and Para–Virtualization – Types of Hypervisor – Types of Virtualization.

**Suggested Activities:**

- Quizzes on process virtual machines and system virtual machines.
- Practical – Install Oracle Virtual Box/Vmware Workstation and create a blackboard application [Hint: One VM should act as a master and other VMs acts as a listeners, when any content is written by the master VM, the content should be displayed in all the Listener VMs].

**Suggested Evaluation Methods:**

- Report submission and evaluation of the working of application in virtual environment.

**UNIT II SERVER VIRTUALIZATION 8**

Server virtualization: Partitioning techniques – Hardware Virtualization – Virtual Hardware – Types of Server Virtualization – Business cases for Sever Virtualization – Uses of Virtual server Consolidation – Selecting server Virtualization Platform.

**Suggested Activities**

- Install any one Sever Virtualization Tool (Vmware Esx,Xen,KVM) and run and create two VM and configure one vm as Web Server and another as File Server.

**Suggested Evaluation Methods**

- Review the Working of Installed Server Virtualization Tools ( Access the Service offered by Remote Virtual machine via web browser)

**UNIT III NETWORK VIRTUALIZATION 10**

Design of Scalable Enterprise Networks – Virtualizing the Campus WAN Design – WAN Architecture – WAN Virtualization – Virtual Enterprise Transport Virtualization–VLANs and Scalability – Theory Network Device Virtualization Layer 2 – VLANs Layer 3 VRF Instances Layer 2 – VFIs Virtual Firewall Contexts Network Device Virtualization – Datapath Virtualization Layer 2: 802.1q –Trunking Generic Routing Encapsulation –IPSec L2TPv3 Label Switched Paths – Control–Plane Virtualization–Routing Protocols– VRF – Aware Routing Multi–Topology Routing.

**Suggested Activities:**

- Create and configure a VLAN using Cisco packet tracer.
- Connect the Created VLANs using router in Cisco packet tracer.

**Suggested Evaluation Methods:**

- Demo – Inter VLAN Communication.

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**UNIT IV STORAGE VIRTUALIZATION 8**

Hardware Devices – SCSI– Speaking SCSI– Using SCSI buses – Fiber Channel – Fiber Channel Cables –Fiber Channel Hardware Devices – Iscsi Architecture – Securing Iscsi SAN Backup & Recovery Techniques – RAID – Classic Storage Model – SNIA Shared Storage Model Host based Architecture – Storage based architecture – Network based Architecture – Fault tolerance to SAN – Performing Backups – Virtual tape libraries.

**Suggested Activities:**

- Setup Iscsi in Linux Machine.

**Suggested Evaluation Methods:**

- Created storage luns should be accessed from target/remote system.

**UNIT V APPLYING VIRTUALIZATION 9**

Comparison of Virtualization Technologies: Guest, host os, hypervisor, emulation, kernel level, shared kernel – Enterprise Solution: Vmware Server, Esxi, Citrix XenServer, Microsoft virtual PC,Microsoft Hyper–V,Virtual box – Server Virtualization: configuring Server with server virtualization, adjusting & tuning virtual servers.VM backup & migration – Desktop Virtualization:terminal services, hosted desktop, web based solutions, localized virtualized desktop – Network & storage virtualization:VPN,VLAN,SAN & VSAN,NAS.

**Suggested Activities:**

- Mini project – Must use any virtualization Concept.

**Suggested Evaluation Methods:**

- Demonstration of the mini project.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

- Create a virtual machine and to extend it to a virtual network.
- Discuss on various virtual machine.
- Compile all types of virtualization techniques and utilize them in design of virtual machines.
- Apply the concepts of virtualization in network and storage.
- Explore the various virtualization tools.
- Be able to use cisco packet tracer to simulate network virtualization.

**REFERENCES:**


1. William von Hagen, “Professional Xen Virtualization”, Wrox Publications, January, 2008.
2. Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, Apress 2005.
3. Kumar Reddy, Victor Moreno, “Network virtualization”, Cisco Press, July, 2006.
4. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005.
5. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: Vmware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | 3 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 1 |
| **CO3** | 3 | 1 | 3 | 3 | 1 | 1 |
| **CO4** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO5** | 3 | 1 | 3 | 3 | 2 | 3 |
| **CO6** | 3 | 1 | 3 | 2 | 2 | 1 |

**IF5089** **UNIX INTERNALS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To learn about the design of the Unix operating system.
- To become familiar with the various data structures used.
- To learn the various low-level algorithms used in Unix.
- To understand the various Unix system calls.
- To explore the process and memory management concepts.

**UNIT I OVERVIEW** **9**

General Overview of the System – System Structure – User Perspective – Operating System Services – Assumptions about Hardware – Introduction to the Kernel Architecture of the UNIX Operating System – Introduction to System Concept – The Buffer Cache – Buffer Headers – Structure of the Buffer Pool – Scenarios for Retrieval of a Buffer – Reading and Writing Disk Blocks – Advantages and Disadvantages of the Buffer Cache.

**Suggested Activities:**

- External learning – Usage of disk blocks and buffer cache.
- Assignment on system calls related to various UNIX commands.

**Suggested Evaluation Methods:**

- Quizzes on services of OS.
- Quizzes on advantages and disadvantages of buffer cache.

**UNIT II FILE SUBSYSTEM** **9**

Internal Representation of Files: Inodes – Structure of a Regular File – Directories – Conversion of a Path Name to an Inode – Super Block – Inode Assignment to a New File – Allocation of Disk Blocks.

**Suggested Activities:**

- Quizzes on inode.
- Practical – Implement superblock structure to handle the allocation and releasing of inode.

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**Suggested Evaluation Methods:**

- Demonstration of the practical implementation.
- Assignment on disk block allocation.

**UNIT III SYSTEM CALLS FOR THE FILE SYSTEM 9**

Open – Read – Write – File and Record Locking – Adjusting the Position of File I/O – lseek – close – File Creation – Creation of Special Files – Changing Directory – Root – Owner – Mode – stat and fstat – Pipes – Dup – Mounting and Unmounting File Systems – Link – Unlink.

**Suggested Activities:**

- Practical – Implement the following UNIX commands using System calls in C Program: cat and mv
- Practical – Write a C program to determine the size of a file using the lseek command. Once you found out the size, calculate the number of blocks assigned for the file.
- Practical – Write two simple programs pipe reader.c and pipe writer.c that use a named pipe to communicate. The pipe reader program will set up a named pipe using mkfifo(), open it read only, and read strings from it until it nalyzin the string exit. The writer will open the named pipe file, read strings from the user and write them to the named pipe. When the user enters exit, the program will write the string to the pipe and then exit.

**Suggested Evaluation Methods:**

- Demonstration of the practical implementations and quizzes on the implementations.

**UNIT IV PROCESSES 10**

Process States and Transitions – Layout of System Memory – The Context of a Process – Saving the Context of a Process – Manipulation of the Process Address Space – Process Control –process Creation – Signals – Process Termination – Awaiting Process Termination – Invoking other programs – User Id of a Process – Changing the size of a Process – Shell – System Boot and the INIT Process.

**Suggested Activities:**

- Practical – Write a program in C that creates a child process, waits for the termination of the child and lists its PID, together with the state in which the process was terminated (in decimal and hexadecimal)
- Practical – In a C program, print the address of the variable and enter into a long loop (say using while (1)). Start three to four processes of the same program and observe the printed address values. Show how two processes which are members of the relationship parent child are concurrent from execution point of view, initially the child is copy of the parent, but every process has its own data.

**Suggested Evaluation Methods:**

- Demonstration of the practical implementations and quizzes on the implementations.

**UNIT V MEMORY MANAGEMENT AND I/O 8**

Memory Management Policies – Swapping – Demand Paging – The I/O Subsystem: Driver Interface – Disk Drivers – Terminal Drivers.

**Suggested Activities:**

- Practical – Implement memory management Policies (Group Activity)
- Practical – Modify the functionality of basic commands in xv6 system (Group Activity)

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**Suggested Evaluation Methods:**

- Demonstration of the mini project.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand UNIX architecture and describe the component of operating system
2. Explain how they interact with computer hardware.
3. Deeper understanding of system calls in Unix operating system.
4. Apply the concepts of operating systems design to practical problems.
5. Design and implement the subsystems of an operating system.
6. Critically analyze different data structures and algorithms used in the building of a kernel.

**REFERENCES:**


1. Maurice J. Bach, “The Design of the Unix Operating System”, First Edition, Pearson Education, 1999.
2. B. Goodheart, J. Cox, “The Magic Garden Explained”, Prentice Hall of India,1986.
3. S. J. Leffler, M. K. Mckusick, M. J. Karels, J. S. Quarterman, “The Design and Implementation of the 4.3 BSD Unix Operating System”, Addison Wesley, 1998.
4. Robert Love, “Linux Kernel Development”, Third Edition, Addison Wesley, 2010.


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| **CO1** | 3 | 1 | 1 | 2 | 2 | 1 |
| **CO2** | 3 | 1 | 1 | 2 | 2 | 1 |
| **CO3** | 3 | 1 | 1 | 2 | 2 | 1 |
| **CO4** | 3 | 1 | 3 | 2 | 3 | 1 |
| **CO5** | 3 | 1 | 2 | 2 | 3 | 1 |
| **CO6** | 3 | 1 | 2 | 2 | 3 | 1 |



**IF5082 NEXT GENERATION WIRELESS NETWORKS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To learn the fundamentals of 5G internet.
- To understand the concept of small cells in 5G mobile networks.
- To learn the mobile clouds in 5G network context.
- To understand the role of cognitive radios in 5G networks.
- To learn the security issues in 5G networks.

**UNIT I PERVASIVE CONNECTED WORLD AND 5G INTERNET 9**

Historical Trend of Wireless Communications – Evolution of LTE Technology to Beyond 4G – 5G Roadmap – Ten Pillars of 5G – Internet of Things and Context Awareness – Networking Reconfiguration and Virtualization Support – Mobility – Quality of Service Control – Emerging Approach for Resource Over-provisioning.

**Suggested Activities:**

- Flipped classroom on Ten Pillars of 5G.
- Assignment on millimeter wave mobile communication.
- External learning – 5G in global level.

**Suggested Evaluation Methods:**

- Viva voce on assignment topic.
- Group discussion on different generations of telecommunication networks.
- Quiz on spectrum allocation strategies for 5G.

**UNIT II SMALL CELLS FOR 5G MOBILE NETWORKS 9**

Introduction to Small Cells – Capacity Limits and Achievable Gains with Densification – Mobile Data Demand – Demand vs. Capacity – Small Cell Challenges.

**Suggested Activities:**

- Flipped classroom on types of small cells.
- Assignments on issues in fem to cells.
- External learning – Small cell challenges.

**Suggested Evaluation Methods:**

- Viva Voce on assignment topic.
- Quizzes on the drawbacks of dense deployment of wifi systems.

**UNIT III COOPERATION FOR NEXT GENERATION WIRELESS NETWORKS 9**

Introduction – Cooperative Diversity and Relaying Strategies: Cooperation and Network Coding, Cooperative ARQ MAC Protocols – PHY Layer Impact on MAC Protocol Analysis: Impact of Fast Fading and Shadowing on Packet Reception for QoS Guarantee, Impact of Shadowing Spatial Correlation– Study: NCCARQ, PHY Layer Impact.

**Suggested Activities:**

- Flipped classroom on network coding.
- External learning – Cooperative MAC protocols.
- Assignment on packet exchange in PRCSMA.

**Suggested Evaluation Methods:**

- Viva voce on assignment topic.
- Quiz on NCCARQ operation under realistic channel conditions.
- Practical – Assessing the performance of NC-aided MAC protocols in event-driven C++ simulator.

**UNIT IV MOBILE CLOUDS AND COGNITIVE RADIO 9**

Introduction – The Mobile Cloud – Mobile Cloud Enablers – Network Coding – Overview of Cognitive Radio Technology in 5G Wireless –Spectrum Optimization using Cognitive Radio – Relevant Spectrum Optimization Literature in 5G – Cognitive Radio and Carrier Aggregation – Energy Efficient Cognitive Radio Technology.

**Suggested Activities:**

- External learning – Network coding.
- Assignment on spectrum optimization using cognitive radio.
- External learning – Key Requirements and Challenges for 5G Cognitive Terminals.
- Assignment on component of a cognitive radio terminal.

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**Suggested Evaluation Methods:**

- Viva voce on assignment topics.
- Quiz on carrier aggregation.

**UNIT V SECURITY &SELF ORGANISING NETWORKS 9**

Overview of Potential 5G Communications System Architecture – Security Issues and Challenges in 5G Communications Systems – Self Organising Networks: Introduction, Self Organising Networks in UMTS and LTE, The Need for Self Organising Networks in 5G, Evolution towards Small Cell Dominant HetNets.

**Suggested Activities:**

- External learning – 5G communications system architecture.
- Flipped classroom on security issues and challenges in communication systems.
- Assignment on centralised 5G mobile botnet.

**Suggested Evaluation Methods:**

- Viva voce on assignment topics.
- Quiz on D-SON and C-SON architectures.
- Group discussion on attacks on 4G Access Network.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Compare the 5G network with older generations of networks.
2. Identify suitable small cells for different applications in 5G networks.
3. Simulate 5G network scenarios.
4. Connect applications to mobile cloud.
5. Design applications with 5Gnetwork support.
6. Analyze the security risks in 5G networks.

**REFERENCES:**


1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.
2. Yin Zhang, Min Chen, “Cloud Based 5G Wireless Networks”, SpringerBriefs in Computer Science, Springer, 2016.
3. Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis Takis Mathiopoulos, “New Directions in Wireless Communications Systems: From Mobile to 5G”, CRC Press, 2017.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO3** | 1 | 2 | 1 | 2 | 2 | 1 |
| **CO4** | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO5** | 2 | 1 | 2 | 2 | 2 | 3 |
| **CO6** | 2 | 2 | 2 | 2 | 2 | 1 |

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**IF5091 WIRELESS SENSOR NETWORKS AND PROTOCOLS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To learn about the physical layer and MAC layer of WSNs.
- To understand the data centric computing to be followed in WSNs.
- To study about the routing protocols followed in WSNs.
- To study about data aggregation and in–network processing.
- To explore various motes, sensor network operating systems, databases and development platforms.

**UNIT I FUNDAMENTALS OF WSN 9**

Wireless Adhoc Networks – Distributed Sensing – Sensors and Transducers – Types of Sensors – Accuracy, Resolution and Hysteresis – Architecture of a Sensor Node and WSN – Sensor Network Design Considerations – Energy Efficient Design Principles for WSNs – Applications of WSNs.

**Suggested Activities:**

- External learning – Exploring various sensors, the corresponding actuators, various motes and their configuration (sensors supported, microcontroller and the clock speed, Flash, RAM, Battery capacity, RF transceivers and data rate supported).
- Flipped classroom on accuracy, hysteresis and resolution of sensors.
- Exploring energy required for transmission, receiving and channel sensing.

**Suggested Evaluation Methods:**

- Assignments on various types of sensors, actuators and motes.
- Quiz and discussion on accuracy, hysteresis and resolution of sensors.
- Assignments on problem solving related to energy consumption in WSNs.

**UNIT II MAC LAYER OF WSN AND ZIGBEE STANDARD 9**

Energy issues in Transceiver Design and Channel Access – PHY Frame Structure – Roles of Nodes – End device, Router and Coordinator – Full Function Device and Reduced Function Device – Star, Mesh and Tree topology – Medium Access Control – Duty cycle S–MAC protocol – IEEE 802.15.4 standard and ZigBee.

**Suggested Activities:**

- External learning – A study of Wireless HART, 6LoWPAN and ISA 100.11a standards.
- Flipped classroom on different roles of nodes in WSNs and different types of ZigBee devices.
- Analyzing duty cycle and sleep cycle of S–MAC protocol.

**Suggested Evaluation Methods:**

- Assignments on various standards available for WSNs.
- Quiz and discussion on roles of nodes and different types of ZigBee devices.
- Assignments on solving problems related to duty cycle of S–MAC protocol.

**UNIT III DATA CENTRIC COMPUTING IN WSN 9**

Data Gathering and Dissemination–Broadcasting and Geocasting from Sink – Data Aggregation – LMST based Aggregation – Power Efficient Data gathering and Aggregation (PEDAP) – In–Network Processing – Aggregate Queries – Routing Challenges and Strategies in WSNs – SPIN, Directed Diffusion, Rumour Routing, Energy Aware Routing, Gradient based Routing.

**Suggested Activities:**

- Flipped classroom on data centric computing and information centric networks.
- Assignments on analyzing the generation and consumption of energy with non-conventional energy sources.
- External learning – Sensor network platforms and tools and sensor network databases.

**Suggested Evaluation Methods:**

- Quiz and discussion on data-centric computing and Information-centric networks.
- Assignments on solving problems regarding generation and consumption of energy sources.
- Assignments on sensor network platforms, tools and sensor network databases.

**UNIT IV SYNCHRONIZATION, LOCALIZATION AND TRACKING IN WSNs 9**

Sensor Management – Topology Control Protocols and Sensing Mode Selection Protocols – Time Synchronization – Localization and Positioning – Ranging techniques – Range based localization algorithms – Location services – Scene analysis, GPS and RFID.

**Suggested Activities:**

- External learning – Exploring tracking of objects using ultrasonic sensors and camera nodes.
- Exploring the idea of smart cities using Object Tracking Sensor Networks (OTSN).
- Flipped classroom on scene analysis, GPS, RFID and location based services.

**Suggested Evaluation Methods:**

- Assignments on tracking of objects using ultrasonic sensors and camera nodes.
- Practical – Designing WSNs to locate and track moving objects using ultrasonic sensors or camera nodes for smart cities.
- Quiz and discussion on scene analysis, GPS, RFID and location based services.

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

Sensor Network Hardware – Berkeley Motes – Arduino IDE – Node Level Software Platforms – Tiny OS – Imperative Language – nesC – Simulators – ns–3, Contiki OS and COOJA IDE, TOSSIM – State Centric Programming – PIECES – A State Centric Framework – Google for Physical World – Role of WSN in IoT.

**Suggested Activities:**

- Explore various network simulators available to carry out experiments in WSNs and various WSN testbeds: WISBED, SensLAB, MoteLAB, CitySense and Sensei
- Flipped classroom on Contiki OS and COOJA IDE
- Practical – Developing Arduino sketches and WSN simulation in ns-3.

**Evaluation Methods:**

- Assignments on various WSN simulators and WSN testbeds
- Quiz and discussion on Contiki OS and COOJA IDE
- Writing Arduino sketches for socially relevant projects and creating a sensor network topology in ns–2.35 with Mannasim patch or in ns–3

**TOTAL: 45 PERIODS**

Attested

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**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Understand different types of sensors, their actuators and the architecture of motes.
2. Design the topology of WSNs using different types of ZigBee devices and understanding their roles.
3. Understand apply data centric computing in wireless sensor networks.
4. Apply appropriate localization techniques for different scenarios.
5. Manage sensor networks by synchronizing the time, locating and tracking objects.
6. Carry out experiments in simulators and real sensors.

**REFERENCES:**


1. Mohammed A. Matin, "Wireless Sensor Networks: Technology and Protocols", InTech, 2012
2. Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
3. Robert Faludi, "Building Wireless Sensor Networks", O'Reilly Media, 2011.
4. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufmann, 2004
5. Bob Tucker, "Wireless Sensor Networks: Signals and Communication Technology", NY Research Press, 2015


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 1 | 2 | 1 | 2 | 2 | 1 |
| **CO2** | 1 | 1 | 1 | 3 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO4** | 2 | 1 | 1 | 2 | 2 | 1 |
| **CO5** | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 2 | 1 | 2 | 3 | 2 |

**IF5084 SOFTWARE ARCHITECTURE AND PRINCIPLES L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To study the basics of software architecture and drivers.
- To be exposed to architectural styles and views.
- To study the need for software architectural standards.
- To be familiar with architectural patterns.
- To understand the basics of software architecture documentation and tools.

**UNIT I INTRODUCTION 9**

Introduction to Software Architecture – Importance of Software Architecture – Standard Definitions – Architectural Drivers – Architectural Structures and Views – Architectural Patterns – Software Processes and Architecture Business Cycle.

**Suggested Activities:**

- Study of the problem in a detailed fashion.
- Identifying the underlying software architecture.

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**Suggested Evaluation Methods:**

- Case studies evaluation – Keyword in Context; Mobile robotics; Cruise control.

**UNIT II ARCHITECTURAL REQUIREMENTS 9**

Quality attributes – Quality Attribute Requirements – Introduction to Tactics – Availability Tactics – Modifiability tactics – Performance Tactics – Security Tactics – Testability Tactics – Usability Tactics – Relationship of Tactics to Architectural Patterns.

**Suggested Activities:**

- Draw a mind map of quality attributes.
- Identify the quality attributes of a given system.

**Suggested Evaluation Methods:**

- Evaluating the mind map for Railway Reservation System.
- Quality Attributes for food management system.

**UNIT III ARCHITECTURAL PATTERNS 9**

Introduction – Pipes and Filters – Blackboard – Data Flow Styles – Call-Return Styles – Shared Information Styles – Event Styles.

**Suggested Activities:**

- Case studies for styles like Data flow systems, Call-and-return systems, Virtual machines, Independent components, Data-centered systems (repositories) etc.
- Match appropriate software architectures to applications.

**Suggested Evaluation Methods:**

- Evaluate various style of Architectural pattern for a given system.
- Assignment on various styles of different architecture.

**UNIT IV ARCHITECTURAL VIEWS 9**

Introduction – Standard Definitions for Views – Structures and Views – Representing Views– View of RUP, Siemens 4 Views, SEI's Perspectives and Views – Reference Models and Reference Architectures – Architectural Structures and Views.

**Suggested Activities:**

- Study of need for organizational standards.
- Case studies for understanding the choice of architectural views.

**Suggested Evaluation Methods:**

- Exploring the various views for cruise control system, mobile robot system, etc.
- Assignment for identifying the choice of views for a keyword in context system.

**UNIT V DOCUMENTATION AND TOOLS 9**

Creating a Skeletal System – Uses of Architectural Documentation – Documentation Across Views – Software Tools for Architecture Design – Excel as an Architecture Tool – Exploiting Style in Architectural Design – Quality-Driven Software Architecture Design.

**Suggested Activities:**

- Documentation for Keyword in Context; Mobile robotics; Cruise control.
- In class discussion for identifying tools that match the current style in software architecture design.

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**Suggested Evaluation Methods:**

- Documentation of Software architecture systems like internet information systems, automotive systems, scenario-based architectural analysis etc...
- Exploring tools like Open Model Sphere etc

**TOTAL: 45 PERIODS**

**OUTCOMES**:

On completion of the course, the students will be able to:

1. Explain influence of software architecture on business and technical activities.
2. Identify key architectural structures.
3. Use styles and views to specify architecture.
4. Design document for a given architecture.
5. Able to match appropriate software architectures to applications.
6. Develop standard process and to follow standard practices.

**REFERENCES:**


1. Len Bass, Paul Clements, Rick Kazman, "Software Architectures Principles and Practices", Second Edition, Addison-Wesley, 2003.
2. Anthony J. Lattanze, "Architecting Software Intensive System. A Practitioner's Guide", Auerbach Publications, 2010.
3. Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson, Robert Nord, Judith Stafford, "Documenting Software Architectures. Views and Beyond", Second Edition, Addison-Wesley, 2010.
4. Mary Shaw and David Garlan, "Software Architecture: Perspectives on an Emerging Discipline", Prentice Hall, 1996.


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| **CO1** | 1 | 1 | 3 | 2 | 2 | 1 |
| **CO2** | 2 | 2 | 2 | 3 | 1 | 2 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 2 |
| **CO4** | 2 | 3 | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 3 | 2 | 1 | 2 | 2 |

**IF5072** **ARTIFICIAL INTELLIGENCE** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To know the underlying structure behind intelligence mathematically.
- To know the logical implications in computational intelligence.
- To know the automated learning techniques.
- To study the techniques of Knowledge Representation.
- To explore Artificial Intelligence techniques in real–time scenarios.

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**UNIT I INTELLIGENT AGENTS AND KNOWLEDGE REPRESENTATION 9**

Agents and Environments – Good Behavior: The concepts of Rationality – The Nature of Environments – The Structure of Agents – Knowledge Representation – Object Oriented Approach – Semantic Nets – Frames – Semantic Web – Ontology.

**Suggested Activities:**

- Flipped classroom on intelligent agents, means o knowledge representation
- Assignment on exercise questions on PEAS formulation from the text-book.
- Examples of knowledge representation through different methods and reasoning.
- Practical – Ontology creation using Protégé.

**Suggested Evaluation Methods:**

- Tutorial on intelligent agents and PEAS formulation.
- Assignments on semantic nets, frames.
- Quizzes on agents.
- Practical – Programming exercises on object oriented structure, semantic nets and frames.

**UNIT II SEARCH TECHNIQUES 9**

Problem Solving by Search – Uninformed Search – Searching with Costs – Informed State Space Search – Heuristic Search: – Problem Reduction Search – Game Search – Constraint Satisfaction Problems.

**Suggested Activities:**

- Flipped classroom on uninformed search and searching with costs.
- In-class activity – Solve puzzles with uninformed and informed searches.
- Practical – Implementation of search through Python/ Other languages.

**Suggested Evaluation Methods:**

- Tutorial – Different types of searches.
- Assignments on uninformed and informed searches.
- Quizzes on heuristic methods.
- Practical – Programming exercises on different search strategies.

**UNIT III REASONING WITH LOWER ORDER LOGICS 9**

Logical Agent – Proposition Logic – Syntax and Semantics – Theorem Proving – Model Checking – Inference in First Order Logic.

**Suggested Activities:**

- Reasoning methods through puzzles and real life scenarios.
- Implementation: Inference through prolog/ python.

**Suggested Evaluation Methods:**

- Tutorial – Inference methods.
- Assignments on theorem proving and resolution.
- Quizzes on basics of logic – syntax and semantics.
- Practical – Programming exercises for theorem proving.

**UNIT IV ARTIFICIAL INTELLIGENCE PLANNING 9**

Classical Planning – Partial Order Planning – Graph Plan and SAT Plan – Hierarchical Planning – Planning and Acting in Nondeterministic Domains – Multiagent Planning.

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**Suggested Activities:**

- Flipped classroom on planning methods.
- Assignments on derivation of plan through partial order plan, graph plan and hierarchical plan.

**Suggested Evaluation Methods:**

- Tutorial – Different planning methods.
- Assignments on graph plan, SAT plan.
- Quizzes on planning in non-deterministic domains.
- Practical – Programming exercises on planning with PDDL/PDL/Python.

**UNIT V LEARNING TECHNIQUES 9**

Logical Formulation of Learning – Knowledge in Learning – Explanation–Based Learning – Learning using Relevance Information – Inductive Logic Programming – Statistical Learning – Learning with Complete Data – Learning with Hidden Data – Applications.

**Suggested Activities:**

- Flipped classroom on theoretical study of learning methods
- Assignment on solving problem in statistical learning
- Practical – Programming exercises using Python/ other programming languages.

**Suggested Evaluation Methods:**

- Tutorial – Learning methods.
- Assignments on statistical methods in learning.
- Quizzes on learning methods.
- Practical – Programming exercises on Statistical learning.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the search techniques.
2. Apply the search techniques to real–time problems.
3. Apply the reasoning techniques to real world problems.
4. Understand the representation of knowledge.
5. Understand the learning techniques.
6. Apply AI techniques in developing real world applications.

**REFERENCES:**


1. Stuart J. Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, Third Edition, Pearson Education, 2015.
2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, “Artificial Intelligence”, Third Edition, Tata McGraw-Hill, 2008.
3. Dheepak Khermani, “A First Course in Artificial Intelligence”, McGraw-Hill, 2013.
4. NPTEL Artificial Intelligence Course by Prof. Dasgupta – http://nptel.ac.in/courses/106105079/2
5. Sebastian Thrun, Peter Norvig, Udacity: Introduction to Artificial Intelligence, https://in.udacity.com/course/intro–to–artificial–intelligence—cs271

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| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 1 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 1 | 3 | 3 | 2 | 1 |
| **CO4** | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO5** | 2 | 1 | 3 | 3 | 2 | 1 |
| **CO6** | 2 | 1 | 1 | 2 | 3 | 2 |

**IF5071 ADVANCED COMPUTER ARCHITECTURE L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To evaluate different computer systems based on performance metrics.
- To explore parallelism in instruction and processor functional block.
- To understand the fundamentals of Graphics processing unit.
- To compare different approaches of memory interfacing in multiprocessor.
- To understand and analyze interconnection in multicore.

**UNIT I INSTRUCTION LEVEL PARALLELISM 11**

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and Its Exploitation – Concepts and Challenges – Overcoming Data Hazards with Dynamic Scheduling – Dynamic Branch Prediction – Speculation – Multiple Issue Processors – Case Studies.

**Suggested Activities:**

- Flipped classroom on classes of processor.
- External learning – Static (compiler) scheduling for instruction execution.
- Survey on multi core and draw a mind map on trends of multicore processor.
- Tutorial – Measuring processor performance.

**Suggested Evaluation Methods:**

- Quizzes on out of order scheduling.
- Group discussion on how to reduce CPI lesser than 1.

**UNIT II THREAD–LEVEL PARALLELISM 8**

Multi–threading – Multiprocessors – Centralized and Distributed Shared Memory Architectures – Cache Coherence Issues – Performance Issues – Synchronization Issues – Models of Memory Consistency.

**Suggested Activities:**

- Flipped classroom on Flynn taxonomy.
- External learning – True and false sharing.
- Survey on memory consistency protocol.

**Suggested Evaluation Methods:**

- Quizzes on memory consistency.
- Group discussion on memory models.

**UNIT III SIMD AND GPU ARCHITECTURES 8**

SIMD Extensions for Multimedia – Graphics Processing Units – GPU Computational Structures – GPU Instruction Set Architecture – GPU Memory Structures – Case Study.

**Suggested Activities:**

- Flipped class on evolution of GPU.
- External learning – Vector architecture.
- Survey on multi core and draw a mind map on trends of multicore.

**Suggested Evaluation Methods:**

- Quizzes on multicore and GPU.
- Group discussion on GPU vs. Vector architecture.

**UNIT IV MEMORY HIERARCHY DESIGN 9**

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Name Mapping Implementations – Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

**Suggested Activities:**

- Flipped classroom on memory hierarchy in Intel i7 and ARM Cortex.
- Practical – Implement a simple functional model for memory mapping in cache using C/C++.
- Study hit/miss rates for various access patterns. Experiment with different replacement policies.

**Suggested Evaluation Methods:**

- Mock test for problems on memory mapping.
- Quizzes on memory management in ARM and Intel processor.

**UNIT V INTERCONNECT AND STORAGE 9**

Interconnection Networks – Buses, Crossbar and Multi–Stage Switches – Multi–Core Processor Architectures – Case Study. Warehouse– Scale Computers – Programming Models and Workloads – Storage Architectures – Physical Infrastructure – Case Study.

**Suggested Activities:**

- Flipped classroom on static and dynamic interconnection.
- Practical – Implement a simple map reduce program for counting a word.
- Case study on ware house scale computers

**Suggested Evaluation Methods:**

- Mock test for problems on types of interconnection.
- Quizzes on large scale computer programming.

**TOTAL: 45 PERIODS**

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**OUTCOMES:**

On completion of the course, the students should be able to:

1. Compare and evaluate the performance of various architectures.
2. Design a coherent and consistent memory system for multiprocessor.
3. Analyze the requirements of large systems to select and build the right infrastructure
4. Design and analyze memory and interconnection system for processor.
5. Distinguish and model multiprocessor architecture styles.
6. Point out the hazards present in a pipeline and suggest remedies

**REFERENCES:**


1. John L. Hennessey, David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann/Elsevier, Fifth Edition, 2012.
2. Richard Y. Kain, “Advanced Computer Architecture – A Systems Design Approach”, PHI, 2011.
3. Hwang Kai, A. Ramachandran, R. Purushothaman, “Advanced Computer Architecture: Parallelism, Scalability, Programmability” McGraw-Hill, 1993.


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| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 |
| **CO2** | 1 | 2 | 3 | 1 | 1 | 1 |
| **CO3** | 2 | 2 | 3 | 1 | 1 | 1 |
| **CO4** | 1 | 2 | 3 | 1 | 1 | 1 |
| **CO5** | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO6** | 1 | 2 | 3 | 1 | 1 | 1 |

**IF5001 REASONING METHODS IN COMPUTER SCIENCE L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To know the mathematical background of Logic.
- To learn the basics of Lower Order Logic.
- To study the background of Higher Order Logic.
- To explore the real world applications with Lower Order Logic.
- To explore the real world applications with Higher Order Logic.

**UNIT I PROPOSITION LOGIC 9**

Introduction to Logic – Foundation in mathematics – Natural Deduction – Formal language Syntax and Semantics – Normal Forms – Applications in AI.

**Suggested Activities:**

- Flipped classroom on natural deduction.
- In-class activity – Solving puzzles through proposition logic.
- Practical – Programming exercises for SAT solver.

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**Suggested Evaluation Methods**

- Quiz on formal proof methods.
- Assignments on natural deduction and SAT Solvers.
- Programming exercises on resolution and SAT Solvers.

**UNIT II PREDICATE LOGIC 9**

Syntax and semantics – Natural Deduction rules – Expressiveness –Micromodels of software – Inference mechanisms in AI.

**Suggested Activities:**

- Flipped classroom on micromodels of software.
- In-class activity – Problem solving exercise on natural deduction rules.

**Suggested Evaluation Methods:**

- Quiz on reasoning methods.
- Assignments on inference mechanisms in AI.

**UNIT III MODAL LOGIC 9**

Higher order logic – Modal logic syntax – Semantics – Accessibility relation – Types of modal logic – Natural deduction.

**Suggested Activities:**

- Flipped classroom on types of modal logic.
- In-class activity – Entailment through Kripke semantics.

**Suggested Evaluation Methods**

- Quiz on different accessibility relations.
- Assignments on Kripke structures.

**UNIT IV TEMPORAL LOGIC 9**

Linear Temporal Logic – Syntax – Semantics – Model Checking – Computational Tree Logic – Syntax – Semantics – Application in Operating Systems and Distributed systems.

**Suggested Activities:**

- Flipped classroom on applications.
- In-class activity – Solving problems with model checking.

**Suggested Evaluation Methods:**

- Quiz on Model Logic with types, temporal logic syntax and semantics.
- Assignment on semantics.
- Programming assignment on Model Checking.

**UNIT V EPISTEMIC LOGIC 9**

Logic of knowledge – Syntax – Semantics – Natural Deduction – Multi–agent reasoning – Applications in Distributed systems.

**Suggested Activities:**

- Flipped classroom on multi-agent reasoning.
- In-class activity – Solving puzzles like Muddy Children and Three Wise Men puzzle.

**Suggested Evaluation Methods:**

- Quiz on Reasoning methods using Muddy Children and Three Wise Men puzzle.
- Assignment on deduction and other reasoning methods.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the mathematical underpinnings of Logic
2. Apply Proposition Logic to Computer Science domains
3. Understand the reasoning process of Predicate Logic
4. Understand the advantages of Higher Order Logic over Lower Order Logic
5. Apply Temporal Logic to Distributed Systems
6. Design Multiagent systems using Epistemic Logic

**REFERENCES:**


1. Michael Huth, Mark Ryan, "Logic in Computer Science: Modeling and Reasoning about Systems", Second Edition, Cambridge University Press, 2005.
2. Johan van Benthem, Hans van Ditmarsch, Jan van Eijck, Jan Jaspars, "Logic in Action", Open Course and ebook, 2016. http://www.logicinaction.org/.
3. Mordechai Ben-Ari, "Mathematical Logic for Computer Science", Third Edition, Springer, 2012.
4. Michael Fisher, "An Introduction to Practical Formal Methods using Temporal Logic", John Wiley, 2011.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 3 | 2 | 2 | 1 |
| **CO3** | 1 | 1 | 3 | 2 | 2 | 1 |
| **CO4** | 1 | 1 | 3 | 2 | 2 | 1 |
| **CO5** | 3 | 1 | 3 | 2 | 2 | 1 |
| **CO6** | 3 | 1 | 3 | 2 | 2 | 1 |

**IF5078 DISTRIBUTED AND CLOUD COMPUTING L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn distributed communication.
- To understand distributed resource management.
- To study the basics of cloud computing.
- To study about virtualization and cloud resource management.
- Be able to install and use current cloud technologies.

**UNIT I INTRODUCTION TO DISTRIBUTED SYSTEM AND COMMUNICATION 8**

Introduction to Distributed Systems – Characteristics – Issues in Distributed Systems – Distributed Architectural Models – Communication Primitives – Remote Procedure Call – Physical Clock Synchronization – Logical Clocks, Vector Clocks and Casual Ordering – Multicast Ordering.

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**Suggested Activities:**

- Practical – Implement clock synchronization in distributed system using Lamport's algorithm.
- Practical – Create and distribute a Torrent file to share a file in LAN environment.

**Suggested Evaluation Methods:**

- Demonstration and assessment of the working of the implemented algorithm.

**UNIT II DISTRIBUTED RESOURCE MANAGEMENT 10**

Distributed Mutual Exclusion Algorithm – Distributed Deadlock Detection Algorithms– Election Algorithm – Distributed File System – Design Issues – Distributed Shared Memory – Global States and Snapshot – Check Point and Recovery – Two Phase Protocol – Non Blocking Commit Protocol.

**Suggested Activities:**

- Practical – Implement Election Algorithm.
- Practical – Implement any one deadlock detection Algorithm.

**Suggested Evaluation Methods:**

- Demonstration and assessment of the working of the implemented algorithm.

**UNIT III CLOUD COMPUTING, ARCHITECTURE MODELS AND SERVICES 9**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning – NIST Cloud Computing Reference Architecture– Architectural Design Challenges – Deployment Models: Public, Private and Hybrid Clouds – Service Models: IaaS – PaaS – SaaS – Benefits of Cloud Computing.

**Suggested Activities:**

- Practical – Use Google Collaboration Tools: Create Google Docs, Sheets, and Slides and share it with others.
- Practical – Explore public cloud services including Amazon, Google, Sales force, and Digital Ocean etc.

**Suggested Evaluation Methods:**

- Quizzes on different service models and deployment models.
- Report submission – Comparison of various services provided by different Cloud Service Provider (Configuration of VM, Cost, Network Bandwidth etc).

**UNIT IV CLOUD ENABLING TECHNOLOGIES 10**

Service Oriented Architecture – SOAP – RESTful Web Services – Basics of Virtualization – Types of Virtualization –Full and Para Virtualization– Implementation Levels of Virtualization – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization –Network and Storage Virtualization – Containers.

**Suggested Activities:**

- Create a simple web service using Python Flask /Java /any language [Web Service: Client-server model should be implemented using socket/http].
- Install Oracle Virtual Box/Vmware Workstation and Create a blackboard application[Hint: One VM should act as a master and other VMs acts as a listeners, when any content is written by the master VM, the content should be displayed in all the Listener VMs].

**Suggested Evaluation Methods:**

- Review of the Web Service Implementation: Proper Connection should be established between the client and server to make use of the service offered by the Server.
- Assessment of the workings of installed Virtualization Tools.
- Review the workings of application in virtual environment [Implemented using basic echo and chat concepts].

**UNIT V CLOUD MANAGEMENT, SECURITY AND COMPUTING PLATFORMS 8**

Resource Provisioning – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Virtual Machine Security – Application and Data Security Cloud Storage – HDFS – Map Reduce – Google App Engine(GAE) – Programming Environment for GAE – Architecture of GFS – Cloud Software Environments – Openstack, Heroku, Docker, Case Studies: Amazon EC2, AWS, Microsoft Azure, Google Compute Engine.

**Suggested Activities:**

- Practical – Use security tools like ACUNETIX, ETTERCAP to scan web applications on the cloud, cloud networks for finding vulnerabilities, verifying leakage of information to an unauthorized third party.
- Practical – Install and configure OpenStack all– in– one using Devstack/Packstack and Launch VMs in OpenStack through dashboard:

**Suggested Evaluation Methods:**

- Report Submission – A detailed report describing vulnerabilities along with the suitable action that can be taken to remedy the loopholes.
- Evaluation of the practical: OpenStack Dashboard should be accessed though web browser and the working of the instances must be verified by logging in to it/pinging the instance.

**PRACTICAL EXECISES: 30**

1. Connect a minimum of 3 nodes and implement a group chat amongst them.
2. Implement any one of the message ordering algorithms on the previously implemented system.
3. Implement an election algorithm to elect a co– ordinator for the system.
4. Perform clock synchronization on the system, with the co– ordinator node's time as reference.Create a VM image which has a C compiler along with an operating system and do the following experiments
    a. Fibonacci Series. B. File Operations.
5. Install Virtualbox with different flavours of linux or windows OS on top of windows7 or 8.
6. Install Google App Engine/Heroku and run a run a simple webapp using python/java.
7. Install and run Openstack using Packstack/Devstack
8. Create two VMs in Openstack and exchange data.
9. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm not present in Cloud Sim.
10. Install hadoop and manipulate a large dataset and run on Hadoop.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Appreciate distributed communication, distributed resource management.
2. Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
3. Learn the key and enabling technologies that help in the development of cloud.
4. Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
5. Explain the core issues of cloud computing such as resource management and security.
6. Choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

**REFERENCES:**


1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems – Principles and Paradigms", Second Edition, Pearson Education, 2006.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann, 2012.
3. Barrie Sosinky, "Cloud Computing bible", Wiley, 2010.
4. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", John Wiley, 2011.
5. Mukesh Singhal, "Advanced Concepts in Operating Systems", McGraw-Hill Series in Computer Science, 1994.
6. John W. Rittinghouse, James F. Ransome, "Cloud Computing: Implementation Management, and Security", CRC Press, 2010.


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| **CO1** | 2 | 2 | 2 | 2 | 2 | 1 |
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| **CO5** | 3 | 1 | 2 | 3 | 2 | 2 |
| **CO6** | 3 | 2 | 2 | 2 | 2 | 3 |

**IF5074** **BUILDING INTERNET OF THINGS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the fundamentals of Internet of Things.
- To build a small low cost embedded system using Arduino / Raspberry Pi or equivalent boards.
- To learn communication protocols that is frequently used in IoT ecosystems.
- To explore the ways of processing enormous amount of data generated in IoT based systems.
- To understand the role of cloud computing in IoT and to become familiar with various cloud offerings.

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**UNIT I ENABLING TECHNOLOGIES AND REFERENCE MODELS 9**

Sensors and Actuators – Centralized Sensing vs Distributed Sensing – Making Physical Objects as Smart Objects – Enabling Technologies – Wireless Sensor Networks, Cloud Computing and Data Analytics – IoTVs M2M – Possible IoT Reference Models – Domain Specific IoTs – Levels of IoT Based Systems.

**Suggested Activities**:

- Flipped classroom on enabling technologies.
- External learning – Exploring proprietary protocols used in IoT and M2M.
- Analyzing the required level of design for different IoT based ecosystems.

**Suggested Evaluation Methods:**

- Quiz and discussion on enabling technologies (WSN, Cloud and Big Data).
- Assignments on proprietary protocols used in IoT and M2M.
- Deciding the level and designing the IoT framework for case studies.

**UNIT II DESIGN OF END DEVICES 9**

Microprocessors vs. Microcontrollers – Open Source Movement in Hardware – Engineering vs Prototyping – Software Development Lifecycle for Embedded Systems – Arduino IDE – Programming and Developing Sketches – Arduino Rest APIs – Raspberry Pi – Interfaces – Python Packages of Interests for IoT

**Suggested Activities:**

- Flipped classroom on open source movement in hardware and SDLC for embedded systems.
- Explore the variants of Arduino Boards, Atmel Microcontrollers, Cypress Pioneer and NXP Freedom.
- Learning to write Arduino Sketches and Python Programs.

**Suggested Evaluation Methods:**

- Quiz and discussion on open source movement in hardware and SDLC for embedded systems.
- Assignments on Arduino boards, Atmel Microcontrollers, Cypress Pioneer and NXP Freedom.
- Practical – Developing Arduino Scripts and Python Programs.

**UNIT III IoT PROTOCOLS 9**

MAC Layer Protocols – IEEE 802.15.4 – G And E Variants of IEEE 802.15.4 – IEEE 802.11ah – IEEE 1901.2a – LoRaWAN – 6LoWPAN – From 6LoWPAN to 6Lo – NBIoT – REST Based Protocols – SCADA, CoAP and MQTT

**Suggested Activities:**

- External learning – Explore various software tools that support Coap and MQTT.
- Flipped classroom on role of Ipv6 in designing IoT based systems.
- Analyze Cisco Reference Model and IBM Reference Models.

**Suggested Evaluation Methods:**

- Assignments on software tools that support Coap and MQTT.
- Quiz and discussion on role of Ipv6 inIoT based systems.
- Assignments on the IoT policy of Meity (Government of India).

**UNIT IV DATA ANALYTICS 9**

Structured vs. Unstructured Data – Data in Motion vs. Transit – Machine Learning Overview – Big Data Tools and Technologies – Hadoop – Map Reduce Programming Model, Job Execution and Work Flow, Cluster Setup – Lambda Architecture – Flexible Netflow Architecture – Providing Multiservice in IoT using FNF Components.

**Suggested Activities:**

- External learning – Exploring popular machine learning algorithms (both supervised and unsupervised).
- Flipped classroom on MapReduce programming.
- Learning dataflow programming using open source software library.

**Suggested Evaluation Methods:**

- Assignments on supervised, unsupervised and reinforcement algorithms.
- Quiz and discussion on MapReduce programming.
- Practicing data flow programming languages using libraries like Tensorflow/CNTK/Theanoetc.

**UNIT V CLOUD OFFERINGS 9**

Cloud Storage Models and Communication API – WAMP AutoBahn – Xively Cloud – Python Web Application Framework – Django–IBM Watson – AWS for IoT – Case Studies – Smart Home, Smart Cities, Smart Agriculture and Weather Monitoring Systems.

**Suggested Activities:**

- Flipped classroom on cloud models and type of clouds.
- External learning – Django framework.

**Suggested Evaluation Methods:**

- Quiz and discussion on cloud models and types of clouds.
- Developing web apps for IoT ecosystems using Django framework.

**PRACTICAL EXERCISE: 30**

1. Develop a BLINK sketch in Arduino.
2. Develop an Arduino sketch that repeats an LED to glow brightly, decrease the brightness, switches off the LED, increases the brightness and LED glows with maximum intensity (a sketch for fading).
3. Develop an Arduino sketch that takes sensor readings for five seconds during the startup, and tracks the highest and lowest values it gets. These sensor readings during the first five seconds of the sketch execution define the minimum and maximum of expected values for the readings taken during the loop (a sketch for calibrating a sensor).
4. Develop an Arduino sketch that reads the value of a variable resistor as an analog input and changes blink rate of the LED.
5. Develop an Arduino sketch to use a piezo element to detect the vibration.
6. Develop a Python program to control an LED using Rapberry Pi.
7. Develop a Python program to interface an LED with a switch using Rapberry Pi.
8. Implement a map reduce program that produces a weather data set.
9. Implement an application that stores big data in Hbase/Mongo DB using Hadoop/R.
10. Use Google Collaboration Tools: Create Google Docs, Sheets, and Slides and share it with others.
11. Miniproject.

**TOTAL: 75 PERIODS**

Attested

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**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the enabling technologies and reference models of IoT.
2. Design portable IoT devices using Arduino IDE/ Raspberry Pi with Python.
3. Apply appropriate protocols in various parts of IoTbased systems.
4. Understand Big Data tools and technologies and apply them in IoT based systems.
5. Design and deploy IoT based systems and connect them to cloud offerings.
6. Design IoT systems for various real time applications.

**REFERENCES:**


1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A Hands-On Approach”, Universities Press, 2015.
2. Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.
3. David Hanes, Gonzalo Salguerio, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of Things”, Cisco Press, 2017.
4. Perry Lea, “Internet of Things for Architects”, PACKT, 2018.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 1 | 1 | 2 | 3 | 2 |
| **CO4** | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO5** | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 2 | 3 | 3 | 2 | 2 |

**IF 5081 INFORMATION RETRIEVAL L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the basics of Information Retrieval with pertinence to modelling, Query operations and indexing.
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of Information Retrieval giving emphasis to Multimedia IR and Web Search.
- To understand the concepts of digital libraries.
- To learn the procedure for recommendation system.

**UNIT I INTRODUCTION 9**

Introduction – Goals And History of IR – The Impact of the Web on IR – The Role of Artificial Intelligence (AI) in IR – Basic IR Models Boolean and Vector Space Retrieval Models – Ranked Retrieval – Text Similarity Metrics – TF-IDF (term frequency/inverse document frequency) Weighting – Cosine Similarity.

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**Suggested Activities:**

- Install Lucene, LingPipe, and Gate.

**Suggested Evaluation Methods:**

- Group discussion on applications of vector space model.

**UNIT II PREPROCESSING 9**

Basic Tokenizing – Indexing and Implementation of Vector Space Retrieval – Simple Tokenizing – Stop Word Removal and Stemming – Inverted Indices – Efficient Processing with Sparse Vectors – Query Operations and Languages – Relevance Feedback – Query Expansion – Query Languages.

**Suggested Activities:**

- Construct manually a frequency table for the collection of documents after removing stop words.
- Index the frequency table using Latent semantic indexing techniques.

**Suggested Evaluation Methods:**

- Apply query document information and nalyzi manually the performance of the retrieval.

**UNIT III METRICS 9**

Experimental Evaluation of IR Performance Metrics Recall, Precision and F Measure – Evaluations on Benchmark Text Collections – Text Representation – Word Statistics – Zipf's law – Porter Stemmer – Morphology – Index Term Selection using Thesauri –Metadata and Markup Languages – Web Search Engines – Spidering – Meta Crawlers – Directed Spidering – Link Analysis Shopping Agents.

**Suggested Activities:**

- Assignments on problems on precision and recall like the following:
- An IR system returns 8 relevant documents and 10 non-relevant documents. There are a total of 20 relevant documents in the collection. What is the precision of the system on this search and what is its recall?

**Suggested Evaluation Methods:**

- Group discussion on metrics.

**UNIT IV CATEGORIZATION AND CLUSTERING 9**

Text Categorization and Clustering – Categorization Algorithms – Naive Bayes – Decision Trees and Nearest Neighbour – Clustering Algorithms – Agglomerative Clustering – K Means – Expectation Maximization (EM) – Applications to Information Filtering – Organization and Relevance Feedback.

**Suggested Activities:**

- Categorize documents by topic using classifiers and build groups of self-organized documents using clustering algorithms.

**Suggested Evaluation Methods:**

- Analyze the algorithm by changing the input set.

**UNIT V EXTRACTION AND INTEGRATION 9**

Recommender Systems – Collaborative Filtering – Content Based Recommendation of Documents and Products – Information Extraction and Integration – Extracting Data from Text – XML – Semantic Web – Collecting and Integrating Specialized Information on the Web.

**Suggested Activities:**

- External learning – Survey on recommendation process that takes place in various online shopping portals.

**Suggested Evaluation Methods:**

- Group discussion on recommendation process in a real time scenario.

**PRACTICAL EXERCISES: 30**

Implement the following exercises using python libraries.

1. Construct a vector space model for the collection of text documents and also compute the similarity between them. (4 hrs)
2. Perform the preprocessing on any text document collection. (4 hrs)
3. Classification and clustering approach on standard text database and also compute performance measures Precision, Recall and F- measure (4 hrs)
4. Construct a search engine index with an optional backend database to manage large document collections. (4 hrs)
5. Parse XML text and compute topic specific page rank. (4 hrs)
6. Mini project. (10 hrs)

**TOTAL: 75PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Build an Information Retrieval system using the available tools.
2. Identify and design the various components of an Information Retrieval system.
3. Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.
4. Analyze the Web content structure.
5. Analyze the approaches used for recommendation systems.
6. Design an efficient search engine.

**REFERENCES:**


1. Christopher D. Manning, Prabhakar Raghavan, HinrichSchütze, ”Introduction to Information Retrieval” , Cambridge University Press, 2008.
2. F. Ricci, L. Rokach, B. Shapira, P. B. Kantor, “Recommender Systems Handbook”, Springer, 2011.
3. Peter Brusilovsky, “The Adaptive Web Methods and Strategies of Web Personalization”, Springer, 2007.
4. Manu Konchady, “Building Search Applications: Lucene, LingPipe, and Gate”, Mustru Publishing 2008.

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| **CO5** | 1 | 2 | 2 | 2 | 1 | 2 |
| **CO6** | 2 | 2 | 2 | 2 | 2 | 2 |

**IF5092** **ANALYSIS OF SOCIAL NETWORKS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the concept of semantic web and related applications.
- To learn knowledge representation using ontology.
- To understand human behavior in social web and related communities.
- To learn visualization of social networks.
- To understand the importance of security and privacy in social networks.

**UNIT I INTRODUCTION TO SOCIAL NETWORKS** **9**

Social Network Analysis: Definition and Features – The Development of Social Network Analysis – Representation of Social Networks: Graph and Matrix Representations – Graph Concepts in Network Analysis – Ties, Degree, Density, Path, Length, Geodesic, Eccentricity, Between – Ness, Centrality, Clique – Overview of Electronic Discussion Networks, Blogs and Online Communities.

**Suggested Activities:**

- Given a social graph derive the various graph metrics.
- Group discussion on pros and cons of various online discussion forums.
- Convert a graph into equivalent matrix representation.

**Suggested Evaluation Methods:**

- Assignment on graph metrics.
- Report submission on features of online social forums.
- Quizzes on graph and matrix representations.

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**UNIT II ONTOLOGY FOR SOCIAL NETWORK ANALYSIS 9**

RDFS – Plus – Using RDFS – SKOS – Managing vocabularies with RDFS–Plus – Introduction to Ontology– OWL–Web Ontology Language– Basic OWL– Bibliographic Ontology (BIBO) – FOAF Good Relations– CIDOC's Conceptual Reference Model (CRM) – Digital Public Library (DPLA) – Counting and Sets in OWL – Ontologies on the Web–Putting it all Together – Ontology Mapping –Good and Bad Modeling Practices – Expert Modeling in OWL The Future Of The Semantic Web – RDF Parser/Serializer– RDF Store – Querying the Semantic Web– SPARQL–Query Language for RDF–Advanced Features of SPARQL – RDF and Inference.

**Suggested Activities:**

- Group activity – Defining concepts and relations for sample scenarios using benchmark ontology.
- Practical – Developing ontology using tools.
- Assignment on inferring the entities involved from a sample RDF schema.

**Suggested Evaluation Methods:**

- Report submission on benchmark ontology.
- Quizzes and assignments on RDF/FOAF and other related vocabulary.

**UNIT III SOCIAL MEDIA MINING AND SEARCH 9**

Discovering Mobile Social Networks by Semantic Technologies – Online Identities and Social Networking – Concept Discovery and Categorization for Video Searching – Discovering Communities in Social Networks – Recommender Systems.

**Suggested Activities:**

- Group discussion on the pros and cons of communities in social networks.
- Charting the metrics for evaluating real time online communities.

**Suggested Evaluation Methods:**

- Group assignment on evaluating real time social network communities.
- Assignment on scenario based comparative analysis of community discovery.
- Open book quizzes on Recommender Systems for specific social networking scenarios.

**UNIT IV SOCIAL NETWORK INFRASTRUCTURES AND COMMUNITIES 9**

Detecting and Discovering Communities in Social Network: Evaluating Communities – Methods for Community Detection – Applications of Community Mining Algorithms – Ethical Practices in Social Network Mining-Understanding and Predicting Human Behavior for Social Communities – Decentralized Online Social Networks – Multi-Relational Characterization of Dynamic Social Network Communities-Inferential Methods in Social Network Analysis.

**Suggested Activities:**

- User interaction data collection from real time social network applications.
- Comparison of behavior models in social networks using sample data.

**Suggested Evaluation Methods:**

- Tutorial – Scenarios to identify suitable web accessibility testing.
- Group projects – Use open source data collection tools and predict user behavior.

**UNIT V PRIVACY IN SOCIAL NETWORKS AND VISUALIZATION 9**

Introduction to Security and Privacy in Online Social Networks – Key Player Problem – Intrusion Detection on Social Networks – Security Requirements for Social Networks – Visualizing Online Social Networks – Novel Visualizations and Interactions for Social Networks Exploration.

**Suggested Activities:**

- Case studies on applications of social network analysis.
- In-class activities – Network visualization using benchmark data and network visualization tools.

**Suggested Evaluation Methods:**

- Assignments on chart work for modeling social networks using node-edge diagrams.
- Mini project on applications of social network analysis.

**PRACTICAL EXERCISES: 30**

1. Download and install open source social network analysis tools like UCINET, Net Miner, Smart Network Analyzer, Pajek, Gephi and explore the visualization and analytical features of that tool using sample real world data.
2. Construct any graph representing a real life social network scenario, feed the same as a matrix input to any tool and explore the graph theoretical metrics of the graph and note down your observations and inferences on those values.
3. Download any RDF schema on tourism and explore various tags in the schema. To nalyzing, open them using a Word Editor. Highlight the subject, predicate and object in each file. If necessary use the RDF validator service by W3C to obtain the triplets.
4. Download and install any open source RDF/Ontology editing tool like protégé, Onto Studio, etc. Try the following in that tool: (i) Load existing RDF schema and visualize and (ii) Add, modify and delete RDF
5. Do the following using W3C RDF Validator: (i) Enter a URI or paste an RDF/XML document and parse the RDF and (ii) Visualize the RDF/XML as Triples and/or Graph.
6. Download any benchmark FOAF ontology/RDF and study the various FOAF classes used in that RDF/Ontology.
7. Download and install Gephi tool and explore importing graph file formats from (i) Spreadsheet import wizard, (ii) Database import. Also use the statistics and metrics framework in Gephi to calculate the following: Betweenness Centrality, Closeness, Diameter, Clustering Coefficient, Page Rank.
8. Load different social network data into Gephi tool and perform community detection using the features available and also compute the shortest path.
9. Explore various forced layout and random forest algorithms in Gephi tool to create a network layout. Compare the outputs of various layouts algorithms.
10. Study of various bibliometric RDFs and visualization of citation networks.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Convert a social network data into its equivalent graph data and derive social graph metrics.
2. Develop social blogs with necessary tags.
3. Design and develop ontology for various domains.
4. Predict human behavior in social web and related communities using community prediction and mining algorithms.
5. Design and develop trust models for social networks.
6. Visualize social network data and quantify its structural properties.

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**REFERENCES:**


1. Peter Mika, “Social Networks and the Semantic Web”, Springer 2007.
2. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 2010.
3. Guandong Xu ,Yanchun Zhang, Lin Li, “Web Mining and Social Networking – Techniques and Applications”, Springer, 2011.
4. Dion Goh, Schubert Foo, “Social Information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, IGI Global Snippet, 2008.
5. Max Chevalier, Christine Julien, Chantal Soulé-Dupuy, “Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling”, IGI Global Snippet, 2009.
6. John G. Breslin, Alexander Passant, Stefan Decker, “The Social Semantic Web”, Springer, 2009.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 3 | 1 | 2 | 2 | 2 |
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| **CO3** | 1 | 1 | 2 | 3 | 2 | 1 |
| **CO4** | 1 | 2 | 1 | 2 | 2 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | 2 | 1 |
| **CO6** | 1 | 2 | 2 | 2 | 2 | 2 |

**IF5077 DIGITAL IMAGE PROCESSING TECHNIQUES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn about the basic concepts of Digital Image Processing and various Image Transforms.
- To familiarize the student with the Image Enhancement Techniques.
- To expose the student to a broad range of Image Processing Techniques and their Applications.
- To appreciate the use of current technologies those are specific to Image Processing Systems.
- To expose the students to real-world applications of Image Processing.

**UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9**

Introduction–Applications of Image Processing – Steps in Image Processing Applications – Digital Imaging System – Sampling and Quantization – Pixel Connectivity – Distance Measures – Colour Fundamentals and Models – File Formats, Image Operations.

**Suggested Activities:**

- Discussion on Image Processing applications.
- External learning – Open Source Tools like Octave/SciLab/OpenCV.

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- External learning – Matlab/Octave Toolboxes.
- Installation of OpenCV/SciLab.
- Numerical Problems in Pixel connectivity and Distance measures.

**Suggested Evaluation Methods:**

- Tutorial problems in image operations, image connectivity and distance measures.
- Assignment on sampling, quantization and image operations.
- Quizzes on image types.

**UNIT II IMAGE ENHANCEMENT 9**

Image Transforms: Fast Fourier Transform and Discrete Fourier Transform – Image Enhancement in Spatial and Frequency Domain – Grey level Transformations–Histogram Processing – Spatial Filtering – Smoothing and Sharpening – Filtering in Frequency Domain.

**Suggested Activities:**

- Discussion of Mathematical Transforms.
- Numerical problem solving using Fourier Transform.
- Numerical problem solving in Image Enhancement.
- External learning – Image Noise and its types.

**Suggested Evaluation Methods:**

- Tutorial – Image transforms.
- Assignments on histogram specification, histogram equalization and spatial filters.
- Quizzes on noise modeling.

**UNIT III IMAGE RESTORATION AND MULTI-RESOLUTION ANALYSIS 9**

MultiResolution Analysis: Image Pyramids – Multi Resolution Expansion – Wavelet Transforms–Image Restoration–Image Degradation Model–Noise Modelling – Blur – Order Statistic Filters–Image restoration Algorithms.

**Suggested Activities:**

- Discussion on Image Arte facts and Blur.
- Discussion of Role of Wavelet Transforms in Filter and Analysis.
- Numerical problem solving in Wavelet Transforms.
- External learning – Image restoration algorithms.

**Suggested Evaluation Methods:**

- Tutorial – Wavelet transforms.
- Assignment problems on order statistics and multi-resolution expansions.
- Quizzes on wavelet transforms.

**UNIT IV IMAGESEGMENTATIONANDFEATUREEXTRACTION 9**

Image Segmentation – Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region based Segmentation –Image Features and Extraction–Image Features– Types of Features–Feature Extraction–SIFT, SURF and Texture–Feature Reduction Algorithms.

**Suggested Activities:**

- Flipped classroom on importance of segmentation.
- External learning – Feature selection and reduction.
- External learning – Image salient features.
- Assignment on numerical problems in texture computation.

**Suggested Evaluation Methods:**

- Tutorial – Image segmentation and edge detection.
- Assignment problems on feature extraction and reduction.
- Quizzes on feature selection and extraction.

**UNIT V IMAGE PROCESSING APPLICATIONS 9**

Image Classifiers – Supervised Learning – Support Vector Machines, Image Clustering – Unsupervised Learning – Hierarchical and Partition Based Clustering Algorithms – EM Algorithm – Case Studies in Biometrics – Iris, Fingerprint and Face Recognition – Case Studies on Image Security – Steganography and Digital Watermarking – Case Studies on Medical Imaging and Remote Sensing.

**Suggested Activities:**

- Discussion on machine learning in image processing.
- Discussion on image classifiers.
- External learning – Study of visual effects, image processing in security, forensic applications.

**Suggested Evaluation Methods:**

- Tutorial – Image classifier and clustering.
- Assignment problems on support vector machines and EM algorithm.
- Quizzes on image processing applications.

**PRACTICAL EXERCISES:**

1. Implementation of Reading and Writing of Images in Matlab and OpenCV/Octave/SciLab.
2. Implementation of simple spatial filters like Low Pass Filters and High Pass Filters in Matlab/OpenCV.
3. Implementation of Histogram Techniques in Matlab/Octave/OpenCV.
4. Implementation of noise modelling in Matlab/Octave/SciLab.
5. Implementation of Wavelet Transforms and Deconvolution Algorithms in Matlab/Octave.
6. Implementation of SIFT, SURF in Matlab/Octave/SciLab.
7. Implementation of PCA in Matlab/Octave.
8. Implementation of Image Classifier using SVM in Matlab/Octave.
9. Implementation of Image Clustering algorithms in Matlab/Octave.
10. Implementation of Feature extraction Fingerprint using Matlab/Octave.

**TOTAL: 75PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Implement basic Image Processing Operations.
2. Apply and develop new techniques in the areas of Image Enhancement and Restoration.
3. Understand the Image segmentation algorithms.
4. Extract features from Images.
5. Apply classifier and Clustering algorithms for Image classification and Clustering.
6. Design and develop an image processing application that uses different concepts of Image Processing.

**REFERENCES:**


1. Rafael Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.
2. S. Sridhar, “Digital Image Processing”, Second Edition, Oxford University Press, 2016.
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis and Machine Vision”, Second Edition, Thompson Learning, 2007.
4. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education, 2011.


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| **CO3** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO6** | 3 | 1 | 2 | 3 | 2 | 1 |

**IF5075 COMPUTER VISION L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To provide knowledge about computer vision algorithms.
- To understand the basic concepts of camera calibration, stereoscopic imaging and higher level image processing operations.
- To familiarize the student with the image processing facilities in Matlab and its equivalent open source tools like OpenCV.
- To appreciate the use of compute vision in Industrial applications and to understand the role of computer vision.
- To understand and implement Object detection and Object tracking Algorithms.

**UNIT I FUNDAMENTALS OF VISION 9**

Image Formation and Representation–Intensity and Range Images – Camera models – Camera parameters – Light and colour – Image Noise – Image Filtering (spatial domain) – Mask based filtering – Image Smoothing –Sharpening.

**Suggested Activities:**

- Installation of OpenCV.
- Numerical Problems on Filtering, Masking, Smoothing and sharpening.

**Suggested Evaluation Methods:**

- Quizzes on various camera models and its effect.
- Practical – Programming assignments on types of filters for different applications.

Attested

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**UNIT II IMAGE SEGMENTATION and CAMERA CALLIBRATION 9**

Point and Line Detection – Hough Transform and Shape detection – Edge Detection – Corner Detection – Harris Detector- Stereopsis – Correspondence Problem –RANSAC and Alignment –Epipolar Geometry.

**Suggested Activities**

- Flipped classroom on importance of segmentation.
- External learning – Various camera calibration methods.

**Suggested Evaluation Methods**

- Quizzes on various segmentation methods.
- Practical – Programming assignments on edge and shape detection methods .

**UNIT III FEATURE DETECTION AND TRACKING 9**

Image Features – Textures – Deformable Contours – Features Reduction – Principal Component analysis – Feature Descriptors – SIFT and SURF– Motion field of rigid objects – Notation of Optical flow – Estimation Motion Field – Horn and Schunck Algorithm – Lucas and Kanade Algorithm.

**Suggested Activities**

- Flipped classroom on various feature reduction methods.
- External learning – Optical flow algorithms.

**Suggested Evaluation Methods**

- Quizzes on various feature detection methods.
- Practical – Programming assignments on object tracking algorithms.

**UNIT IV SHAPE FROM CUESAND OBJECT DETECTION 9**

Shape from Shading and shape from Texture Model based Vision – Smooth Surfaces and their Outlines–Aspect Graphs and Range Data – Localization – Classification and Evaluation – AdaBoost – Random Decision Forests – Pedestrian Detection.

**Suggested Activities**

- Flipped classroom on pedestrian detection methods.
- Assignments on numerical problems on Shading and Texture Model based Vision.
- Assignments on numerical problems on AdaBoost and Random Decision Forests.

**Suggested Evaluation Methods**

- Quizzes on methods to identify the shape of an object in an image.
- Practical – Programming assignments on algorithms and methods used for identification of objects.

**UNIT V COMPUTER VISION APPLICATION 9**

Emotion Recognition – Real Time Object Detection – Gesture Recognition – Face Detection.

**Suggested Activities**

- External learning – Exploring advancement in computer vision.
- Discussion on Emotion Recognition methods.

**Suggested Evaluation Methods**

- Quizzes on various real time computer vision application.
- Group discussion on methods to solve the real world problems in computer vision applications.

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**PRACTICAL EXERCISE:** **30**

1. Implementation of Noise removal algorithms using OpenCV.
2. Implementation of Object detection based on Edge detection algorithms on any application using OpenCV.
3. Implementation of Perspective projection of the lane borders using OpenCV.
4. Implementations of Feature Extraction of an object using SIFT in OpenCV.
5. Implementation of Feature Extraction of an object using SURF in OpenCV.
6. Implementation of Emotion Recognitionin OpenCV.
7. Implementation of Gesture Recognitionin OpenCV.
8. Implementation of Face Detection in OpenCV.
9. Implementation of Object detection using AdaBoost in OpenCV

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Implement basic computer vision algorithms.
2. Familiar with the use of MATLAB and OpenCV environment.
3. Apply and develop various object detection methods.
4. Design and implement industrial applications that incorporate different concepts of Image Processing.
5. Analyze different Object detection algorithms used in Computer Vision.
6. Understand the proper use of shape and Shape related cue features for Computer Vision Applications.

**REFERENCES:**


1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer International, 2011.
2. Reinhard Klette, “Concise Computer Vision: An Introduction into Theory and Algorithms”, Springer, 2014.
3. E. R. Davies, “Computer and Machine Vision”, Fourth Edition, Elsevier, 2012.


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| **CO3** | 3 | 1 | 1 | 3 | 1 | 1 |
| **CO4** | 2 | 1 | 2 | 3 | 2 | 1 |
| **CO5** | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO6** | 3 | 1 | 2 | 2 | 1 | 1 |

**IF5076** **DEEP LEARNING** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

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

**UNIT I BASICS OF NEURAL NETWORKS 9**

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

**Suggested Activities:**

- Discussion of role of Neural Networks.
- External learning – Boltzmann Machine and Perceptron.
- Practical – Installation of TensorFlow and Keras.

**Suggested Evaluation Methods:**

- Tutorial – Perceptron.
- Assignment problems on backpropagation networks.
- Quizzes on Neural Networks.

**UNIT II INTRODUCTION TO DEEP LEARNING 9**

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.

**Suggested Activities:**

- Discussion of role of Gradient Descent in Deep Learning.
- External learning – Feature extraction and feature learning.
- Survey of Deep Learning Development Frameworks.
- Discussion of Gradient Descent Problem.

**Suggested Evaluation Methods**

- Tutorial – Gradient descent in deep learning.
- Assignment problems in optimization.
- Quizzes on deep learning regularization and optimization.

**UNIT III CONVOLUTIONAL NEURAL NETWORKS 9**

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

**Suggested Activities:**

- Discussion of role of Convolutional Networks in Machine Learning.
- External learning – Concept of convolution and need for Pooling.

**Suggested Evaluation Methods:**

- Tutorial – Image classification and recurrent nets.
- Assignment problems in image classification performances.
- Quizzes on Convolutional Neural Networks.

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**UNIT IV MORE DEEP LEARNING ARCHITECTURES 9**

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

**Suggested Activities:**

- Discussion of role of Deep Learning architectures.
- External learning – Compression of features using Autoencoders.

**Suggested Evaluation Methods:**

- Tutorial – LSTM and Autoencoders.
- Assignment problems in deep generative models, Deep Belief Networks.
- Quizzes on deep learning architectures.

**UNIT V APPLICATIONS OF DEEP LEARNING 9**

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.

**Suggested Activities:**

- Discussion of role of Deep Learning in Image and NLP applications.
- External learning – NLP concepts.

**Suggested Evaluation Methods:**

- Tutorial – Image segmentation.
- Assignment problems in parsing and sentiment analysis.
- Quizzes on deep learning architectures.

**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 SimpleLSTM using TensorFlow/Keras.
9. Implement an Opinion Mining in Recurrent Neural network.
10. Implement an Object Detection using CNN.
11. Mini Project

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

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.

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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.


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| **CO1** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 1 | 3 | 1 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO5** | 2 | 1 | 1 | 1 | 3 | 3 |
| **CO6** | 1 | 3 | 1 | 1 | 1 | 2 |

**IF5080 HUMAN COMPUTER INTERACTION TECHNIQUES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn the principles and fundamentals of HCI.
- To understand components of interfaces and screens, including windows, menus and controls.
- To understand user interface design principles, and apply them to designing an interface.
- To learn user interface designs through usability inspection and user models.
- To understand the rationale and guidelines for an effective interface design methodology.

**UNIT I DESIGN PROCESS 9**

Humans – Information Process – Computer – Information Process – Differences and Similarities between them – Need for Interaction – Framework and HCI – Models – Ergonomics – Style – Context – Paradigms – Designing of Interactive systems – Design rules: Golden Rules and Heuristics- Usability – Paradigm Shift – Interaction Design Basics – Design Process – Scenarios – Users need –Complexity of Design – Design Alternatives and Selection.

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**Suggested Activities:**

- Flipped classroom on knowledge on the HCI design process.
- External learning – Exploration of various human computer interfaces.

**Suggested Evaluation Methods:**

- Tutorials – HCI design process.
- Assignment on comparison of various interfaces.

**UNIT II DESIGN AND EVALUATION OF INTERACTIVE SYSTEMS 9**

Software Process – Usability Engineering – Issue Based Information Systems – Iterative Design Practices – Design Rules – Maximum Usability – Principles – Standards and Guidelines – Design Patterns – Programming Tools – Windowing Systems – Interaction Tool Kit – Interaction Devices – Layouts – Fragments – Widgets – Views – Adapters – Interaction styles – Direct Manipulation and Virtual Environments – Menu Selection – Form Fill – Dialog Boxes – Command and Natural Languages – User Interface Management System – Prototype Development– Evaluation Techniques – Evaluation Design – Evaluating Implementations – Observational Methods- Evaluation Strategies.

**Suggested Activities:**

- Flipped classroom on designing a good User Interface system based on design rules.
- External learning – Techniques related to evaluation of HCI design.

**Suggested Evaluation Methods:**

- Tutorial – Usage of design rules to create interfaces.
- Assignment on applying evaluation techniques on different user interfaces.

**UNIT III COMMUNICATION MODELS 9**

Universal Design Principles – Multimodal Systems – User Support – Presentation and Implementation Issues – Types – Requirements – Approaches – Task Models – Task Analysis and Design – Face to Face Communication – Conversation – Text Based Communication – Group Working.

**Suggested Activities:**

- Flipped classroom on basic knowledge of various models used in HCI design.
- External learning – Design and implementation of various models used in HCI design.

**Suggested Evaluation Methods:**

- Tutorial – Task models.
- Assignment on dialog models and task models.

**UNIT IV EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS OF HCI 9**

Basic Design Structure – Single Independent Variable – Multiple Independent Variable – Factorial Design – Split-plot Design – Random Errors – Experimental Procedure – Statistical Analysis – T tests – Analysis of Variance Test – Regression – Chi-Square Test – Survey – Probabilistic Sampling – Non-probabilistic Sampling – Developing Survey Questions.

**Suggested Activities:**

- Flipped classroom on basic concepts of probability and statistics.
- External learning – Practical problems related to hypothesis testing.

**Suggested Evaluation Methods:**

- Tutorial – Statistical testing related to UI evaluation parameters.
- Assignment on problems on hypothesis testing for UI parameters.

**UNIT V DIALOGUE AND CURRENT TRENDS 9**

Dialogue Notations and Design – Dialogue Need – Dialogue Design Notations – Graphical – Textual – Representing Dialogue – Formal Descriptions – Dialogue Analysis – System Models – Interaction Models – Relationship with Dialogue – Formalisms – Formal Notations – Interstitial Behavior – Virtual Reality – Devices for Virtual Reality and 3D Interaction – Modeling Rich Interaction – Status Event Analysis – Properties – Rich Contexts – Sensor-Based systems – Groupware – Applications – Ubiquitous Computing – Applications – HCI for Smart Environment – HCI for Scientific Applications, Medical Applications – HCI for Assistive Technology.

**Suggested Activities:**

- Flipped classroom on basic concepts of dialogue notations and design.
- External learning – Study of how Virtual Reality interface are used in various real time applications.

**Suggested Evaluation Methods:**

- Tutorial – Recent trends in human computer interface systems.
- Assignment on dialogue notation representation for various interfaces.

**PRACTICAL EXERCISES: 30**

1. Study of UI Development Tools like scratch, React, Adobe XD, Flash, Wix, Bootstrap and Angular js.
2. Study of user interfaces of common applications like Facebook, UberEats, Twitter, IRCTC, Anna university Sems, Amazon etc. Prepare a comparative Design document.
3. Design and development of simple user interface for an E-commerce website.
4. Design and development of the user interface of a university Web portal.
5. Design and development of movie ticket booking interface for Physically Challenged people. Prepare design document for the following interfaces which should include the design process, design methodology and the design rules used in the development of the UI application. The document should also justify the chosen methodology for the given application. Using an evaluation technique, evaluate the way in which user experiences with your proposed design would be satisfiable to the end user.
6. Implementation of Mixed Reality based visual interface for dialogue based systems.
7. Implementation of user interfaces for video streaming application which caters to the need of older people.
8. Design and development of mobile application interfaces for chat bots.
9. Design and development of novel user interfaces for any wearable device.
10. Design and develop an interface for geographical information system.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Interpret the contributions of human factors and technical constraints on human-computer interaction.
2. Evaluate the role of current HCI theories in the design of software.
3. Design and develop interfaces related to real applications.
4. Apply exploratory and experimental research methods in HCI.
5. Familiarize with principles and guidelines of user centered interface design process, evaluation methodologies and tools to analyze the interfaces.
6. Implement human computer interfaces for different applications using various tools and technologies.

**REFERENCES:**


1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, Third Edition, Prentice Hall, 2004.
2. Preece, J., Sharp, H., Rogers, Y. “Interaction Design: Beyond Human-Computer Interaction”, Fourth Edition, John Wiley, 2015.
3. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, “Research Methods in Human-Computer Interaction”, Wiley, 2010.
4. Ben Shneiderman, Catherine Plaisant, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Fifth Edition, Reading, Addison Wesley, 2009.
5. Jeff Johnson, “Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules”, Morgan Kauffman, 2010.


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| **CO1** | 3 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 3 | 2` | 1 | 1 | 3 | 1 |
| **CO3** | 3 | 2 | 2 | 1 | 3 | 1 |
| **CO4** | 3 | 1 | 2 | 2 | 1 | 1 |
| **CO5** | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO6** | 2 | 1 | 2 | 3 | 3 | 1 |

**IF5083** **PATTERN RECOGNITION** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To provide basic knowledge about the fundamentals of pattern recognition and its application.
- To understand about unsupervised algorithms suitable for pattern classification.
- To familiarize with the feature selection algorithms and method of implementing them in applications.
- To learn about the basis of algorithm used for training and testing the dataset.
- To learn basic fuzzy system and neural network architectures, for applications in pattern recognition, image processing, and computer vision**.**

**UNIT I PATTERN CLASSIFIER 9**

Overview of Pattern Recognition – Discriminant Functions – Supervised Learning – Parametric Estimation – Maximum Likelihood Estimation – Bayes Theorem – Bayesian Belief Network–Naive Bayesian Classifier.

**Suggested Activities:**

- Discussion on pattern recognition application like image classification .
- Installation of Matlab.
- Assignment on numerical problem solving on Naive Bayesian classifier.

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**Suggested Evaluation Methods:**

- Quizzes on importance of classifier in recognizing various patterns.
- Practical – Programming assignments on implementation of Bayes theorem.

**UNIT II CLUSTERING 9**

Clustering Concept – Hierarchical Clustering Procedures – Partitional Clustering – Clustering of Large Data Sets – EM Algorithm – Grid Based Clustering– Density Based Clustering.

**Suggested Activities:**

- Assignments on numerical problem solving using hierarchical Clustering in Matlab.
- Assignments on numerical problem solving using EM Algorithm in Matlab.

**Suggested Evaluation Methods:**

- Quizzes on various clustering methods in pattern recognition.
- Practical – Programming assignments on the working of clustering algorithms on various applications.

**UNIT III FEATURE EXTRACTION AND SELECTION 9**

Entropy Minimization – Karhunenloeve Transformation – Feature Selection through Functions Approximation – Binary Feature Selection – K-NN.

**Suggested Activities:**

- Assignment on numerical problem solving using K-NN algorithm.
- Assignment on numerical problem solving using Decision Tree algorithm.

**Suggested Evaluation Methods:**

- Quizzes on various feature selection methods.
- Practical – Programming assignments on various feature extraction algorithms for various applications.

**UNIT IV HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE 9**

State Machines – Hidden Markov Models: Maximum Likelihood for the HMM, Forward-Backward Algorithm, Sum and Product Algorithm for the HMM, Scaling Factors, Viterbi Algorithm, Extensions of the Hidden Markov Model – Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines.

**Suggested Activities:**

- Assignments on numerical problem solving using HMM algorithm in Matlab.
- Assignments on numerical problem solving using SVM classifier in Matlab.

**Suggested Evaluation Methods:**

- Quizzes on various Markov models.
- Practical – Programming assignments on working of SVM and HMM over real world application.

**UNIT V RECENT ADVANCES 9**

Fuzzy Classification: Fuzzy Set Theory, Fuzzy and Crisp Classification, Fuzzy Clustering, Fuzzy Pattern Recognition– Introduction to Neural Networks: Elementary Neural Network for Pattern Recognition, Hebbnet, Perceptron, ADALINE, and Back Propagation.

**Suggested Activities:**

- Numerical problem solving on simple neuron in Matlab.
- Numerical problem solving on custom neural networks in Matlab.

**Suggested Evaluation Methods:**

- Quizzes on various fuzzy classification methods.
- Practical – Programming assignments on neural network for pattern recognition applications.

**PRACTICAL EXERCISE:** **30**

1. Implementation of Image classification using Hebbnet method inMatlab.
2. Implementation of Image classification using Perceptron method in Matlab.
3. Implementation of Fuzzy pattern recognition in Matlab/OpenCV.
4. Implementation of Feature extraction using KL transform Matlab/OpenCV.
5. Implementation of Clustering using partitional based clustering in Matlab/OpenCV.
6. Implementation of Clustering using density based clustering in Matlab/OpenCV.
7. Implementation of Classification using SVM in Matlab/OpenCV.
8. Implementation of Classification using HMM in Matlab/OpenCV.
9. Implementation of Classification using Bayes in Matlab/OpenCV.
10. Implementation of Neural Network methods using OpenCV.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Implement basic pattern classifier algorithms.
2. Have knowledge about the working principle of unsupervised algorithm
3. Have knowledge about functionality of classifiers
4. Perceive the recent advancement in pattern recognition
5. Apply SVM and HMM algorithms for real time applications.
6. Implement advanced methodologies over image processing applications.

**REFERENCES:**


1. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2. M. Narasimha Murthy, V. Susheela Devi, “Pattern Recognition”, Springer, 2011.
3. Andrew Webb, “Statistical Pattern Recognition”, Arnold Publishers, 1999.
4. R. O. Duda, P. E. Hart, D. G. Stork, “Pattern Classification”, John Wiley, 2001.
5. S. Rajasekaran, G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall, 2010.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 2 | 1 | 2 | 3 | 1 | 2 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO6** | 2 | 1 | 2 | 2 | 1 | 3 |

**IF5073 AUTONOMOUS GROUND VEHICLE SYSTEMS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn the fundamentals of autonomous driving.
- To study the different ways of sensing internal states of Autonomous Ground Vehicles (AGVs).
- To learn the environment perception for autonomous driving.
- To explore the navigation techniques of AGVs.
- To learn the fundamentals of vehicle control systems and connected vehicles.

**UNIT I INTRODUCTION TO AUTONOMOUS DRIVING 9**

Autonomous Driving Technologies Overview – Autonomous Driving Algorithms – Autonomous Driving Client System – Autonomous Driving Cloud Platform – Components of autonomy – Difference between Unmanned and Autonomous Vehicles – Introduction to Unmanned Aerial Vehicles (UAVs).

**Suggested Activities:**

- Flipped classroom on autonomous driving system architecture.
- External learning – Building blocks of typical Unmanned Aerial Vehicles.
- Flipped classroom onrobot operating system.
- External learning – Applications of autonomous vehicles (aerial, under water, ground vehicles).
- Assignment on the design requirement specifications of autonomous vehicles (aerial, under water, ground vehicles).

**Suggested Evaluation Methods:**

- Viva voce on assignment topics.
- Quizzes on Advanced Driver Assistance Systems (ADAS).
- Group Discussion on Google's self-driving car.

**UNIT II SENSORS FOR AUTONOMOUS GROUND VEHICLES 9**

Sensor Characteristics – Vehicle Internal State Sensing: OEM Vehicle Sensors, GPS, Inertial Measurements, Magnetometer – External World Sensing: RADAR, Lidar, Image Processing Sensors.

**Suggested Activities:**

- Flipped Classroom on sensor characteristics.
- External learning – Working principle of IMU/GPS/RADAR sensors.
- External learning – Exploring Velodyne Lidar sensor dataset in Veloview software.

**Suggested Evaluation Methods:**

- Practical-Experiments on interfacing IMU sensor to Raspberry Pi board and recording the acceleration of a dummy vehicle.
- Practical-Experiments on interfacing Lidar/RADAR sensor to Raspberry Pi board and recording the distances to the nearby objects.
- Practical-Experiments on interfacing camera to Raspberry Pi board and capturing images/videos.

**UNIT III ENVIRONMENT PERCEPTION AND MODELING 9**

Road Recognition: Basic Mean Shift Algorithm, Mean Shift Clustering, Mean Shift Segmentation, Mean Shift Tracking, Road Recognition Algorithm –Vehicle Detection and Tracking: Generating ROIs, Multi Resolution Vehicle Hypothesis, Vehicle Validation using Gabor Features and SVM, Boosted Gabor Features –Multiple Sensor Based Multiple Object Tracking.

**Suggested Activities:**

- Flipped classroom onBasic Mean Shift Algorithm.
- External learning – Lane detection algorithm.
- Flipped classroom onvehicle tracking.

**Suggested Evaluation Methods:**

- Practical – Implementation of Mean Shift Clustering / Mean Shift Segmentation Algorithm.
- Practical – Experiments onstationary obstacle detection algorithm using Lidar sensor.

**UNIT IV NAVIGATION FUNDAMENTALS 9**

Introduction – Navigation: GNSS Overview, GPS, GLONASS, Galileo, Compass – Inertial Navigation Overview: Inertial Sensor Technology – GNSS/INS Integration Overview – Case Studyon Kalman Filtering.

**Suggested Activities:**

- Flipped classroom on GPS orbits/GPS Signals.
- External learning – Indian Regional Navigation Satellite System (IRNSS).
- Assignment onthe working principles of Google Map.

**Suggested Evaluation Methods:**

- Quizzes on GNSS signal structure.
- Viva Voce on assignment topics.
- Practical – Simulation of Waypoint Navigation Algorithm.

**UNIT V VEHICLE CONTROL AND CONNECTED VEHICLE 9**

Vehicle Control: Cruise Control, Antilock Brake Systems, Steering Control and Lane Following, Parking – Connected Vehicles: Vehicle to Vehicle Communication, Vehicle to Infrastructure Communication.

**Suggested Activities:**

- Flipped classroom on cruise control.
- External learning – Study on proportional integral derivative (PID) control.
- Assignment – Communication protocols for connected vehicles.

**Suggested Evaluation Methods:**

- Viva Voce on assignment topic.
- Practical – Experiment on simple velocity control.
- Practical – Experiment on simple longitudinal motion control.

**PRACTICAL EXERCISES: 30**

1. Write a python program to read Lidar sensor data and write it in a text file.
2. Write an Arduino sketch to operate DC motors through motor driver.
3. Write a python program on Raspberry Pi board to control the movement of pan-tilt platform with 5v dc motors.
4. Write a python program to read the IMU sensor values through I2C bus in Raspberry Pi board.
5. Develop an Arduino application to drive a simple rover with four wheels in a random path.
6. Write a python program to send the location of a rover with GPS to Firebase real-time database.
7. Develop a Lidar sensor assisted application to implement 2D collision cone based obstacle avoidance for rovers.

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8. Develop an application using python program to control the pan-tilt motion of a camera and to take pictures/videos in the field of view of the camera.
9. Develop a convolutional neural network model to detect cars in videos.
10. Develop a convolutional neural network model to detect road lanes in videos.
11. Mini Project.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Identify the requirements and design challenges of AGVs.
2. Select suitable sensors to sense the internal state and external world of AGVs.
3. Implement lane detection, road detection & vehicle detection algorithms.
4. Simulate/implement ground vehicle navigation algorithms.
5. Simulate/implement ground vehicle control systems.
6. Design communication protocols for connected vehicles.

**TEXT BOOKS:**

1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, "Creating Autonomous Vehicle Systems", Morgan & Claypool, 2018.
2. UmitOzguner, TankutAcarman, Keith Redmill, "Autonomous Ground Vehicles", Artech House, 2011.

**REFERENCES:**

1. Hong Cheng, "Autonomous Intelligent Vehicles Theory, Algorithms, and Implementation", Springer, 2011.
2. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, "Global Navigation Satellite Systems, Inertial Navigation, and Integration", Third Edition, John Wiley & Sons, 2013.

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| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 |
| **CO2** | 1 | 3 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 1 |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 1 |
| **CO5** | 3 | 2 | 2 | 2 | 3 | 1 |
| **CO6** | 3 | 2 | 2 | 2 | 3 | 3 |

**IF5002 OPEN SOURCE TECHNOLOGIES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To introduce the essence of free software.
- To understand the basic shell commands needed for running applications in Linux.
- To learn the working of server side web applications using Flask.
- To understand the back-end framework of NoSql databases with connection to Python.
- To provide an exposure to open hardware.

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**UNIT I INTRODUCTION 9**

Need for Free and Open Source Software – Overview of Linux – Distributions – Licensing Schemes – Versions – Collaborative Version Control Systems – Shell Commands – LAMP.

**Suggested Activities:**

- Flipped classroom on free software varieties, GPL.
- Programming small pieces of fresh snippets.
- Complete the program from the given starter code.

**Suggested Evaluation Methods:**

- Quizzes on various distributions of Linux.
- Programming assignments on shell commands and LAMP.

**UNIT II PYTHON PROGRAMMING 9**

Variables – Lists – Tuples – Conditionals – Strings – Recursion – Functions – Object Oriented approach.

**Suggested Activities:**

- Flipped classroom on overview of Python
- In-class activity – Programming small pieces of fresh snippets.
- In-class activity – Complete the program from the given starter code.

**Suggested Evaluation Methods:**

- Quizzes on conditionals and string manipulation.
- Programming assignments on functions.
- Assignment on finding the total number of commits in Git.

**UNIT III WEB DEVELOPMENT WITH PYTHON 9**

HTML – CSS – Bootstrap – Introduction to Flask – Templates – Models – Forms – Modules.

**Suggested Activities:**

- Flipped classroom on basic HTML coding techniques.
- Practical – Programming small pieces of fresh snippets.
- Complete the program from the given starter code.

**Suggested Evaluation Methods:**

- Quizzes on bootstrap method.
- Programming assignments on Flask.

**UNIT IV WORKING WITH DATABASES 9**

Introduction to Document Databases – Working – Relational Database versus NOSQL – Modeling – Mapping Classes to MongoDB – Building Data layer with Mongo Engine.

**Suggested Activities:**

- Flipped classroom on working with relational databases.
- Programming small pieces of fresh snippets.
- Complete the program from the given starter code.

**Suggested Evaluation Methods:**

- Quizzes on NoSQL.
- Programming assignments on MongoDB.
- Total number of commits in Git.

**UNIT V OPEN HARDWARE** **9**

Raspberry Pi – Arduino – Installation of Portable OS – Building Web Applications with Raspberry Pi and Arduino

**Suggested Activities:**

- Flipped classroom on overview of available portable devices
- Programming small pieces of fresh snippets.
- Practical – Complete the program from the given starter code.

**Suggested Evaluation Methods:**

- Quizzes on different components of the unit.
- Programming assignments on web application.

**PRACTICAL EXERCISES:** **30**

1. Use of Linux shell commands.
2. Programming a simple application such as a calendar using Python.
3. Working with git commands.
4. Working with dynamic websites using HTML.
5. Working with HTML – bootstrap strategies.
6. Installation of Flask and creating websites with Flask.
7. Design a website with Flask – HTML – Bootstrap.
8. Installation and working with Mongodb.
9. Creation of website with Flask+Mongodb+HTML.
10. Installation of Linux OS in open hardware.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Use shell commands for executing programs and applications.
2. Use Git for collaboration and maintaining different versions.
3. Develop a web application using Flask framework.
4. Work with NoSQL structures.
5. Develop a server side web application using Python.
6. Explore the features of open hardware.

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3. https://getbootstrap.com/
4. Peter Wentworth, Jeffrey Elkner, Allen B. Downey, Chris Meyers, “How to Think Like a Computer Scientist”, Open Book, 2012.
5. Scott Chacon, Ben Straub, “Pro Git”, Free ebook under Creative Commons, Second Edition, Apress, 2016.
6. Miguel Grinberg, “Flask Web Development Developing Web Applications with Python”, O’Reilly, 2014.
7. Karl Seguin, “The Little Mongo DB Book”, https://github.com/karlseguin/the–little–mongodb–book.
8. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.


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| **CO2** | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 1 | 1 | 3 | 3 | 3 | 2 |
| **CO4** | 1 | 1 | 3 | 1 | 2 | 1 |
| **CO5** | 2 | 1 | 3 | 3 | 3 | 1 |
| **CO6** | 1 | 1 | 2 | 1 | 3 | 1 |

**IF5079 GPU ARCHITECTURE AND PROGRAMMING L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the basics of GPU architectures.
- To write programs for massively parallel processors using CUDA/OpenCL.
- To understand the issues in mapping algorithms for GPUs.
- To understand different GPU programming models.
- To analyze performance of algorithms on GPUs.

**UNIT I GPU ARCHITECTURE 12**

Evolution of GPU Architectures – Understanding Parallelism with GPU – Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

**Suggested Activities:**

- Assignment on surveying machines in the lab and identifying the configuration of the GPUs in them.
- Practical – Download the CUDA toolkit and setup the CUDA environment.
- Practical – Write simple CUDA code and vary the parameters to understand the concept of threads, blocks and grids.

**Suggested Evaluation Methods:**

- Evaluation of the assignment by checking the configuration.
- Demonstrate the CUDA setup by running simple and sample programs.

**UNIT II CUDA PROGRAMMING 8**

CUDA Basics – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

**Suggested Activities:**

- Code walkthrough of sample CUDA programs.
- Practical – Execute sample CUDA programs with different memory options.

**Suggested Evaluation Methods:**

- Evaluation of the practical by checking the trace of the CUDA programs.
- Evaluation of the practical by checking the output corresponding to different memory options.

**UNIT III PROGRAMMING ISSUES 8**

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.

**Suggested Activities:**

- Code walkthrough of sample CUDA programs with synchronization within thread blocks and across thread blocks.
- Practical – Write CUDA programs with and without pitched memory and compare.

**Suggested Evaluation Methods:**

- Quiz on synchronization options.
- Evaluation of the practical.

**UNIT IV OPENCL BASICS 8**

OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples.

**Suggested Activities:**

- Code walkthrough of sample OpenCL programs.
- Practical – Execute sample OpenCL programs with different memory options.

**Suggested Evaluation Methods:**

- Evaluation of the practical by checking the trace of the OpenCL programs.
- Evaluation of the practical by checking the output corresponding to different memory options.

**UNIT V ALGORITHMS ON GPU 9**

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster.

**Suggested Activities:**

- Assignment on studying and analyzing programs in CUDA/OpenCL to perform graph traversal, tree traversal.
- Assignment on studying and analyzing sample programs for matrix multiplication and analyzing their performance.

**Suggested Evaluation Methods:**

- Check the output of the CUDA/OpenCL programs.
- Check Performance chart.

**PRACTICAL EXERCISES: 30**

1. Implement matrix multiplication using CUDA. Experiment with different matrix sizes and kernel launch options and compare the performance. (4 hours )
2. Implement vector reduction using CUDA, and check output with CUDA profiler.
3. Implement matrix multiplication with tiling and shared memory.
4. Implement various performance tuning techniques for matrix multiplication.

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5. Implement matrix multiplication using OpenCL.
6. Implement vector reduction using OpenCL.
7. Implement graph traversal using CUDA
8. Implement image processing algorithms using CUDA
9. Experiment with advanced features such as dynamic parallelism
10. Mini project: Choose an application and implement using GPU and do performance analysis.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Describe GPU Architecture.
2. Write programs using CUDA, identify issues and debug them.
3. Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication.
4. Write simple programs using OpenCL.
5. Given a problem, identify efficient parallel programming patterns to solve it.
6. Compare different GPU programming paradigms.

**REFERENCES:**


1. Shane Cook, “CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs”, Morgan Kaufmann, 2013.
2. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, “Heterogeneous Computing with OpenCL 2.0”, Morgan Kauffman, 2015.
3. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors – A Hands-on Approach”, Third Edition, Morgan Kaufmann, 2016.
4. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison Wesley, 2013.
5. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison Wesley, 2011.
6. http://www.nvidia.com/object/cuda_home_new.html.
7. http://www.openCL.org.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 1 | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO6** | 3 | 2 | 2 | 1 | 1 | 1 |

| IF5003 | SERVICE ORIENTED ARCHITECTURE AND MICROSERVICES | L T P C<br>3 0 2 4 |
|---|---|---|

**OBJECTIVES:**

- To understand the basic principles of service orientation.
- To analyze various software architectures.
- To introduce service oriented and microservices architecture.
- To analyze and implement a web service based applications.
- To understand the technology underlying service design and microservices applications.

**UNIT I SOFTWARE ENGINEERING PRACTICES 9**

Software Engineering Principles – SDLC – Agile Development Methodologies – Emergence of Devops Architecture – Need for Software Architecture – Types of IT Architecture – Pattern & Style – Architecting Process for Software Applications – High Level Architecture – Solution Architecture – Software Platforms – Enterprise Applications – Custom Software Applications – Cloud Computing Platforms.

**Suggested Activities:**

- Sample application for each type of architecture.
- Study of popular enterprise applications.
- Cloud computing platforms comparison.
- DevOPs solution fundamentals.

**Suggested Evaluation Methods:**

- Quiz on various concepts.
- Simple development based on the solutions and study.

**UNIT II SOA AND MICROSERVICE ARCHITECTURE BASICS 9**

SOA and MSA – Basics – Evolution of SOA & MSA – Drivers for SOA – Dimensions, Standards and Guidelines for SOA – Emergence of MSA – Enterprise-wide SOA – Strawman and SOA Reference Architecture – OOAD Process & SOAD Process – Service Oriented Application – Composite Application Programming Model.

**Suggested Activities:**

- Applications of SOA and MSA.
- OOAD and SOAD comparison.
- Identifying simple services based on SOA and MSA.

**Suggested Evaluation Methods:**

- Case studies of various SOA applications.
- Application based comparison.

**UNIT III WEB SERVICES 9**

XML – DOM and SAX Processors – SOAP – WSDL – UDDI – JSON – WS – Security – Web Services Standards – Java, .NET, Python Web Services – RESTful Web Services – Middleware Services for IoT – Mobile Services.

**Suggested Activities:**

- XML processing.
- Exploring the structure of SOAP, WSDL and UDDI.
- Creation of web services in Java/.NET/Python environment.
- RESTful web services.
- Study of middleware services for IoT.

**Suggested Evaluation Methods:**

- Implementing XML, DOM and SAX.
- Programming exercises.

**UNIT IV SERVICE ORIENTED ANALYSIS AND DESIGN 9**

Principles of Service Design – Design of Activity, Data, Client, Business Process Services – Resilience Services –Technologies for SOA – Service Enablement – Integration – Orchestration – SOA Governance – Design Time and Run Time Governance – SOA Best Practices – EA and SOA for IT Alignment.

**Suggested Activities:**

- Study for various service design.
- SOA best practices case studies.

**Suggested Evaluation Methods:**

- Quiz on service design principles.
- Practical – Programming exercises on service orchestration.

**UNIT V MICROSERVICE BASED APPLICATIONS 9**

Implementing Microservices with Python – Microservice Discovery Framework – Coding, Testing & Documenting Microservices – Interacting with Other Services – Monitoring and Securing the Services – Containerized Services – Deploying on Cloud.

**Suggested Activities:**

- Implementation of microservices architecture with python.
- Creation of container services.
- Cloud deployment.

**Suggested Evaluation Methods:**

- Microservice based application case study.
- Cloud deployment in different platforms.

**PRACTICAL EXERCISES: 30**

1. Exploring DevOps based Application Development tools in Open Source Environment.
2. Creation of XML Document and manipulate using DOM and SAX parser in Java /.Net /Python framework.
3. Creation of WSDL and SOAP Request and Response and exploring UDDI.
4. Developing RESTful web services in Java / Python framework, deploy and consume in different environment using Web Service Interoperable Technology (WSIT)
5. Developing RESTful web services in .NET framework, deploy and consume in different environment using Web Service Interoperable Technology (WSIT).
6. Creation of a web service based application incorporating WS-Security standards.
7. Composing web services using BPEL workflow engine.
8. Creation of an application following Micro Service Architecture (MSA) using HTTP (and REST) and Remote Procedure Call (RPC) over Advanced Message Queuing Protocol (AMQP) in Python environment with Flask-Nameko framework.
9. Creation of an application following Micro Service Architecture (MSA) using Microservices frameworks for Java (Spring Boot, Jersey, Swagger)
10. Mini project.
    Requirements:

**a.** Java
**b.** .Net Visual Studio
**c.** Python (Latest version)
**d.** Flask-Nameko

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Analyze and design SOA based solutions.
2. Understand the basic principles of service orientation.
3. Analyze and implement a web service based applications.
4. Understand the technology underlying service design.
5. Implement SOA with Microservices applications.
6. Classify and make reasonable decision on the adoption of different SOA platforms.

**REFERENCES:**


1. Shankar Kambhampaty, "Service-Oriented Architecture and Microservice Architecture: For Enterprise, Cloud, Big Data and Mobile", Third Edition, Wiley, 2018.
2. Tarek Ziadé , "Python Microservices Development", O'REILLY publication,2017.
3. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.
4. Ron Schmelzer et.al, "XML and Web Services", Pearson Education, 2002.
5. Leonard Richardson, Sam Ruby, "RESTful Web Services", O'REILLY publication, 2007.
6. Nicolai M. Josuttis, "SOA in Design – The Art of Distributed System Design", O'REILLY publication, 2007.
7. Raj Balasubramanian, Benjamin Carlyle, Thomas Erl, Cesare Pautasso, "SOA with REST – Principles, Patterns & Constraints for Building Enterprise Solutions with REST", Prentice Hall, 2013.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO6** | 2 | 1 | 2 | 1 | 1 | 1 |

**IF5004 CRYPTOGRAPHY AND INFORMATION SECURITY** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the mathematics behind Cryptography.
- To understand the standard algorithms used to provide confidentiality, Integrity and authenticity.
- To understand Cryptographic theories and Systems.
- To get a working knowledge of layer wise security in order to build secure systems.
- To understand necessary approaches and techniques to build protection mechanisms in order to secure computer networks.

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**UNIT I INTRODUCTION TO SECURITY AND MATHEMATICAL FOUNDATIONS 9**

Introduction to Security – Mathematics of Security: Number theory – Modular Arithmetic – Extended Euclidean Theorem – Algebraic structures – Galois field – Primality test – Fermat and Euler's theorem – Legendre and Jacobi symbols – Chinese Remainder theorem – Discrete Logarithms – Elliptic Curves – Classical Cryptosystems.

**Suggested Activities:**

- In-class activity – Cryptanalysis of classical cryptography.
- In-class activity – Solve some examples related to number theory and the theorem.
- External learning – Evolution of computer systems, identification of benchmarks.
- Demonstration on Cryptool.

**Suggested Evaluation Methods:**

- Assignment problems on first three activities.
- Quiz on external learning.
- Group discussion on tool demonstration.

**UNIT II SYMMETRIC CRYPTOGRAPHY 9**

Symmetric and Asymmetric cipher – Block and Stream Cipher – Feistel Ciphers – Non Feistel Ciphers – Data Encryption Standard –Linear and Differential cryptanalysis – Triple DES – Advanced Encryption Standard (AES) – RC4.

**Suggested Activities:**

- External learning – Attacks on DES and AES and Crptanalysis.
- Practical – Study of a various attacks related to symmetric key encryption.

**Suggested Evaluation Methods:**

- Assignment on problems on cryptographic algorithms.
- Quiz on DES and AES attacks.

**UNIT III ASYMMETRIC KEY CRYPTOGRAPHY 9**

Asymmetric Key Cryptography – RSA – ElGamal Public Key Cryptosystems – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography Key Exchange – Hash Functions – Hash Algorithms – Secure Hash – Birthday Attacks – MD5 – Message Authentication Codes – Authentication protocols – Digital Signatures.

**Suggested Activities:**

- External learning – Familiarizing with public and private key in asymmetric cryptography.
- Practical – Verify the message integrity using hashing techniques.

**Suggested Evaluation Methods:**

- Tutorial – ECC.
- Quiz on various hashing and authentication techniques.

**UNIT IV NETWORK SECURITY 9**

Authentication applications – Kerberos – PKI – Digital Certificates: X.509 – Electronic Mail security – PGP-IP Security – Web Security – Transport layer Security: SSL, SET – Firewall: Firewall Generation – Intrusion Detection System – Types of IDS – Wireless LAN – Wireless LAN Security – Configuration of WLAN Security – Security Administration – ISO and GLBA Standards on Information Security – Access Control Models – ACL.

**Suggested Activities:**

- Understand the components of x.509 certificate.
- Demonstration of email security.
- Practical – Experiment with SSL in web server.
- External learning – Understanding how the existing firewalls work and their usages.

**Suggested Evaluation Methods:**

- Group discussion on demonstration.
- Quiz on layer-wise security protocols.

**UNIT V SYSTEM SECURITY 9**

Penetration testing – Vulnerability Assessment tools – System security: Security models – Trusted Operating systems – Data Assurance –Database security – Multilevel databases – Multi–level security – Cloud Security – Ethical Hacking – Crypto Currency – Introduction to Blockchain.

**Suggested Activities:**

- External learning – Designing trusted OS.
- Case study – Applications that use Blockchain technology.

**Suggested Evaluation Methods:**

- Group Discussion – various applications that use Block chain technology.
- Group discussion – The need for Ethical Hacking.

**PRACTICAL EXERCISES: 30**

1. Write a program to perform encryption and decryption using the following algorithms.
    a. Caesar cipher, Affine Cipher.
    b. Hill Cipher, Playfair Cipher.
    c. Transposition Cipher.
2. Perform Cryptographic attack on the ciphertext generated using any of the algorithm implemented in exercise 1.
3. Implementation of symmetric cryptographic algorithms such as DES, AES, etc.
4. Implementation of RSA algorithm and demonstration of the key generation and encryption process.
5. Generation of Keys between two end parties using Diffie Hellman Key Exchange.
6. Write a program to generate message digest for the given message using the SHA/MD5 algorithm and verify the integrity of message.
7. Write a program to sign and verify a document using DSA algorithm.
8. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools in kali Linux.
9. Hands–on with Software and Hardware firewall configuration and intrusion detection using SNORT
10. Configuring and utilizing network protection components like VPNs, anti–virus software, anti–spyware, etc.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the fundamentals of network security, security architecture, threats and vulnerabilities.
2. Apply the different cryptographic operations of symmetric cryptographic algorithms.
3. Apply the different cryptographic operations of public key cryptography.
4. Apply the various Authentication schemes to simulate different applications.
5. Understand various Security practices and System security standards
6. Know the state of art technologies like Ethical Hacking, Block chain etc.

**REFERENCES:**


1. William Stallings, “Crpyptography and Network security Principles and Practices”, Pearson Education/PHI, Fourth Edition, 2006.
2. Behourz Forouzan, Debdeep Mukhopadyay, “Cryptography & Network Security” Tata MCGraw-Hill Education, 2010
3. Charles P. Pfleeger, Shari L. Pfleeger, “Security in Computing”, Third Edition, PHI/Pearson Education, 2003.
4. Wenbo Mao, “Modern Cryptography Theory and Practice”, Pearson Education, 2004.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO3** | 2 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 2 | 2 | 3 | 3 |
| **CO5** | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO6** | 1 | 3 | 3 | 3 | 3 | 3 |

**IF5005 SOFTWARE QUALITY ASSURANCE AND TESTING L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To give a clear picture on quality management, documentation and controlling for software quality.
- To provide knowledge on standards, models and tools used for quality management.
- To perform measurement and assessment of software quality.
- To introduce the basics and necessity of Software testing.
- To introduce various testing techniques along with software production.

**UNIT I INTRODUCTION TO SOFTWARE QUALITY & ARCHITECTURE 9**

Need For Software Quality – Quality Challenges – Software Quality Assurance (SQA) – Definition And Objectives – Software Quality Factors – McCall’S Quality Model – SQA System and Architecture – Software Project Life Cycle Components – Management of SQA components – Pre Project Software Quality Components – Contract review – Development and Quality Plans.

**Suggested Activities:**

- External learning – Software Quality models.
- Preparation of Report on Quality plans.

**Suggested Evaluation Methods:**

- Assignment – Quality models and Quality Plans.

**UNIT II SQA COMPONENTS AND PROJECT LIFE CYCLE 9**

Software Development Methodologies – Quality Assurance Activities In The Development Process – Verification, Validation& Qualification – Reviews: Objectives – Formal design review – Peer review – Quality of Software Maintenance components – Pre-Maintenance Software Quality Components – Maintenance Software Quality Assurance Tools– Assuring the Quality of External participants contributions: Objectives, Types, Risks & Benefits, Tools – CASE Tools and their effect on Software Quality.

**Suggested Activities:**

- Discussion Forum – Software Quality Assurance Components.
- External learning – Quality assurance tools.

**Suggested Evaluation Methods:**

- Quiz – Software Quality Assurance Components.
- Assignment – Quality assurance tools.

**UNIT III SOFTWARE QUALITY INFRASTRUCTURE 9**

Procedures And Work Instructions – Supporting Quality devices – Templates – Checklists – Staff Training And Certification – Corrective And Preventive Actions – Configuration Management – Software Change Control – Configuration Management Audit – Documentation Control – Storage And Retrieval.

**Suggested Activities:**

- Discussion forum – Configuration management audit.
- Discussion forum – Documentation control.

**Suggested Evaluation Methods:**

- Assignment – Configuration management audit report.
- Quiz – Documentation control.

**UNIT IV SOFTWARE QUALITY MANAGEMENT, METRICS & STANDARDS 9**

Project Process Control – Computerized Tools – Software Quality Metrics – Objectives of Quality Measurement – Process Metrics – Product Metrics – Implementation – Limitations of Software Metrics – Cost of Software Quality – Classical Quality Cost Model – Extended Model – Application of Cost Model – Quality Management Standards – ISO 9001 And ISO 9000-3 – Capability Maturity Models(CMM & CMMI) – Organization of Quality Assurance – Department Management Responsibilities – Project Management Responsibilities – SQA Units and Other Actors In SQA Systems.

**Suggested Activities:**

- Discussion – ISO Quality standards.
- External learning – Software Quality metrics.

**Suggested Evaluation Methods:**

- Assignment – ISO Quality standards.
- Quiz – Process and Product metrics.

**UNIT V SOFTWARE TESTING 9**

Definition and objectives – Software testing strategies – Software test classifications – White box testing: Data processing, Calculation correctness tests, McCabe's cyclomatic complexity metrics, Software qualification and reusability testing, Advantages and disadvantages of white box testing – Black box testing: Equivalence classes for output correctness tests, Revision factor testing classes, Transition factor testing classes, Advantages and disadvantages of black box testing– Implementation: The testing process – Test case design – Automated testing – Alpha and beta site testing programs.

**Suggested Activities:**

- Discussion on Test case generation and testing methods.

**Suggested Evaluation Methods:**

- Assignment on Test case generation tools.
- Quiz on testing procedures.

**PRACTICAL EXERCISES: 30**

1. Generation of Quality assessment report of Contract documents.
2. Generation of Quality Assessment report of Plan documents.
3. Quality assessment report of Design work products.
4. Quality assessment of Risk management documents.
5. Quality Assessment of Configuration management documents.
6. Quality Assessment of Cost models.
7. Automatic Test case generation for Black box testing.
8. Automatic Test case generation for White box testing.
9. Automation of Black box testing.
10. Automation of White box testing.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Learn document, control and manage software quality with the aid of tools and standards.
2. Distinguish various software quality models.
3. Measure and assess Software Quality through process and product metrics.
4. Distinguish the Software quality standards.
5. Perform automated testing using test tools.
6. Document the testing procedures.

**REFERENCES:**


1. Daniel Galin, "Software Quality Assurance: From theory to implementation", Pearson Education, 2004.
2. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Pearson Education, 2002.
3. Mordechai Ben – Menachem and Garry S.Marliss, "Software Quality", CL EMEA, 2009.
4. Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003.
5. Glenford J. Myers, Tom Badgett, Corey Sandler, "The Art of Software Testing", Third Edition, John Wiley, 2012.
6. Ron Patton, "Software testing", Second edition, Pearson Education, 2009.
7. Srinivasan Desikan, Gopalaswamy Ramesh, "Software testing- Principles and Practices", Pearson Education, 2009.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO6** | 1 | 3 | 3 | 1 | 1 | 3 |

**IF5006 SOFT COMPUTING AND ITS APPLICATIONS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn fuzzy logic, fuzzification and defuzzification.
- To design a soft computing system required to address a computational task.
- To learn and apply artificial neural networks, fuzzy sets and fuzzy logic, and genetic algorithms in problem solving and use of heuristics based on human experience.
- To introduce the ideas of fuzzy sets, fuzzy logic To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inferencing systems.
- To familiarize with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations.

**UNIT I FUZZY COMPUTING 9**

Basic Concepts of Fuzzy Logic – Fuzzy Sets and Crisp Sets – Fuzzy Set Theory and Operations – Properties of Fuzzy Sets – Fuzzy and Crisp Relations – Fuzzy to Crisp Conversion – Membership Functions – Interference in Fuzzy Logic – Fuzzy If-Then Rules – Fuzzy Implications and Fuzzy Algorithms – Fuzzification and Defuzzification – Fuzzy Controller – Industrial Applications.

**Suggested Activities:**

- Practical – Install MatLab Fuzzy Logic toolbox and ANN toolbox to design and simulate systems.

**Suggested Evaluation Methods:**

- Quiz on basic concepts of fuzzy logic and operations.

**UNIT II FUNDAMENTALS OF NEURAL NETWORKS 9**

Neuron – Nerve Structure and Synapse – Artificial Neuron and its Model – Activation Functions – Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks – Recurrent Networks – Various Learning Techniques: Perception and Convergence Rule – Back Propagation Learning Methods – Auto-Associative and Hetero-Associative Memory.

.

**Suggested Activities:**

- Practical – Develop a supervised model to train neural net that uses the AND/OR/XOR two input binary/bipolar input and output data and learn linear models to understand the importance of initialization parameters.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementation with appropriate input set.

**UNIT III COMPETETIVE NEURAL NETWORKS 9**

Kohenen's Self Organizing Map–SOM Architecture – Learning procedure – Application – Learning Vector Quantization – Learning by LVQ – Adaptive Resonance Theory – Learning procedure – Applications.

**Suggested Activities:**

- Practical – Develop an unsupervised model to train neural net that uses any dataset and plot the cluster of patterns.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementation with appropriate input set.

**UNIT IV GENETIC ALGORITHM 9**

Basic Concepts – Working Principle – Procedures of GA – Flow Chart of GA – Genetic Representations – Initialization and Selection – Genetic Operators – Mutation – Generational Cycle –Applications – Multi-objective optimization problems – Multi-Objective Evolutionary Algorithm – Non-Pareto approaches to solve MOOPs – Pareto-based approaches to solve MOOPs – Some applications with MOEAs.

**Suggested Activities:**

- Practical – Implement GA for the Travelling Salesman problem to find the shortest path that visits all cities in a set exactly once.

**Suggested Evaluation Methods:**

- Implementation evaluation by testing the code on different route maps and checking the optimal solution.

**UNIT V HYBRID SYSTEMS 9**

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Integration of neural networks – fuzzy logic and genetic algorithms.

**Suggested Activities:**

- Practical – Develop adaptive neuro-fuzzy hybrid technique to train NAND gate with two binary and targets and observe the training performance.

**Suggested Evaluation Methods:**

- Group discussion on developing a hybrid system for solving a problem.
- Evaluation of the practical implementation.

**PRACTICAL EXERCISES: 30**

Implement the following exercises using any programming language:

1. Develop an application that fraud detection systems from data using fuzzy logic.
2. Develop a system to implement Neural Networks techniques to define predictive models for fraud detection.
3. Develop a system that can optimize the solution of the fraud detection system developed by fuzzy logic.

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4. Implement Pareto-based approaches to solve MOOPs.
5. Develop a hybrid system by integrating neural networks, fuzzy logic and genetic algorithms for any real time application.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

1. Identify and describe soft computing techniques and their roles in building intelligent machines.
2. Recognize the feasibility of applying a soft computing methodology for a particular problem.
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
4. Apply genetic algorithms to optimization problems.
5. Design neural networks to pattern classification and regression problems using soft computing approach.
6. Describe the importance of tolerance of imprecision and uncertainty to a design of robust and low-cost intelligent machines.

**REFERENCES:**


1. S. Rajasekaran, G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall, 2010.
2. J. S. R. Jang, C. T. Sun, E. Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education, 2004.
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4. Siman Haykin, “Neural Networks”, Prentice Hall, 1999.
5. Timothy Ross, “Fuzzy Logic with Engineering Applications”, Wiley, 2016.
6. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2008.
7. Frank Neumann, Carsten Witt, “Bioinspired Computation in Combinational Optimization – Algorithm and their Optimization Complexity”, Natural Computing Series, Springer, 2010.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO2** | 3 | 2 | 1 | 1 | 2 | 1 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 2 |
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| **CO5** | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO6** | 2 | 1 | 1 | 2 | 2 | 1 |

**IF5007** **MACHINE LEARNING TECHNIQUES** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the concepts of machine learning.
- To appreciate supervised and unsupervised learning and their applications.
- To understand the theoretical and practical aspects of Probabilistic Graphical Models.
- To appreciate the concepts and algorithms of reinforcement learning.
- To learn aspects of computational learning theory.

**UNIT I INTRODUCTION** **9**

Machine Learning – Basic Concepts in Machine Learning – Types of Machine Learning – Examples of Machine Learning – Applications – Linear Models for Regression – Linear Basis Function Models – The Bias-Variance Decomposition – Bayesian Linear Regression – Bayesian Model Comparison – Dimensionality Reduction.

**Suggested Activities:**

- Install python and explore the packages required for machine learning including numpy, scikit-learn, and matplotlib, Ipython, hmmpytk and pgmpy.

**Suggested Evaluation Methods:**

- Quiz on different applications of machine learning.

**UNIT II SUPERVISED LEARNING I** **9**

Linear Models for Classification – Discriminant Functions – Probabilistic Generative Models – Probabilistic Discriminative Models –The Laplace Approximation – Bayesian Logistic Regression – Principal Component Analysis – Probabilistic PCA – Independent Components Analysis.

**Suggested Activities:**

- Practical – Collection of data from different recourses and summarize the data.
- Practical – Build linear, multi-linear, logistic Regression model to predict the data.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementations using the test set.
- Group discussion on basics of classification and regression.

**UNIT III SUPERVISED LEARNING II** **9**

Neural Networks – Feed-Forward Network Functions – Error Back Propagation – Regularization – Mixture Density and Bayesian Neural Networks – Kernel Methods – Dual Representations – Radial Basis Function Networks – SVM-Ensemble Methods – Bagging – Boosting.

**Suggested Activities:**

- Practical – Develop SVM model for a two class problem, whose training points are distributed in a 2D plane and improve the performance of the model by applying kernel methods.
- Practical – Implement bagging approach for credit card analysis.

**Suggested Evaluation Methods:**

- Tutorial – Kernel methods.
- Evaluation of the practical implementations using appropriate test set.
- Group discussion on back propagation.

**UNIT IV UNSUPERVISED LEARNING 8**

Clustering– K-means – Hierarchical Clustering – EM – Mixtures of Gaussians – The EM Algorithm in General – Model Selection for Latent Variable Models.

**Suggested Activities:**

- Implement k means algorithm to cluster the traffic data set based on accident type.

**Suggested Evaluation Methods:**

- Tutorial on model selection and validation.
- Evaluation of the practical implementation using appropriate test set.

**UNIT V PROBABILISTIC GRAPHICAL MODELS 10**

Directed Graphical Models – Bayesian Networks – Exploiting Independence Properties – From Distributions to Graphs – Examples – Markov Random Fields – Inference in Graphical Models – Markov Models – Hidden Markov Models – Inference – Learning-Generalization – Undirected Graphical Models – Markov Random Fields – Conditional Independence Properties – Parameterization of MRFs – Examples – Learning – Conditional Random Fields (CRFs) – Structural SVMs – Sampling.

**Suggested Activities:**

- Assignment on solving numerical problem using HMM.

**Suggested Evaluation Methods:**

- Group discussion on graphical models.

**PRACTICAL EXERCISES: 30**

Implement the following exercise using python libraries on UCI Machine Learning Repository.

1. Develop an application that makes predictions from data using Linear Regression.
2. Develop an application that makes predictions from data using Logistic Regression.
3. Develop a system to implement classifier using SVM / Neural Networks.
4. Develop a system that can automatically group articles by similarity using K–Means Clustering & PCA.
5. Develop a system that can extract the word from the given sentences using Hidden Markov model.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Implement a neural network for an application of your choice using an available tool.
2. Implement probabilistic discriminative and generative algorithms for an application of your choice and analyze the results.
3. Use a tool to implement typical clustering algorithms for different types of applications.
4. Design and implement an HMM for a sequence model type of application
5. Implement a PGM for any real time application using an open source tool.
6. Identify applications suitable for different types of machine learning with suitable justification.

**REFERENCES:**


1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
3. Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, 2005.
4. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.

5. T. Hastie, R. Tibshirani, J. Friedman, “The Elements of Statistical Learning”, Second Edition, Springer, 2008.
6. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, CRC Press, 2009.
7. Daphne Koller, N. Friedman, Francis Bach, “Probabilistic Graphical Models – Principles and Techniques”, MIT Press,2009.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 3 | 3 | 3 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 1 |
| **CO3** | 2 | 1 | 3 | 2 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | 1 | 2 | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO6** | 3 | 2 | 1 | 2 | 1 | 1 |

**IF5090** **SEMANTIC WEB** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn the fundamentals of semantic web and to conceptualize and depict Ontology for semantic web.
- To understand the languages for semantic web.
- To learn about the ontology learning algorithms and to utilize in the development of an application.
- To know the fundamental concepts of ontology management.
- To learn the applications related to semantic web.

**UNIT I THE QUEST FOR SEMANTICS** **9**

Building Models – Calculating with Knowledge – Exchanging Information – Semantic Web Technologies – Layers – Architecture – Components – Types – Ontological Commitments – Ontological Categories – Philosophical Background – Sample Knowledge Representation Ontologies – Top Level Ontologies – Linguistic Ontologies – Domain Ontologies – Semantic Web – Need – Foundation.

**Suggested Activities:**

- Flipped classroom on semantic web background and tutorial activity in class.
- Brainstorming session on various knowledge representation formats in class.

**Suggested Evaluation Methods:**

- Tutorial – Semantic web basics.
- Quizzes on knowledge representation formats.

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**UNIT II LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES 9**

Web Documents in XML – RDF – Schema – Web Resource Description using RDF – RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics – Pragmatics –Traditional Ontology Languages – LOOM – OKBC – OCML – Flogic Ontology Markup Languages – SHOE – OIL – DAML+OIL – OWL.

**Suggested Activities:**

- Flipped classroom on comparison of various semantic web related languages and tutorial activity in class.

**Suggested Evaluation Methods:**

- Quizzes on various ontology related languages.

**UNIT III ONTOLOGY LEARNING FOR SEMANTIC WEB 9**

Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning – Importing and Processing Ontologies and Documents – Ontology Learning Algorithms – Methods for evaluating Ontologies.

**Suggested Activities:**

- Flipped classroom on natural language processing techniques like statistical text analysis, term extraction, Word sense disambiguation, concept extraction and tutorial activity in class.
- External reading – https://nlp.stanford.edu/fsnlp/

**Suggested Evaluation Methods**

- Tutorials – Language processing techniques.

**UNIT IV ONTOLOGY MANAGEMENT AND TOOLS 9**

Overview – Need for management – Development process – Target Ontology – Ontology mapping – Skills management system – Ontological class – Constraints – Issues – Evolution –Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based Annotation Tools.

**Suggested Activities:**

- Flipped classroom on study of various ontology related tools.

**Suggested Evaluation Methods**

- Tutorials – Ontology related tools like Protege, Ontolingua, Webonto.

**UNIT V APPLICATIONS 9**

Web Services – Semantic Web Services – Case Study for specific domain – Security issues – Web Data Exchange and Syndication – Semantic Wikis – Semantic Portals – Semantic Metadata in Data Formats – Semantic Web in Life Sciences – Ontologies for Standardizations – Rule Interchange Format.

**Suggested Activities:**

- Flipped classroom on other applications of semantic web.

**Suggested Evaluation Methods**

- Quizzes on semantic web applications.

**PRACTICAL EXERCISES: 30**

1. Design of simple ontology on their domain of interest using Protege like tool.
2. Create RDF document using PHP library EasyRdf.

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3. Use OWL language to represent relationships, properties and to provide inferences from created ontology.
4. Term extraction and Term disambiguation from corpus using Alchemy like API.
5. Use of any tool to apply SAPRQL queries and implement reasoning for avoiding inconsistencies.
6. Exercises on Merging two ontologies, Applying association rules and Applying clustering algorithms.
7. Development of Simple application like chat bot, semantic search engine creation using Topic map data models extracted from Ontopia/Mappa.
8. Creating intelligent expert systems using semantic Wikis like SMW+.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Create ontology for a given domain.
2. Develop an application using ontology languages and tools.
3. Understand the concepts of semantic Web.
4. Use ontology related tools and technologies for application creation.
5. Design and develop applications using semantic web.
6. Understand the standards related to semantic web.

**REFERENCES:**


1. Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, “Foundations of Semantic Web Technologies”, Chapman & Hall/CRC, 2009.
2. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez, “Ontological Engineering: with Examples from the Areas of Knowledge Management, e-Commerce and the Semantic Web”, Springer, 2004.
3. Grigoris Antoniou, Frank van Harmelen, “A Semantic Web Primer (Cooperative Information Systems)”, MIT Press, 2004.
4. Alexander Maedche, “Ontology Learning for the Semantic Web”, First Edition, Springer. 2002.
5. John Davies, Dieter Fensel, Frank Van Harmelen, “Towards the Semantic Web: Ontology Driven Knowledge Management”, John Wiley, 2003.
6. John Davies, Rudi Studer, Paul Warren, (Editor), “Semantic Web Technologies: Trends and Research in Ontology-Based Systems”, Wiley, 2006.


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| **CO2** | 3 | 1 | 2 | 3 | 3 | 1 |
| **CO3** | 2 | 2 | 2 | 3 | 1 | 1 |
| **CO4** | 3 | 1 | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 1 | 2 | 3 | 3 | 2 |
| **CO6** | 2 | 2 | 1 | 2 | 2 | 3 |
| **Overall** | 3 | 1 | 2 | 3 | 3 | 2 |

| IF5008 | TEXT MINING | L T P C<br>3 0 2 4 |
|---|---|---|

**OBJECTIVES:**

- To understand the basic issues and needs of text mining.
- To appreciate the different aspects of text categorization and clustering.
- To understand the role played by text mining in Information retrieval and extraction.
- To appreciate the use of probabilistic models and its principles applicable in text mining.
- To appreciate the current trends in text mining on various systems.

**UNIT I INTRODUCTION 8**

Overview of Text Mining – Definition – General Architecture – Algorithms – Core Operations – Preprocessing – Types of Problems – Basics of Document Classification – Information Retrieval – Clustering and Organizing Documents – Information extraction – Prediction and Evaluation – Textual Information to Numerical Vectors – Collecting Documents – Document Standardization – Tokenization – Lemmatization Vector Generation for Prediction – Sentence Boundary Determination – Evaluation Performance.

**Suggested Activities:**

- Develop a web application for search engine.
- Tokenize the given text information using any parser.
- Practical – Implement all the preprocessing steps needed for text mining.

**Suggested Evaluation Methods:**

- Practical assessment may be conducted in laboratory environment to implement any preprocessing steps.

**UNIT II TEXT CATEGORIZATION AND CLUSTERING 10**

Text Categorization – Definition – Document Representation – Feature Selection – Decision Tree Classifiers – Rule-based Classifiers – Probabilistic and Naive Bayes Classifiers – Linear Classifiers Classification of Linked and Web Data – Meta-Algorithms – Clustering – Definition – Vector Space Models – Distance Based Algorithms – Word and Phrase-Based Clustering – Semi-Supervised Clustering – Transfer Learning.

**Suggested Activities:**

- Role playing to be carried out for groups of students for the understanding of the working principles of clustering and classification.

**Suggested Evaluation Methods:**

- Assignment on analyzing the performance of different clustering and classification algorithms and showing the best performance of each algorithm for any specific application.

**UNIT III TEXT MINING FOR INFORMATION RETRIEVAL AND INFORMATION EXTRACTION 10**

Information Retrieval And Text Mining – Keyword Search – Nearest Neighbor Methods – Similarity – Web Based Document Search – Matching – Inverted Lists – Evaluation – Information Extraction – Architecture – Co-Reference – Named Entity and Relation Extraction – Inductive – Unsupervised Algorithms for Information Extraction – Text Summarization Techniques – Topic Representation – Influence of Context – Indicator Representations – Pattern Extraction – Apriori Algorithm – FP Tree Algorithm.

**Suggested Activities:**

- In class activity – Name entity and relation extraction using role play game.
- In class activity – Show the working principle of searching technique.

**Suggested Evaluation Methods:**

- Assignment on developing Flash or animated presentation for explaining the working principles of any one algorithm for information retrieval and extraction.

**UNIT IV PROBABILISTIC MODELS 9**

Probabilistic Models for Text Mining – Mixture Models – Stochastic Processes in Bayesian Nonparametric Models – Graphical Models –Relationship Between Clustering – Dimension Reduction and Topic Modeling – Latent Semantic Indexing – Latent Dirichlet Allocation– Interpretation and Evaluation – Probabilistic Document Clustering and Topic Models – Probabilistic Models for Information Extraction – Hidden Markov Models – Conditional Random Fields.

**Suggested Activities:**

- In-class activity – Document clustering and Information Extraction.
- External learning – Markov models and entropy models.

**Suggested Evaluation Methods:**

- Tutorials – Topic modeling to show its behavior on different data types.

**UNIT V RECENT TRENDS 8**

Visualization Approaches – Architectural Considerations – Visualization Techniques in Link Analysis – Example – Mining Text Streams – Text Mining in Multimedia – Text Analytics in Social Media – Opinion Mining and Sentiment Analysis – Document Sentiment Classification – Aspect – Based Sentiment Analysis – Opinion Spam Detection – Text Mining Applications and Case studies.

**Suggested Activities:**

- In-class activity – Visualization Approaches.
- External learning – Understanding text mining applications and case studies.

**Suggested Evaluation Methods:**

- Assignment on extracting the sentiment expressed in the given sentence using opinion word.
- Tutorials – Methodologies available to detect the spam in opinion mining.

**PRACTICAL EXERCISES: 30**

1. Study Natural Language toolkit (NLTK) and explore the features within that.
2. Study experiment for implement simple text processing operations like character count, word count, stop word removal, etc.,
3. Write a Java program for parsing and tokenizing the given text using NLTK.
4. Write a Java program to implement the named entity recognition and part of speech tagging.
5. Write a Java program to extract the specific pattern for gene – gene and protein – protein interaction information
6. Install RapidMiner and Vega tools and explore the features.
7. Classify any given data set using two classification algorithms using RapidMiner.
8. Clustering the given data set using two clustering algorithms using RapidMiner.
9. Classify any given data set using two classification algorithms using Vega Tool.
10. Clustering the given data set using two clustering algorithms using Vega Tool.

**TOTAL: 75 PERIODS**

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**OUTCOMES:**

On completion of the course, the students will be able to:

1. Identify the different features that can be mined from text and web documents.
2. Use available open source classification and clustering tools on some standard text data sets.
3. Modify existing classification/clustering algorithms in terms of functionality or features used.
4. Design a system that uses text mining to improve the functions of an existing open source search engine.
5. Implement a text mining system that can be used for an application of your choice.
6. Use the opinion mining concepts to extract the sentiment from the large database.

**REFERENCES:**


1. S. M. Weiss, N. Indurkhya, T. Zhang, F. Damerau, "Text Mining: Predictive Methods for Analyzing Unstructured Information", Springer, 2005.
2. Ronen Feldman, James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2009.
3. Michael Berry, "Survey of Text Mining: Clustering, Classification and Retrieval", Springer, 2004.
4. Hercules Antonio do Prado, Edilson Ferneda, "Emerging Technologies of Text Mining: Techniques and Applications", Information Science Reference (IGI), 2008.
5. Charu C. Aggarwal, Cheng Xiang Zhai, "Mining Text Data", Springer, 2012.


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| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 1 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO6** | 3 | 2 | 2 | 2 | 2 | 3 |



**IF5009 E-LEARNING TECHNIQUES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn the various E-learning approaches and Components.
- To understand the key elements of Design Thinking.
- To explore the models for E-learning courseware development.
- To learn about E-learning Authoring tools.
- To Know about Evaluation and management of E-learning solutions.

**UNIT I INTRODUCTION 9**

Need for E-learning – Approaches of E-learning – Components of E-learning – 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.

**Suggested Activities:**

- External learning – E-learning approaches and Components.
- Discussion on design thinking.

**Suggested Evaluation Methods:**

- Assignment – E-learning approaches and Components.
- Quiz on design thinking.

**UNIT II DESIGNING E-LEARNING COURSE CONTENT 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.

**Suggested Activities:**

- Discussion – Design models.
- External learning – E-learning instructional methods.

**Suggested Evaluation Methods:**

- Assignment on design models of e-learning.
- Quiz on e-learning instructional methods.

**UNIT III CREATING INTERACTIVE CONTENT 9**

Preparing Content: Tips for Content Development and Language Style – Creating Storyboards: Structure of an Interactive E-Lesson – Techniques For Presenting Content – Adding Examples – Integrating E-learning Elements – Adding Examples – Developing Practice and Assessment Tests – Adding Additional Resources – Courseware Development – Authoring Tools – Types of Authoring Tools – Selecting an Authoring Tool.

**Suggested Activities:**

- Discussion – Creation of story boards.
- External learning – Types of authoring tools.

**Suggested Evaluation Methods:**

- Assignment – Story Boards creation.
- Quiz – Authoring tools.

**UNIT IV LEARNING PLATFORMS 9**

Types of Learning Platforms – Proprietary vs. Open-Source LMS – LMS versus LCMS – Internally Handled and Hosted LMS – LMS Solutions – Functional Areas of LMS.

**Suggested Activities:**

- Discussion – LMS categories for E-learning.
- External learning – Functional areas e-learning.

**Suggested Evaluation Methods:**

- Assignment on proprietary and open source LMS.
- Quiz on LMS solutions.

**UNIT V COURSE DELIVERY AND EVALUTION 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

**Suggested Activities:**

- Discussion – Planning and Documentation.
- External learning – Evaluation and delivery methods.

**Suggested Evaluation Methods:**

- Assignment on planning and documentation.
- Quiz on evaluation and delivery methods.

**PRACTICAL EXERCISES:** **30**

1. Creation of Users and Schedule users Vs Courses in Moodle.
2. Preparation and Organization of Course Contents in Moodle.
3. Aligning the course objectives, Assessments and evaluation methods of Courseware in Moodle.
4. Courseware Content generation with various instructional formats.
5. Adding communication tools in Moodle for effective collaboration.
6. Creation of instructor led courses in Moodle.
7. Creation of self-learning courses in Moodle.
8. Implementation of various Evaluation strategies of Courseware in Moodle.
9. Implementation of various delivery strategies in Moodle.
10. Assessing the Quality of Multimedia Courseware in Moodle.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of course, the students will be able to:

1. Distinguish the phases of activities in models of E-learning.
2. Identify appropriate 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. Manage the E-learning courseware.

**REFERENCES:**


1. Clark, R. C. and Mayer, R. E, “eLearning and the Science of Instruction”, Third Edition, John Wiley, 2016.
2. Means, B., Toyama, Y., and Murphy, R, “Evaluation of Evidence – Based Practices in Online Learning: A Meta – Analysis and Review of Online Learning Studies”, Centre for Learning Technologies, 2010.
3. Crews, T. B., Sheth, S. N., and Horne, T. M, “Understanding the Learning Personalities of Successful Online Students”, Educause Review, 2014.
4. Johnny Schneider, “Understanding Design Thinking, Lean and Agile”, O’Riley Media, 2011.
5. Madhuri Dubey, “Effective E – learning Design, Development and Delivery”, University Press, 2011.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 1 | 2 | 1 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 1 | 2 | 3 |

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**IF5010** **DATA WAREHOUSING AND DATA MINING** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To get exposed to the concepts of Data warehousing Architecture and Implementation.
- To analyze the mining techniques for realistic data, and also to conceptualize Data Mining and the need for pre-processing.
- To characterize the kinds of patterns that can be discovered by association rule mining.
- To implement classification and clustering techniques on large datasets.
- To identify Business applications and Trends of Data mining.

**UNIT I DATA WAREHOUSE** **9**

Data Warehousing – Operational Database Systems versus Data Warehouses – Multidimensional Data Model – Schemas for Multidimensional Databases – OLAP Operations – Data Warehouse Architecture – Indexing – OLAP Queries and Tools.

**Suggested Activities:**

- Practical – Data warehouse modeling using a real time scenario.
- Assignment on describing the similarities and the differences of the multidimensional models, and analyzing their respective advantages and disadvantages.
- Practical – Implementing various OLAP operations on a multidimensional data.
- Practical – Execute multi-dimensional data model using SQL queries.
- Discussion on the advantages of indexing structures.

**Suggested Evaluation Methods:**

- Tutorials – Case study on OLAP schema level representation and OLAP operations.
- Assignment on OLAP operation and schema level representation.
- Tutorials – Building a data warehouse using open source tools.

**UNIT II DATA MINING & DATA PREPROCESSING** **9**

Introduction to KDD process – Knowledge Discovery from Databases – Need for Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation.

**Suggested Activities:**

- Discussion on Knowledge Discovery Database.
- Assignments on numerical problems on smoothing, normalization and attribute subset selection.
- Assignments on evaluation of attribute relevance analysis on a real time application data warehouse.
- Assignments on evaluation of information gain of an attribute in a real time database.

**Suggested Evaluation Methods:**

- Tutorial – Data cleaning.
- Assignment on data integration and transformation.
- Assignment on data reduction and data discretization.
- Quizzes on data preprocessing.

**UNIT III ASSOCIATION RULE MINING 9**

Introduction – Data Mining Functionalities – Association Rule Mining – Mining Frequent Itemsets with and without Candidate Generation – Mining Various Kinds of Association Rules – Constraint – Based Association Mining.

**Suggested Activities:**

- Discussion and problem solving of different association rule mining algorithms (Apriori algorithms and FP-Growth algorithms).
- Practical – Implementation of association rule mining using data mining tools such as Weka.
- Practical – Comparing the performance of each algorithm with various kinds of large data sets.

**Suggested Evaluation Methods:**

- Quizzes on Apriori and FP-Growth algorithms.
- Tutorials – Different real time applications of association rule mining.

**UNIT IV CLASSIFICATION & PREDICTION 9**

Classification versus Prediction – Data preparation for Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

**Suggested Activities:**

- Discussion on tree pruning.
- Assignment on calculation of the computational complexities and accuracy of the classification algorithms.
- Discussion on different real-time applications of classification and evaluating the accuracy of a classifier.
- Assignment on solving classification algorithms.
- Assignment on Comparativel study on different classification algorithms.

**Suggested Evaluation Methods:**

- Quizzes on decision tree classification methods.
- Tutorial – Bayesian classification methods.
- Assignment on support vector machines.

**UNIT V CLUSTERING 9**

Cluster Analysis – Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High- Dimensional Data – Constraint Based Cluster Analysis – Outlier Analysis.

**Suggested Activities:**

- Comparative study on the various clustering algorithms.
- Discussion on real time applications of outlier analysis.
- Practical – Implementation of clustering algorithms using data mining tools.
- Practical – Design and implement a clustering method that finds clusters in large data cubes effectively and efficiently.
- Assignment on comparative study of clustering algorithms in terms of the following criteria: shapes of clusters that can be determined, input parameters that must be specified and limitations.

- Assignment on categorizing kinds of constraints that can be imposed on the clusters produced and analyzing how to perform clustering efficiently under such kinds of constraints.
- Practical – Develop an application where the border between normal objects and outliers is often unclear, so that the degree to which an object is an outlier has to be well estimated.

**Suggested Evaluation Methods:**

- Quizzes on partitioning methods.
- Tutorial – Outlier analysis.
- Assignment on density-based, grid-based and model-based clustering methods.

**PRACTICAL EXERCISES: 30**

1. Design and implement multi-dimensional data models namely Star, Snowflake and Fact Constellation schemas for any one enterprise (ex. Banking, Insurance, Finance, Healthcare, manufacturing, Automobiles, sales etc) using open source tools like Pentaho Data Integration Tool, Pentaho Business Analytics; or other data warehouse tools like Microsoft-SSIS,Informatica,Business Objects,etc.
2. Install and explore the explorer, experimenter, knowledge flow and simple CLI features of Weka.
3. Create new .arff files and try loading the same in weka tool. Try importing sample data sets from the following data sources using Weka: File, Database, and Websource.
4. Open IRIS data set and explore the various descriptive data metrics available in Weka. Try different data sets and compare the descriptive metrics.
5. Explore various options in Weka for preprocessing data and apply (like Discretization Filters, Resample filter, etc.) on each dataset.
6. Load retail dataset into Weka and run Aprior algorithm with different support and confidence values. Study the rules generated. Apply different discretization filters on numerical attributes and run the Aprior association rule algorithm. Study the rules generated. Derive interesting insights and observe the effect of discretization in the rule generation process.
7. Load IRIS dataset into Weka and run ID3, J48 classification algorithm, study the classifier output. Compute entropy values, Kappa statistic. Extract if-then rues from decision tree generated by classifier, observe the confusion matrix and derive Accuracy, F- measure, TP rate, FP rate, Precision and recall values. Apply cross-validation strategy with various fold levels and compare the accuracy results.
8. Load the IRIS each dataset into Weka and perform Naïve-bayes classification and k-Nearest Neighbor classification, Interpret the results obtained. Compare classification results of ID3, J48, Naïve-Bayes and k-NN classifiers for each dataset, and reduce which classifier is performing best and poor for each dataset and justify.
9. Load each dataset into Weka and run simple k-means clustering algorithm with different values of k (number of desired clusters). Study the clusters formed. Observe the sum of squared errors and centroids, and derive insights. Explore visualization features of weka to visualize the clusters.
10. Load any weather dataset into Weka and build Linear Regression model. Study the cluster formed. Use training set option. Interpret the regression model and derive patterns and conclusions from the regression results.
11. Use options cross-validation and percentage split and repeat running the Linear Regression Model. Observe the results and derive meaningful results.
12. Try few of the above exercises using Orange Canvas Tool.

**TOTAL: 75 PERIODS**

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**OUTCOMES:**

On completion of the course, the students will be able to:

1. Design, create and maintain data warehouses.
2. Understand large data sets and data preprocessing.
3. Characterize the kinds of patterns that can be discovered by association rule mining.
4. Evaluate various mining techniques on complex data.
5. Discover the knowledge imbibed in the high dimensional system.
6. Evolve multidimensional intelligent model from typical system.

**REFERENCES:**


1. Jiawei Han, Micheline Kamber, “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2012.
2. K. P. Soman, Shyam Diwakar, V. Ajay, “Insight into Data Mining Theory and Practice”, Prentice Hall, 2006.
3. G. K. Gupta, “Introduction to Data Min Data Mining with Case Studies”, Prentice Hall of India, Third Edition, 2014.
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7. George M. Marakas, “Modern Data Warehousing, Mining and Visualization: Core Concepts”, Prentice Hall, 2002.
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| **CO1** | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO2** | 1 | 2 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 1 | 1 | 3 | 2 | 3 |
| **CO4** | 1 | 1 | 2 | 3 | 3 | 2 |
| **CO5** | 2 | 1 | 3 | 2 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 3 | 2 | 3 |

**IF5011** **BIOINFORMATICS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To get exposed to Bioinformatics Technologies.
- To solve various problems in biologicalsciences- sequence analysis.
- To solve various problems in gene expression analysis, biomedicalimage analysis.
- To solve various problems in metabolic pathway analysis.
- To be familiar with working of bioinformatics models in MatLab.

**UNIT I INTRODUCTION 9**

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.

**Suggested Activities:**

- Exploring about Biological Data Integration System.

**Suggested Evaluation Methods:**

- Quizzes on need of bioinformatics for real world scenario.
- Practical – Programming assignments on methods used for integrating biological data.

**UNIT II BIOINFORMATICS TOOL BOX 9**

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

**Suggested Activities:**

- Analyzing biomedical data using data mining tool in MatLab.

**Suggested Evaluation Methods:**

- Quizzes on various bioinformatics tools and its usage.
- Practical – Programming assignments on methods to analyze bio data using any one data mining tool.

**UNIT III BIOLOGICAL DATA ANALYSIS 9**

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

**Suggested Activities:**

- Flipped classroom on statistical classification of biological data.

**Suggested Evaluation Methods:**

- Quizzes on various data analysis methods.
- Practical – Programming assignments on various classification methods.

**UNIT IV IMAGE PROCESSING 9**

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.

**Suggested Activities:**

- Extract the key features for biological image in MatLab.
- Implementing Spatial Transformations for imageinMatLab.

**Suggested Evaluation Methods:**

- Quizzes on transformations used in bio-images .
- Practical – Programming assignments on applying various image processing methods on a simple bio application.

Attested

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**UNIT V SYSTEMS BIOLOGY 9**

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.

**Suggested Activities**

- Implementing sensitivity analysis for biology data in MatLab.

**Suggested Evaluation Methods**

- Quizzes on system biology.
- Practical – Programming assignments on nalyzing sensitivity metrics for bio data.

**PRACTICAL EXERCISES: 30**

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.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

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 simbiology.
5. Understand the pharmacokinetic modeling.
6. Understand the working model of biological data in Matlab.

**REFERENCES:**


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

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| **CO1** | 3 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 1 | 1 | 3 | 1 | 1 |
| **CO3** | 2 | 2 | 1 | 3 | 1 | 1 |
| **CO4** | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO5** | 3 | 1 | 1 | 2 | 1 | 1 |
| **CO6** | 3 | 2 | 1 | 3 | 1 | 1 |

**IF5012** **COMPILER ENGINEERING** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn about Automata theory and Regular Expressions.
- To learn the concepts in the design of compilers.
- To learn about the runtime store organization.
- To know the data structures used to implement symbol tables.
- To be familiar with garbage collection.

**UNIT I INTRODUCTION TO AUTOMATA THEORY AND REGULAR EXPRESSIONS** **9**

Finite Automata – Deterministic Finite Automata – Non-deterministic Finite Automata – NFA to DFA – Finite Automata with EpsilonTransitions – Epsilon-NFA to DFA – Kleene's Theorem – Minimization of Automata – Regular Expressions – Equivalence between Regular Expression and Automata-Properties of Regular Expressions.

**Suggested Activities:**

- Flipped classroom on Finite Automata and Regular Expressions.
- External learning -
  - Automata, basics of finite automata, NFA, DFA.
  - Finite state machines – regular expressions.
- Installation of Ubuntu and study of lexical analysis tools and generators.

**Suggested Evaluation Methods:**

- Tutorial – NFA to DFA conversion.
- Assignment on DFA state reduction, construction of automata.
- Quizzes on Regular Expressions.
- Assignment on numerical problems in regular expressions.
- Assignment on numerical problems in conversion of NFA to DFA.

**UNIT II LEXICAL ANALYSIS** **9**

Introduction – The Structure of Compiler – Evolution of Programming Languages – Application of Compiler Technology – Programming Languages Basics – Lexical Analysis – Role of Lexical Analyzer – Specification and Recognition of Tokens – Lexical Analyzer Generators.

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**Suggested Activities:**

- Flipped classroom:
  - Compilers and interpreters.
  - The compilation process and the anatomy of a compiler.
  - Bootstrapping.
- External learning – The role of the lexical analyzer, Finite state machines and Regular expressions.
- Assignment on numerical problems in State reduction.

**Suggested Evaluation Methods:**

- Tutorial – Lexical Analysis.
- Assignment on Lex construction of regular grammars,
- Quizzes on compiler stages,

**UNIT III SYNTAX ANALYSIS 9**

Introduction – Context Free Grammar – Top Down Parsing – Recursive Descend Parsing – Predictive Parsing – Non-Recursive Predictive Parsing – Error Recovery – Bottom Up Parsing – LR Parsers: Construction of SLR (1) Parsing Table, Canonical LR (1) Parsing Table and LALR (1) Parsing Table – Parser Generators.

**Suggested Activities:**

- Flipped classroom:
  - Languages.
  - Writing grammars for programming languages.
  - Transformations on grammars.
- External learning – Parser generators and writing grammars for programming language constructs.
- Assignment on numeric problems in parser construction.

**Suggested Evaluation Methods:**

- Tutorial – LR, SLR Parsers.
- Assignment problems on Yacc parser construction.
- Quizzes on parsing concepts.

**UNIT IV INTERMEDIATE CODE GENERATION 9**

Symbol Table Construction – Syntax Directed Definitions – Evaluation Orders for Syntax Directed Definitions – Applications of Syntax Directed Translation – Intermediate Code Generation – Three Address Code – Types and Declarations – Expression Translation – Type Checking – Back Patching.

**Suggested Activities:**

- Flipped classroom on attributes grammars.
- External learning – Type checking, intermediate code and abstract machines.
- Assignment on numerical problems in syntax directed translation.

**Suggested Evaluation Methods:**

- Tutorial – Syntax directed translations.
- Assignment problems on intermediate code generation.
- Quizzes on type checking.

**UNIT V CODE GENERATION AND OPTIMIZATION 9**

Issues – Design of Code Generator – Addresses in the Target Code – Basic Blocks in Flow Graph – Simple Code Generator – Peephole Optimization – Machine Independent Optimization – Principal Sources of Optimizations – Bootstrapping a Compiler – Compiling Compilers – Full Bootstrap.

**Suggested Activities:**

- Flipped classroom on target machine.
- External learning –
  - Code generation.
  - Elementary optimizations. Basic blocks.
  - Dataflow analysis.
- Assignment on numerical problems in code generation.

**Suggested Evaluation Methods:**

- Tutorial – Code generation.
- Assignment problems in optimization.
- Quizzes on optimization concepts.

**PRACTICAL EXERCISES: 30**

1. Implement and perform Lexical analysis of a sample text file consisting of some random texts.
2. Write a C program for a simple calculator.
3. Implementation of Lexers using FLEXfor the above simple calculator.
4. Implementation of Parsers using YACC in Linux/Unix Environment.
5. Use Parser of YACC and check out the output of simple calculator.
6. Implementation of Semantic Analyzers using YACC.
7. Write a C program for a symbol table and integrate it with YACC.
8. Perform semantic analysis including static checking, intermediate representations and attribute grammars.
9. Implement code generators for performing code generation.
10. Implement a simple code optimization routine.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the concept of lexical analysis and construction of deterministic and non-deterministic automata.
2. Understand the concept of parsing and construction of parser.
3. Study the concept of intermediate code generation techniques.
4. Study the programming language design, target machine design and run time environment of compilers.
5. Study the compiler construction tools.
6. Obtain knowledge to construct a prototype compiler for a subset of a programming language.

**REFERENCES:**


1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools”, Second Edition, Pearson Education, 2009.
2. John Hopcroft, Rajeev Motwani, Jeffrey Ullman, “Introduction To Automata Theory Languages, and Computation”, Third Edition, Pearson Education, 2007.
3. Torbengidius Mogensen, “Basics of Compiler Design”, Springer, 2011.
4. LeBlanc Jr., Richard J., Cytron, Ron K., Fischer, Charles N., “Crafting a Complier”, First Edition, Addison Wesley, 2009.

5. K. D. Cooper, L. Torczon, “Engineering a Compiler”, Second Edition, Morgan-Kaufmann, 2011.
6. Micheal Sipser, “Introduction to the Theory of Computation” Third Edition, Cenage, 2014.
7. K. Muneeswaran, “Compiler Design”, Oxford University Press, 2013.

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| **CO1** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 3 | 1 | 1 | 1 | 1 | 1 |
| **O5** | 1 | 3 | 1 | 1 | 1 | 1 |
| **CO6** | 2 | 1 | 1 | 1 | 2 | 3 |

**IF5088 MOBILE APPLICATION DEVELOPMENT L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the need and characteristics of mobile applications.
- To design the right user interface for mobile application.
- To understand the design issues in the development of mobile applications.
- To understand the development procedures for mobile application.
- 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.

**Suggested Activities:**

- Flipped classroom on survey on mobile application models.
- External learning - mobile application design using frameworks and tools.

**Suggested Evaluation Methods:**

- Quiz - questionnaire related to mobile application models.
- Assignment - evaluate using learning content management system like Moodle.

**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.

**Suggested Activities**:

- Flipped classroom on discussion on UI for mobile application like voice and gestures.
- External learning - survey on different view elements for mobile application.

**Suggested Evaluation Methods:**

- Quiz - questionnaire related to user interface design for mobile applications.
- Assignment - evaluate using learning content management system like Moodle.

**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.

**Suggested Activities:**

- Flipped classroom on discussion on memory constraints for mobile application design.
- External learning - survey on resource management and concurrent operations.

**Suggested Evaluation Methods:**

- Quiz - questionnaire related to memory constraints in design for mobile applications.
- Assignment - evaluate using learning content management system like Moodle.

**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.

**Suggested Activities:**

- Simple Android application development like user account creation.
- Android application accessing the mobile database to view user data.

**Suggested Evaluation Methods:**

- Evaluation based on the demonstrated application functionality using emulators.

**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.

**Suggested Activities:**

- Application accessing Internet for communication like web application.
- Android application accessing GPS for location based service.

**Suggested Evaluation Methods:**

- Evaluation based on the demonstrated application functionality using emulators.

**PRACTICAL EXERCISES: 30**

1. Develop an application that uses GUI components, Font and Colours.
2. Develop an application that uses Layout Managers and event listeners.
3. Develop a native calculator application.
4. Write an application that draws basic graphical primitives on the screen.
5. Develop an application that makes use of database.
6. Write an application that makes use of internet for communication (mobile web app).
7. Develop a native application that uses GPS location information.
8. Implement an application that writes data to the SD card.
9. Implement an application that creates an alert upon receiving a message.
10. Write a mobile application that creates alarm clock.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will 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.
6. Implement android application with multimedia support.

**REFERENCES:**


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.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 3 |

**IF5013 CYBER FORENSICS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To provide an understanding Computer forensics fundamentals.
- To analyze various computer forensics technologies.
- To identify methods for data recovery.
- To apply the methods for preservation of digital evidence.
- To learn about the types of attacks and remedial actions in the context of systems, networks, images and video.

**UNIT I INCIDENT AND INCIDENT RESPONSE 9**

Introduction to Security Threats: Introduction, Computer Crimes, Computer Threats and Intrusions, Telecommunication Fraud, Phishing , Identity Theft, Cyber Terrorism and Cyber War – Need for Security : Information Security, OS Security, Database Security, Software Development Security – Security Architecture – Introduction to Incident – Incident Response Methodology – Steps – Activities in Initial Response Phase after Detection of an Incident.

**Suggested Activities:**

- Survey of forensics tools such as WinHex, EnCase, FTK, or ProDiscover.
- External learning - Demonstrate some of the mechanisms used by malicious attackers as well as forensic experts to disrupt computer networks and manipulate information access.

**Suggested Evaluation Methods:**

- Demonstration on forensic tools
- Assignment on solving with sample cyber crime reports.

**UNIT II FILE STORAGE AND DATA RECOVERY 9**

File Systems: FAT, NTFS, NTFS – Encrypting File System – Forensic Analysis of File Systems – Storage Fundamentals-Initial Response and Volatile Data Collection from Windows System – Initial Response & Volatile Data Collection from UNIX System – Forensic Duplication – Tools –Discover of Electronic Evidence – Identification of Data – Reconstructing Past Events – Networks.

**Suggested Activities:**

- Flipped classroom and activity.
- External learning - Tools for data storage and access, bypassing filtered [blocked] ports, reviewing Internet activity, open source forensic tools for file storage and data recovery will be introduced.

**Suggested Evaluation Methods:**

- Total quantity of files recovered from the disk for reconstruction.
- Quiz on forensic analysis of file system.

**UNIT III NETWORK AND EMAIL FORENSICS 9**

Network Evidence – Types of Network Monitoring – Setting Up a Network Monitoring System – Network Data Analysis – Email Clients – Email Tracing – Internet Fraud – Spam Investigations Mobile Forensics – Subscriber Identity Module (SIM) Investigations – Wireless Device Investigations – PDA Investigations.

**Suggested Activities:**

- External learning - Familiarizing with Port Redirection tools: Quick 'n Easy FTP Server, FPIPE and FPORT.
- Practical - Study of the forensics tools.

**Suggested Evaluation Methods:**

- Demonstration of Port Redirection tools.
- Practical - Assessment of real-time problems like email analysis for tracing.

**UNIT IV SYSTEM FORENSICS 9**

Data Analysis: Analysis Methodology – Investigating Live Systems (Windows & Mac OS) – Hacking: Investigating Hacker Tools – Ethical Issues – Cybercrime. Forensic and Investigative tools – Forensic Equipments for Evidence Collection – Postexploitation.

**Suggested Activities:**

- Demonstration of MD5Hash tool.
- Practical - IE Activity analysis.

**Suggested Evaluation Methods:**

- Assignment on live windows and Linux investigation
- Quiz on ethical hacking.

Attested

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**UNIT V IMAGE AND VIDEO FORENSICS 9**

Recognizing a Graphics File – Data Compression – Locating and Recovering Graphics Files – Identifying Unknown File Formats – Copyright Issues with Graphics – Fraud using Image and Video – Detection of Fraud in Images and Video.

**Suggested Activities:**

- External learning - Steganography.
- Practical – Install and use Steganalysis tool.

**Suggested Evaluation Methods:**

- Assignment on forgery detection in images.
- Quiz on locating and recovering graphics files.

**PRACTICAL EXCERCISES: 30**

1. Demonstrate some of the mechanisms used by malicious attackers as well as forensic experts to disrupt computer networks and manipulate information access.
2. Demonstrate FTK Imager to access data's evidence. It is used to quickly preview and create a forensically sound image of the disk if the preview warrants such action.
3. Demonstrate how data can be modified within a file or hidden on a disk without the data being saved as a file.
    a. Hex Workshop v4.23 hex editor (Shareware download from www.hexworkshop.com).
    b. MD5Hash (Freeware download from www.digitaldetective. co.uk/freetools/md5.asp).
    c. Text editor (Notepad is good enough).
4. Demonstrate how an attacker could exploit a machine and obtain access to a server with a filtered port by piping another unfiltered port.
    a. Quick 'n Easy FTP Server (Freeware download from http://www.pablovandermeer.nl).
    b. FPIPE (Freeware download from http://www.foundstone.com)
    c. FPORT (Freeware download from www.digitaldetective.co.uk/freetools/md5.asp).
5. Show how the encrypted Internet Explorer cache may be viewed using some freely available tools.
    a. Pasco (Freeware download from http://www.foundstone.com).
    b. Galleta (Freeware download from http://www.foundstone.com).
6. Demonstrate the typical use of steganography.
7. Demonstrate mobile forensics with software:
    a. BitPim.
    b. Mobile Phone Examiner (MPE+).
8. Trace an Email.
    a. eMailTrackerPro.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Recognize attacks on systems.
2. Design a counter attack incident response and incident-response methodology.
3. Illustrate the methods for data recovery, evidence collection and data seizure.
4. Understand network and email attacks and forensic investigation with tools.
5. Use Forensic tools and collect evidences of a computer crime.
6. Analyze various image encryption/decryption, steganography and fraud in image.

Attested

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**REFERENCES:**


1. Kevin Mandia, T. Jason Luttgens, Matthew Pepe, “Incident Response and Computer Forensics”, Tata McGraw-Hill, 2014.
2. Bill Nelson, Amelia Philips, Christopher Stueart, “Guide to Computer Forensics and Investigations”, Cengage Learning, 2018.
3. John R. Vacca, “Computer Forensics”, Firewall Media, 2009.
4. Eoghan Casey, “Handbook of Computer Crime Investigation's Forensic Tools and Technology”, Academic Press, 2001.
5. Davide Cowen, “Computer Forensics: A Beginners Guide”, McGraw-Hill Education, 2011.
6. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, Auerbach Publications, 2014


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 1 | 2 | 1 | 3 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO6** | 2 | 2 | 3 | 2 | 2 | 2 |

**IF5014** **BIOMETRICS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

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

**UNIT I BIOMETRICSFUNDAMENTALS 9**

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 – Falsematchrate – Falsenon - matchrate – Failureto Enrolmentrate – Derived metrics – Applications of Biometrics.

**Suggested Activities:**

- Flipped classroom on applications of biometrics.
- External learning - Practical problems in accuracy computations.
- Numerical Problems in Biometrics accuracy computations.

**Suggested Evaluation Methods:**

- Tutorial - Performance measures.
- Assignment problems on computation of error and performance measures
- Quizzes on biometrics applications.

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**UNIT II FINGERPRINT AND FACIAL SCAN 9**

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.

**Suggested Activities:**

- Flipped classroom on applications of fingerprint and face biometrics applications.
- External learning - Physiological biometrics.

**Suggested Evaluation Methods:**

- Assignment problems in fingerprint scan.
- Quizzes on fingerprint and face biometrics.

**UNIT III ADDITIONAL PHYSIOLOGICAL BIOMETRICS 9**

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

**Suggested Activities:**

- Discussion of iris identification in Matlab.
- Discussion of sound production mechanisms.
- External learning - Practical problems on iris localization and Indian Sign Language.

**Suggested Evaluation Methods:**

- Tutorial - Iris scan.
- Assignment problems on performance measures of iris scan.
- Quizzes on physiological measures.

**UNIT IV BEHAVIOR BIOMETRICS 9**

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.

**Suggested Activities:**

- Discussion of hand scan in Matlab.
- Discussion of multimodal biometrics.
- External learning - Practical problems on signature and keystroke biometrics in OpenCV.

**Suggested Evaluation Methods:**

- Tutorial - Keystroke metrics.
- Assignment problems on performance measures of behavior metrics
- Quizzes on behavior biometrics.

**UNIT V BIOMETRICS APPLICATION DEVELOPMENT 9**

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.

**Suggested Activities:**

- Discussion of biometric standards.
- External learning - Practical issues of privacy and confidentiality.
- External Learning - Biometric standards.

**Suggested Evaluation Methods:**

- Tutorial - Information security.
- Assignment problems in privacy in biometric systems.
- Quizzes on biometrics standards.

**PRACTICAL EXERCISES:** **30**

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.
11. Mini project.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

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.

**REFERENCES**:


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.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO2** | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO3** | 2 | 1 | 1 | 1 | 1 | 2 |
| **CO4** | 2 | 1 | 1 | 2 | 1 | 2 |
| **CO5** | 1 | 3 | 1 | 1 | 1 | 2 |
| **CO6** | 2 | 1 | 1 | 2 | 1 | 3 |

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| IF5015 | BLOCKCHAIN TECHNOLOGIES | L T P C<br>3 0 2 4 |
|---|---|---|

**OBJECTIVES:**

- To decompose a blockchain system's fundamental components, how they fit together and examine a decentralization using blockchain.
- To explain how Cryptocurrency works, from when a transaction is created to when it is considered part of the blockchain.
- To explain the components of Ethereum and Programming Languages for Ethereum.
- To study the basics Hyperledger and Web3.
- To provide a details of alternative blockchain and blockchain projects in different perspective.

**UNIT I INTRODUCTION TO BLOCKCHAIN 9**

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

**Suggested Activities:**

- External learning - programming to create your own blockchain.
- Flipped classroom on studying blockchain security issues.

**Suggested Evaluation Methods:**

- Practical assessment to be conducted to evaluate the program for creating blockchain.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin Limitations – Name Coin – Prime Coin – Zcash – Smart Contracts – Ricardian Contracts.

**Suggested Activities:**

- External learning - creating the Wallets.
- Flipped classroom on showing the tracking process of transaction in Cryptocurrency.

**Suggested Evaluation Methods:**

- Assignment to be given on Cryptocurrency failures.

**UNIT III ETHEREUM 9**

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language.

**Suggested Activities:**

- External learning - For exploring Ethereum tools like Ganache and GO.
- Implement Ethereum development environment.

**Suggested Evaluation Methods:**

- Practical assessment on developing smart contract on private Blockchain.

**UNIT IV WEB3 AND HYPERLEDGER 9**

Introduction to Web3 – Contract Deployment – POST Requests – Development frameworks – Hyperledger as a protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**Suggested Activities:**

- Creating and deploying a business network on Hyperledger Composer Playground.
- Implementing Business Network in Blockchain using HyperLedger Fabric.

**Suggested Evaluation Methods:**

- Practical assessment on developing business network on Hyperledger Fabric.

**UNIT V ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS 9**

Kadena – Ripple- Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous tools.

**Suggested Activities:**

- External learning - blockchain using Multichain.
- Study about blockchain frameworks and business applications.

**Suggested Evaluation Methods:**

- Practical assessment on developing blockchain using Multichain for banking system.

**PRACTICAL EXERCISES: 30**

1. Construct the simple blockchain based application to store and retrieve the crypto-currencies.
2. Create the wallet to send the digital currencies from one account to another account.
3. Perform bitcoin transactions using Python - bitcoinlib.
4. Develop the environment for Ethereum by using Ganache.
5. Create the nodes on Ethereum blockchain and mine the blockchain.
6. Learn Solidity programming language and develop simple Ethereum based applications.
7. Build the decentralized app and deploy it to provide Ethereum environment.
8. Build a simple application using hyperledger in blockchain environment.
9. Design a smart contract and test it in a Ethereum environment.
10. Develop a block chain based applications which is suitable for your online shopping services.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Understand the technology components of Blockchain and how it works behind-the scenes.
2. Aware of different approaches to developing decentralized applications.
3. Understand the Bitcoin and its limitations by comparing with other alternative coins.
4. Establish deep understanding of the Ethereum model, its consensus model, code execution.
5. Understand the architectural components of a Hyperledger and its development framework.
6. Come to know the Alternative blockchains and emerging trends in blockchain.

**REFERENCES:**

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing.
2. Arshdeep Bahga, Vijay Madisetti, “Blockchain Applications: A Hands-On Approach”, VPT, 2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, “Mastering Bitcoin”, O’Reilly Publishing, 2014.
4. Roger Wattenhofer, “The Science of the Blockchain” CreateSpace Independent Publishing Platform, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.
6. Alex Leverington, “Ethereum Programming”, Packt Publishing, 2017.

**IF5016 MULTIMEDIA TECHNOLOGIES L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To enrich student learning in Multimedia systems.
- To train the students to acquire knowledge in multimedia related technologies.
- To acquire knowledge about multimedia techniques to enhance quality of service.
- To acquire knowledge in the development of multimedia systems.
- To learn about the multimedia elements in a comprehensive way.

**UNIT I INTRODUCTION TO MULTIMEDIA ELEMENTS 9**

Multimedia – Medium – Properties of a Multimedia System – Traditional Data Stream Characteristics – Data Stream Characteristics of Continuous Media – Basic Sound Concepts – Speech – Images and Graphics – Computer Image Processing – Video and Animation – Computer Based Animation.

**Suggested Activities:**

- Flipped classroom on multimedia primitives.

**Suggested Evaluation Methods:**

- Quizzes on properties of multimedia system.

**UNIT II MULTIMEDIA COMPRESSION 9**

Storage Space – Coding Requirements – Hybrid Coding – JPEG: Image Preparation, Lossy Mode, Lossless Mode, Hierarchical Mode – H.261-MPEG: Video Encoding, Audio Encoding, Data Stream, MPEG 3, MPEG 7, MPEG 21– DVI – Audio Encoding.

**Suggested Activities:**

- Flipped classroom on compression of different techniques.
- External learning - Adobe After Effects, Adobe Media Encoder, Adobe Audition.

**Suggested Evaluation Methods:**

- Assignment hybrid coding.
- Quizzes on different JPEG activities.

Attested

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**UNIT III MULTIMEDIA ARCHITECTURES 9**

User Interfaces – OS Multimedia Support – Multimedia Extensions – Hardware Support – Distributed Multimedia Applications – Real Time Protocols – Play Back Architectures – Synchronization – Document and Document Architecture – Hypermedia Concepts – Hypermedia Design – Digital Copyrights – Digital Library – Multimedia Archives.

**Suggested Activities:**

- Flipped classroom on concepts of Multimedia hardware architectures.
- External learning - Digital Repositories.

**Suggested Evaluation Methods:**

- Tutorial - Digital copyrights.
- Quizzes on different architectures.

**UNIT IV MULTIMEDIA OPERATING SYSTEM AND DATABASES 9**

Real Time-Resource Management – Process Management – File systems – Inter Process Communication and Synchronization – Memory Management – Device Management – Characteristics of MDBMS – Data Analysis – Data Structures – Operations on Data – Integration in a Database Model.

**Suggested Activities:**

- Flipped classroom on multimedia database and indexing structures.
- External learning - Data structures for storing multimedia data.

**Suggested Evaluation Methods:**

- Demonstration of EL.
- Quizzes on device and memory management.

**UNIT V MULTIMEDIA COMMUNICATION &APPLICATIONS 9**

Tele Services – Implementation of Conversational Services, Messaging Services, Retrieval Services, Tele Action Services, Tele Operation Services – Media Consumption – Media Entertainment – Virtual Reality – Interactive Audio – Interactive Video – Games.

**Suggested Activities:**

- External learning - Mixed reality.

**Suggested Evaluation Methods:**

- Quizzes on virtual reality and augmented reality.

**PRACTICAL EXERCISES: 30**

1. Creating and editing various fonts and adding special effects to text using tools like Fontographer, Blender, Photoshop and flash
2. Editing various images (Image restoration, Changing colour image to Grey scale and vice versa) and adding special effects to images using tools like Photoshop, Gimp and flash
3. Creating and Editing various video clippings and adding special effects using tools like Adobe Premier Pro
4. Creating and Editing various audio files and adding special effects using tools like SoundForge and Audacity
5. Creating three dimensional models and animations using tools like Blender, 3DS Max, Unity
6. Working on Text compression algorithms like Run length and Huffman
7. Implementation of transformations like DCT and FFT
8. Designing User Interfaces and developing simple games using multimedia elements
9. Creating simple multimedia applications using Authoring tools like Flash, Macromedia Director.
10. Mini Project(4 Periods)

**TOTAL: 75 PERIODS**

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**OUTCOMES:**

On completion of the course, the students will be able to:

1. Handle the multimedia elements effectively.
2. Encode and decode the multimedia elements.
3. Understand the underlying multimedia computing architectures used for media development.
4. Develop effective strategies to deliver Quality-of-Experience in Multimedia applications.
5. Design and implement algorithms and techniques related to multimedia objects.
6. Design and develop multimedia applications in various domains.

**REFERENCES:**


1. Ralf Steinmetz, Klara Nahrstedt, “Multimedia computing, communications, and applications”, Pearson Education, 2009.
2. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017.
3. Ralf Steinmetz, Klara Nahrstedt, “Multimedia Systems”, Springer IE, 2004.
4. Tay Vaughan, “Multimedia: Making it Work”, Ninth Edition, McGraw-Hill Education, 2014.
5. Mark S. Drew, Zee Nian Li, “Fundamentals of Multimedia”, Prentice Hall, 2006.
6. Jerry D. Gibson, Toby Berger, Tom Lookabaugh, Dave Lindergh and Richard L. Baker “Digital Compression for Multimedia: Principles and Standards”, Elsevier, 2006.


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| **CO2** | 3 | 1 | 3 | 2 | 1 | 1 |
| **CO3** | 3 | 1 | 3 | 3 | 3 | 1 |
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| **CO6** | 2 | 1 | 3 | 3 | 2 | 2 |



**IF5017** **ADVANCED DATABASE SYSTEMS** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To learn the fundamentals of data modeling and design in advanced databases.
- To study the working principles of distributed databases.
- To have an introductory knowledge about the query processing in Object-based databases and its usage.
- To understand the basics of Spatial, temporal and Mobile Databases and their applications.
- To learn emerging databases such as XML, Data warehouse and NoSQL.

**UNIT I DISTRIBUTED DATABASES 9**

Distributed Systems – Introduction – Architecture; Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing.

**Suggested Activities:**

- Practical - Design of distributed database with fragmentation using any DBMS.
- Flipped classroom on distributed transaction protocols.
- Practical - Writing distributed queries and optimizing the queries.

**Suggested Evaluation Methods:**

- Evaluation of practical implementation.
- Quizzes on distributed transaction protocols.
- Tutorial - Distributed queries and optimization.

**UNIT II NOSQL DATABASES 9**

NoSQL – CAP Theorem – Sharding – Document based-MongoDB Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment – Using MongoDB with PHP / JAVA – Advanced MongoDB Features – Cassandra: Data Model – Key Space – Table Operations – CURD Operations – CQL Types – HIVE : Data types – Database Operations – Partitioning – HiveQL – OrientDB Graph database: OrientDB Features.

**Suggested Activities:**

- Practical - Exploring MongoDB using JAVA/Python/Ruby/PHP.
- Practical - Perform database operations using MongoDB/Cassandra/HYPE.
- Practical - Scenario based query development for database applications.

**Suggested Evaluation Methods:**

- Evaluation of the database operations.
- Tutorial - Scenarios to analyze the need for DB in various applications.
- Quizzes on MongoDB basics.

**UNIT III ADVANCED DATABASE SYSTEMS 9**

Spatial Databases: Spatial Data Types – Spatial Relationships – Spatial Data Structures – Spatial Access Methods – Temporal Databases: Overview – Active Database – Deductive Databases – Recursive Queries in SQL – Mobile Databases: Location and Handoff Management – Mobile Transaction Models – Concurrency-Transaction Commit Protocols – Multimedia Databases.

**Suggested Activities:**

- Individual/group activities for application specific data handling.
- Discussion about advantages and drawbacks of transaction models for different applications involving spatial-temporal data.

**Suggested Evaluation Methods:**

- Assignment on application specific data handling.
- Quizzes on different transaction models.

**UNIT IV XML AND DATAWAREHOUSE 9**

XML Database: XML – XML Schema – XML DOM and SAX Parsers – XSL – XSLT – XPath and XQuery – Data Warehouse: Introduction –Multidimensional Data Modeling – Star and Snowflake Schema – Architecture – OLAP Operations and Queries.

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**Suggested Activities:**

- Flipped classroom on demonstrate the operations on XML data and data warehouse.
- Practical - Use tools to solve data access scenarios.

**Suggested Evaluation Methods:**

- Quizzes on XML data and basics of data warehouse.
- Project demonstration on practical implementation.

**UNIT V INFORMATION RETRIEVAL AND WEB SEARCH 9**

IR concepts –Retrieval models – Queries in IR system – Text Preprocessing – Inverted indexing – evaluation measures – web search and analytics – current trends.

**Suggested Activities:**

- Flipped classroom on basics of IR concepts.
- Practical - Evaluation measures of IR.

**Suggested Evaluation Methods:**

- Quizzes on basic IR concepts.
- Demonstration for practical learning.

**PRACTICAL EXERCISES: 30**

1. Create a distributed database using horizontal and vertical fragmentation in any DBMS.
2. Creation of distributed queries using the fragmented data created.
3. Create a document based database using mongodb and manipulate the data.
4. Create a data warehouse and perform OLAP operations in an unstructured data environment.
5. Create a database to store multimedia elements and perform data retrieval operations.
6. Create a temporal database and explore the usage of temporal queries in it.
7. Creation of an XML document and validate it using an XML schema.
8. Given an XML document, traverse the document using DOM and SAX parser.
9. Design a web crawler to extract the information from the websites containing product reviews and classify the reviews as either positive or negative.
10. Create an information retrieval system which processes the corpus of documents and create TF/IDF for the keywords extracted from the documents. Create an inverted index to enable an efficient retrieval process.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Design a distributed database system and execute distributed queries.
2. Use NoSQL database systems and manipulate the data associated with it.
3. Have knowledge on advanced database system concepts.
4. Design a data warehouse system and apply OLAP operations.
5. Design XML database systems and validating with XML schema.
6. Have knowledge on information retrieval concepts and apply it in web databases.

**REFERENCES:**


1. Henry F. Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Sixth Edition, McGraw-Hill, 2011.
2. R. Elmasri, S. B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education/Addison Wesley, 2017.
3. C. J. Date, A. Kannan, S. Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
4. Jiawei Han, Micheline Kamber, Jian Pei, “Data Mining: Concepts and Techniques”, Third Edition, Morgan Kaufmann, 2012.
5. Brad Dayley, “Teach Yourself NoSQL with MongoDB in 24 Hours”, Sams, 2014.
6. Shashank Tiwari, “Professional NoSQL”, O’Reilly Media, 2011.
7. Vijay Kumar, “Mobile Database Systems”, John Wiley, 2006.


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| **CO3** | 2 | 1 | 1 | 1 | 2 | 2 |
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| **CO5** | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO6** | 2 | 1 | 1 | 2 | 2 | 1 |

**IF5018** **LINKED OPEN DATA** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the computational aspects of creation, storage & retrieval of Linked Open Data (LOD).
- To learn about Web of Data.
- To understand knowledge representation languages like RDF and OWL.
- To learn about querying using SPARQL.
- To understand the publishing & consumption of LOD in WWW.

**UNIT I INTRODUCTION TO LINKED OPEN DATA 9**

Introduction to Linked Data (LD) and the Semantic Web – Linked Data Structure for Sophisticated Processing – Introducing Big Lynx Productions – Principles of Linked Data – URIs, RDF Data Model, RDF Serialisation, Relationship Links, Identity Links, Vocabulary Links.

**Suggested Activities:**

- Study on various RDF literals with examples.
- Browsing for various linked open data on the web.
- Sample scenarios and RDF construction.

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**Suggested Evaluation Methods:**

- Assignments on RDF literals and open data.
- Quiz on all topics of the Unit.

**UNIT II WEB OF DATA 9**

Bootstrapping the Web of Data – Topology of the Web of Data – Cross-Domain Data – Geographic Data – Media Data – Government Data – Libraries and Education – Life Sciences Data – Retail and Commerce – User Generated Content and Social Media – Linked Data Design Considerations – Using URIs as Names for Things – Describing Things with RDF – Literal Triples and Outgoing Links – Publishing Data about Data – Choosing and Using Vocabularies.

**Suggested Activities:**

- Data collection using tools.
- Use tools to understand properties of collected data.
- Create simple applications using open data.

**Suggested Evaluation Methods:**

- Group assignments on application creation.
- Quiz on different types of Web of Data.

**UNIT III ONTOLOGICAL LANGUAGES 9**

RDFS-Plus – Using RDFS – SKOS – managing vocabularies with RDFS-Plus – Introduction to Ontology – OWL-Web Ontology Language – Basic OWL – Bibliographic Ontology (BIBO) – FOAF Good Relations – CIDOC's Conceptual Reference Model (CRM) – Digital Public Library (DPLA) – Counting and Sets in OWL – Ontologies on the Web – Ontology Mapping – Good and Bad Modeling Practices – Expert Modeling in OWL – The Future of the Semantic Web–RDF Parser/Serializer – RDF Store.

**Suggested Activities:**

- Study of ontology development tools.
- Case studies on real time domain specific ontology.
- Simple ontology creation using open source (Protégé and OntoStudio) tool.

**Suggested Evaluation Methods:**

- Group assignment on Ontology design and creation.
- Open book quiz on ontology DPLA and BIBO.

**UNIT IV INTRODUCTION TO SPARQL 9**

Introduction – Querying with SPARQL: Submitting a Query – Types of Query: ASK, SELECT, CONSTRUCT, DESCRIBE – Unary and Binary Operators – Updating Linked Data with SPARQL: Adding, Deleting Data from Graph, Loading and Clearing a Graph, Other Graph Management Operations – SPARQL Protocol – Reasoning using RDFS and OWL.

**Suggested Activities:**

- Exercises on basics of SPARQL like data type, query types, etc.
- Solving exercises on graph data and querying.
- Exercises on SPARQL operators.

**Suggested Evaluation Methods:**

- Quiz on SPARQL queries.
- Assignment on case studies and equivalent SPARQL queries.

**UNIT V PUBLISHING & CONSUMING LINKED OPEN DATA 9**

Linked Data Publishing Patterns – The Recipes – Serving Linked Data as Static RDF/XML Files – Serving Linked Data as RDF Embedded in HTML Files – Serving RDF and HTML with Custom Server-Side Scripts – Serving Linked Data from Relational Databases – Serving Linked Data from RDF Triple Stores – Serving Linked Data by Wrapping Existing Application or Web APIs – Linked Data Publishing Checklist Consuming Linked Data – Deployed Linked Data Applications – Generic Applications – Domain-specific Applications – Developing a Linked Data Mashup – Architecture of Linked Data Applications – Effort Distribution between Publishers-Consumers and Third Parties.

**Suggested Activities:**

- Survey exercise on real RDF/XML files.
- Case studies on Linked Data Applications.
- Student Presentation on applications.

**Suggested Evaluation Methods:**

- Quiz on all topics in Unit V.
- Assignments on Linked open data applications.

**PRACTICAL EXERCISES: 30**

1. Download any RDF schema on tourism and explore various tags in the schema. To visualise, open them using a Word Editor. Highlight the subject, predicate and object in each file. If necessary use the RDF validtor service by W3C to obtain the triplets.
2. Convert any RDF into graph.
3. Handling RDF in java: Set up Jena in Eclipse. Then create and manipulate RDF graphs for domains like tourism, festivals, living thing, etc.
4. Download and install any open source RDF/Ontology editing tool like protégé, Onto Studio, etc. Try the following in that tool:
    a. Load existing RDF schema and visualize.
    b. Add, modify and delete RDF.
5. Do the following using W3C RDF Validator:
    a. Enter a URI or paste an RDF/XML document and parse the RDF.
    b. Visualize the RDF/XML as Triples and/or Graph.
6. Formulate natural language queries as SPARQL 1.0 queries and execute them against the DBpedia SPARQL endpoint (http://dbpedia.org/isparql).
7. Interpret the SPARQL queries executed in DBpedia SPARQL endpoint in natural language.
8. Create a simple RDFS forward-chaining inference engine with the following requirements:
    a. Use Jena to store and load triples.
    b. Use SPARQL queries to infer all new triples.
9. Open the pizza ontology in Protégé. Run Protégé on a linux computer with the command protege. The pizza ontology is found in the bookmarks in the “Open OWL ontology from URI” menu. Browse the class hierarchy, the property hierarchies and the individuals and note how the ontology describes the domain of pizzas.
    a. Find *hasIngredient*. What is the domain and range of this property? What are the subproperties of *hasIngredient*? What is the inverse property of *hasIngredient*? What property characteristics does *hasIngredient* have?.
    b. Find Margherita and see how it is defined as a pizza with only cheese and tomato topping. Look at the definition of VegetarianPizza. Is a Margherita pizza a vegetarian pizza? Why why not?.
10. Mini projects on developing simple applications Serving RDF and HTML with Custom Server Side Scripts and serving Linked Data from Relational Databases.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Design methodologies for publishing & consuming LOD.
2. Construct RDF for domain specific data using tools.
3. Use SPARQL to query LOD.
4. Infer and reason from Domain specific RDF data.
5. Create and deploy simple applications using web open data.
6. Design algorithms for handling LOD using large scale machine learning.

**REFERENCES:**


1. Tom Heath, Christian Bizer, “Linked Data: Evolving the Web into a Global Data Space”, Morgan and Claypool, 2011.
2. David Wood, “Linking Government Data”, Springer Science and Business Media, 2011.
3. Dean Allemang, James Hendle, “Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL”, Second Edition, Elsevier, 2011.
4. Bob DuCharme, “Learning SPARQL: Querying and Updating SPARQL 1.1”, Second Edition, O’Reilly Media, 2013.
5. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2014.
6. Olivier Curé, Guillaume Blin, “RDF Database Systems: Triples Storage and SPARQL Query Processing”, Morgan Kaufmann, 2014.
7. Bob DuCharme, “Learnig SPARQL”, O'Reilly Media, 2011.


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| **CO1** | 3 | 1 | 1 | 2 | 3 | 1 |
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| **CO4** | 3 | 1 | 3 | 3 | 3 | 1 |
| **CO5** | 1 | 1 | 2 | 2 | 3 | 1 |
| **CO6** | 1 | 2 | 1 | 3 | 3 | 3 |

**IF5085 VIDEO PROCESSING AND ANALYTICS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To have a better knowledge about video representation and its formats.
- To know the fundamental concepts of data science and analytics.
- To enrich students familiar with video processing tools for analytics.
- To understand the data analytics for processing video content.
- To expose the student to emerging trends in video analytics.

Attested

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**UNIT I VIDEO FUNDAMENTALS 9**

Basic Concepts and Terminology – Analog Video Standards – Digital Video Basics – Analogto Digital Conversion – Color Representation and Chroma Sub Sampling – Video Sampling Rate and Standards Conversion – Digital Video Formats – Video Features – Colour, Shape and Textural Features.

**Suggested Activities:**

- In-class activity - Numerical problems on sampling and standard conversions.
- Flipped classroom on description about video features.

**Suggested Evaluation Methods:**

- Assignments on sampling and standard conversions.
- Quiz on video features.

**UNIT II MOTION ESTIMATION AND VIDEO SEGMENTATION 9**

Fundamentals of Motion Estimation – Optical flow –2D and 3D Motion Estimation – Block based point correspondences – Gradient Based Intensity Matching – Feature Matching – Frequency Domain Motion Estimation – Video Segmentation.

**Suggested Activities:**

- In-class activity - Numerical problems on motion estimation.
- External learning - Survey on optical flow techniques.

**Suggested Evaluation Methods:**

- Online quiz on optical flow techniques.
- Assignments on numerical problems in motion estimation.

**UNIT III FUNDAMENTALDATA ANALYSIS 9**

Exploratory Data Analysis – Collection of Data – Graphical Presentation of Data – Classification of Data – Storage and Retrieval of Data – Big Data – Challenges of Conventional Systems – Web Data – Evolution of Analytic Scalability – Analytic Processes and Tools – Analysis versus Reporting.

**Suggested Activities:**

- In-class activity - Graphical presentation of data for visualization.
- Flipped classroom on description about analytic processes and tools.

**Suggested Evaluation Methods:**

- Assignments on data visualization.
- Quiz on questionnaires on analytic tools.

**UNIT IV MINING DATA STREAMS AND VIDEO ANALYTICS 9**

Introduction to Streams Concept– Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Analytic Processes and Tools – Video Shot Boundary Detection – Model Based Annotation and Video Mining – Video Database – Video Categorization – Video Query Categorization.

**Suggested Activities:**

- Flipped classroom on discussion on streaming data.
- External learning - Survey on video based content retrieval.

**Suggested Evaluation Methods:**

- Quiz on questionnaires on data streams.
- Assignments on video based content retrieval.

**UNIT V EMERGING TRENDS** **9**

Affective Video Content Analysis – Parsing a Video into Semantic Segments – Video Indexing and Abstraction for Retrieval – Automatic Video Trailer Generation– Video Inpainting – Forensic Video Analysis.

**Suggested Activities:**

- External learning - Survey on Affective Video Content Analysis.
- Flipped classroom on discussion on forensic video analysis.

**Suggested Evaluation Methods:**

- Assignments on affective video content analysis.
- Quiz on questionnaires on forensic video analysis.

**PRACTICAL EXERCISES:** **30**

1. Choose appropriate features for video segmentation for given sample video.
2. Compute two dimension motion estimation using block based match technique.
3. Calculate the motion estimation based on Frequency domain.
4. Compare the video features extracted from a given video dataset using graphical representation.
5. Compute the number of distinct elements found in the given sample data stream.
6. Detect shot boundary for given sample video.
7. Parse the given sample video for indexing and faster retrieval.
8. Generate an automatic video trailer for given sample video.
9. Design simple application using video inpainting technique.
10. Mini project for video categorization based on content analysis.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Compute basic video processing functions.
2. Segment video based on its features.
3. Compute optical flow and motion estimation.
4. Visualize data using graphical presentation for analysis.
5. Index and retrieve videos for faster access.
6. Design applications for video analytics in current trend.

**REFERENCES:**


1. A. Roy, R. Dixit, R. Naskar, R. S. Chakraborty, “Digital Image Forensics: Theory and Implementation”, Springer, 2018.
2. Paul Kinley, “Data Analytics for Beginners: Basic Guide to Master Data Analytics”, CreateSpace Independent Publishing, 2016.
3. A. Murat Tekalp, “Digital Video Processing”, Second Edition, Prentice Hall, 2015.
4. Henrique C. M. Andrade, Bugra Gedik, Deepak S. Turaga, “Fundamentals of Stream Processing: Application Design, Systems, and Analytics”, Cambridge University Press, 2014.
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications“, Wiley, 2014.
6. Oges Marques, “Practical Image and Video Processing Using MATLAB”, Wiley-IEEE Press, 2011.


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| **CO5** | 1 | 2 | 2 | 3 | 3 | 3 |
| **CO6** | 2 | 2 | 3 | 3 | 3 | 3 |

**MM5072** **MIXED REALITY** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To impart the fundamental aspects and principles of mixed reality technologies.
- To know the internals of the hardware and software components involved in the development of mixed reality enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about mixed reality application development.
- To know the technologies involved in the development of mixed reality based applications.

**UNIT I INTRODUCTION** **9**

Introduction to Virtual Reality and Mixed Reality – Definition – Introduction to Trajectories and Hybrid Space – Three I"S of Virtual Reality – Virtual Reality vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies – Input Devices – 3D Position Trackers – Performance Parameters – Types of Trackers – Navigation And Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices. Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

**Suggested Activities:**

- Flipped classroom on Uses of MR applications.
- Videos-Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.

**Suggested Evaluation Methods:**

- Tutorial - Applications of MR.
- Quizzes on the displayed video and the special effects.

**UNIT II MR COMPUTING ARCHITECTURE** **9**

Computing Architectures of VR – Rendering Principle – Graphics and Haptics Rendering – PC Graphics Architecture – Graphics Accelerators – Graphics Benchmarks – Workstation Based Architectures – SGI Infinite Reality Architecture – Distributed VR Architectures – Multipipeline Synchronization – Collocated Rendering Pipelines – Distributed Virtual Environments – MR architecture.

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**Suggested Activities:**

- Flipped classroom on basic graphics pipeline.
- External learning - Different types of Graphics architectures and workstations.
- Practical - GPU programming on simple modeling and rendering.

**Suggested Evaluation Methods:**

- Tutorial - Graphics pipelines.
- Brainstorming session on GPU architecture.
- Quizzes on graphical architectures.
- Demonstration of GPU related simple modeling and rendering programs.

**UNIT III MR MODELING 9**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**Suggested Activities:**

- Flipped classroom on modeling three dimensional objects.
- External learning - Collision detection algorithms.
- Practical - Creating three dimensional models.

**Suggested Evaluation Methods:**

- Tutorial - Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three dimensional scene creation.

**UNIT IV PROGRAMMING AND APPLICATIONS 9**

VR Programming – Toolkits and Scene Graphs – World Tool Kit – Java 3D – Comparison of World Tool Kit and Java 3D - GHOST – People Shop – Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – MR in Business – MR in entertainment – MR in education.

**Suggested Activities:**

- External learning - Different types of programming toolkits and Learn different types of available VR applications.
- Practical - Create VR scenes using any toolkit and develop applications.

**Suggested Evaluation Methods:**

- Tutorial - VR tool comparison.
- Brainstorming session on tools and technologies used in VR.
- Evaluate the developed VR application.
- Demonstration of the created VR applications.

**UNIT V MIXED REALITY TECHNOLOGIES 9**

Synchronizing Time – Tangible & Ubiquitous –Vision Based Tracking – Sensing Technologies – Seamful Design – Assembling Interaction – Trajectories through Mixed Reality Performance –Mobile Interface Design – Wearable Computing-Games

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**Suggested Activities:**

- External learning - Different types of sensing and tracking devices for creating mixed reality environments.
- Practical - Create MR scenes using any toolkit and develop applications.

**Suggested Evaluation Methods:**

- Demonstration and evaluation of the developed MR application.
- Tutorial - Mobile interface design.
- Brainstorming on efficient usage of various MR technologies.

**PRACTICAL EXERCISES: 30**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop MR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Familiarize with the basic concepts of mixed reality.
2. Understand the tools and technologies related to Mixed Reality.
3. Know the working principle of mixed reality related Sensor devices.
4. Develop the Virtual Reality applications in different domains.
5. Design of various models using modeling techniques.
6. Expose the concept of Virtual Reality and Mixed reality Programming with toolkits.

**REFERENCES:**


1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create Compelling VR Experiences for Mobile”, Packt Publisher, 2018
2. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
3. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 1 | 3 | 3 | 3 | 1 |
| **CO3** | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO4** | 2 | 1 | 3 | 3 | 3 | 1 |
| **CO5** | 2 | 1 | 3 | 3 | 3 | 1 |
| **CO6** | 2 | 1 | 3 | 3 | 3 | 1 |

**IF5087** **VISUALIZATION TECHNIQUES** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the fundamentals of data visualization.
- To know the working principles of various information visualization tools.
- To acquire knowledge about the issues in data representation.
- To visualize the complex engineering design.
- To gain skill in designing real time interactive information visualization system.

**UNIT I INTRODUCTION** **9**

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

**Suggested Activities:**

- Blended Learning - Displaying Different types visualization images.
- Flipped classroom on task of representing information.
- External learning - Problems related to acquiring data.

**Suggested Evaluation Methods:**

- Tutorial - Different data visualizing images.
- Assignment on different data acquiring methods.
- Quizzes on issues and solutions in different visualization applications.

**UNIT II DATA REPRESENTATION** **9**

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.

**Suggested Activities:**

- Blended learning - Human visual and auditory system.
- Flipped classroom on color formats.
- External learning - Survey on different human computer interaction and types of user interface.

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**Suggested Evaluation Methods:**

- Assignment on human visual and auditory system.
- Quizzes on various color format.
- Assignment on human computer interaction user interface.

**UNIT III DATA PRESENTATION 9**

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.

**Suggested Activities:**

- Blended learning - Drawing charts for display.
- Flipped classroom on various presentation techniques.
- External learning - Different font and font styles, symbols and Gesture representation.

**Suggested Evaluation Methods:**

- Assignment on chart preparation.
- Tutorial - Various presentation techniques.
- Assignment on gesture presentation.

**UNIT IV INTERACTION AND DESIGN 9**

Norman's Action Cycle – Interacting with Visualization – Interaction for Information Visualization – Interaction for Navigation – Interaction with Models – Interacting with Visualization – Interactive 3D Illustrations with Images and Text – Personal View – Attitude – user perspective – Convergence – Sketching – Evaluation.

**Suggested Activities:**

- Flipped classroom on various interacting techniques.
- External learning - Interaction facilities and high level support for animation design.

**Suggested Evaluation Methods:**

- Tutorial - Interaction models.
- Assignment on animation design.

**UNIT V CURRENT TRENDS 9**

Design – Virtual Reality: Interactive Medical Application – Tactile Maps for Visually Challenged People – Animation Design for Simulation – Integrating Spatial and Nonspatial Data – Innovating the Interaction- Small Interactive Calendars – Selecting One from Many – Web Browsing Through a Key Hole – Communication Analysis – Archival Galaxies.

**Suggested Activities:**

- External learning - Mini project for designing and implementing a innovative interfaces.
- Flipped classroom on implementation of virtual reality environment.

**Suggested Evaluation Methods:**

- Demonstration of the mini project.
- Tutorial - Virtual reality application.

**PRACTICAL EXERCISES:** **30**

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: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Apply mathematics and basic science knowledge for designing information visualizing System.
2. Collect data ethically and solve engineering problem in visualizing the information.
3. Implement algorithms and techniques for interactive information visualization.
4. Conduct experiments by applying various modern visualization tool and solve the space layout problem.
5. Analyze and design system to visualize multidisciplinary multivariate Data individually or in teams.
6. Develop a cost effective and a scalable information visualization system.

**REFERENCES:**


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.


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| **CO2** | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO6** | 3 | 2 | 2 | 3 | 3 | 3 |

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**MM5071 ADVANCED COMPUTER GRAPHICS AND ANIMATIONS L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To understand the basics of geometry processing.
- To understand the fundamentals of pipelined rasterization rendering of meshed objects and curved surfaces.
- To understand and work with advanced rendering methods such as radiosity.
- To design programs for advanced animation methods.
- To become proficient in graphics programming using OpenGL.

**UNIT I FUNDAMENTALS 9**

Basics - Scope and Applications – Graphics Standards – Display Systems – Image Formation – Graphics Systems – 2D and 3D Coordinate Systems – Vectors – Matrices and Basic Vector/Matrix Operations – Line Drawing – Object Representation – Anti-Aliasing.

**Suggested Activities**:

- Practical - Basic application to be implemented for vectors and matrices.
- Practical - Apply various implementations of the graphics algorithms and analyze.
- Practical - Execute some shader application and fix the warnings and errors.

**Suggested Evaluation Methods:**

- Quiz to check the understanding of the graphics concepts (like graphics hardware, displays and standards).
- Assessing the understanding of various basic graphics algorithms through programming assessment by using vectors and matrices.

**UNIT II TRANSFORMATIONS 9**

2D and 3D Geometric Transformations: Translation, Rotation, Scaling, Affine – Hierarchical Modelling & viewing – The Camera Transformation – Perspective – Orthographic and Stereographic Views.

**Suggested Activities:**

- Flipped classroom on rasterization.
- Practical - Execute any shader application and set viewports, windows, draw polylines and explore the keyboard and mouse interaction routines.
- Familiarize with transformations and hierarchical in OpenGL using a matrix stack.

**Suggested Evaluation Methods:**

- Quizzes on rasterization schemes.
- Assessing the understanding of the basic elements available in the OpenGL environment through the programming structs.
- Demonstration on transformations hierarchies using matrix stack.

**UNIT III FRACTALS 9**

Fractals and Self Similarity – Peano Curves – Creating Image by Iterated Functions – Mandelbrot Sets – Julia Sets – Random Fractals – Intersecting Rays with Other Primitives – Reflections and Transparency – Boolean Operations on Objects and its Applications.

**Suggested Activities:**

- Flipped classroom on various algorithms used to generate the fractals.
- Practical - Generation of fractals using Python and Numpy
- Practical - Run any shader application and set viewports, windows, fractal rendering and explore the keyboard and mouse interaction routines.

**Suggested Evaluation Methods:**

- Quiz on Fractals.
- Demonstration the generation of fractals using Python and Numpy.
- Assessing the understanding of generation of fractals by changing the various parameters in the OpenGL environment through the programming structs.

**UNIT IV ADVANCED GRAPHICS 9**

Hidden Surface Removal– Parametric Curves and Surfaces– Global Illumination – Ray Casting –Monte Carlo Algorithm – Texture Synthesis – Bump Mapping – Environmental Mapping –Advanced Lighting and Shading – Shadows –Volumetric Rendering.

**Suggested Activities:**

- Flipped classroom on Texture Synthesis and photo realistic rendering
- Run the shader application and add the texture and shadow.
- Analyze few more shaders - Toon/Cell, Cook-Torrance, Oren-Nayar, Gradient.

**Suggested Evaluation Methods:**

- Quiz on advanced graphics techniques (like texture synthesis and photo realistic rendering).
- Demonstration of shader application exploring texture and shadow features.
- Discussion on bi-directional reflectance distribution function after analyzing the various shader models.

**UNIT V ANIMATION 9**

Overview of Animation Techniques – Key framing, Computer Animation – Motion Capture and Editing–Forward/Inverse Kinematics– 3D Computer Animation for Applications Such as Games and Virtual Environments – Character Animation Techniques Such as Synthesizing their Body Movements – Facial Expressions and Skin Movements – Behaviors in Crowded Scenes.

**Suggested Activities:**

- Exploration of various animation techniques and tools (Self Study).
- Carry out small projects like Design of small animation movies using any tools with good aesthetic sense.

**Suggested Evaluation Methods:**

- Discussion on various animation techniques and tools.
- Projects may be evaluated base on the theme, design, creativity, tools and aesthetic sense.

**PRACTICAL EXERCISE: 30**

1. Introduction to Programming in OpenGL.
2. Write a program to draw the following points: (0.0,0.0), (20.0,0.0), (20.0,20.0), (0.0,20.0) and (10.0,25.0). For this purpose, use the GL_POINTS primitive.
3. Re-write the previous program in order to draw a house. The house consists of two figures: a square and a triangle. The first four points given above define the square, while the last three points define the triangle. For this purpose, use the GL_QUADS and GL_TRIANGLES primitives.

4. Write a program to color to primitives like cube, triangle and perform 2D rotation using OpenGL.
5. Modify the above program extending the 2D rotation to 3D with a simple 3D Orthographic Projection.
6. Write a program to roll a wheel on a horizontal line using OpenGL.
7. Draw the Koch snowflake (or some other variation of the Koch curve) using python.
8. Create a rotating cube with lighting using OpenGL.
9. Create a scene consisting of multiple spheres and cubes, apply a different texture to each object, and give a bumpy-looking appearance to each surface using normal mapping.
10. Create 10 seconds Walking animation with a rigged character using any animation tool.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Prepare for the emerging field of digital modelling and fabrication based on the competence gained.
2. Understand and apply 3d graphics algorithms related to transformations, illumination, texturing, etc. With the aid of software libraries.
3. Develop interactive applications using 3d graphics
4. Investigate and apply software libraries for 3d graphics and related software needs.
5. Understand the issues relevant to computer animation.
6. Describe and synthesise character animation techniques, including motion, changing their facial expressions and crowd behaviour.

**REFERENCES:**


1. Donald D. Hearn, M. Pauline Baker, Warren Carithers, “Computer Graphics with Open GL”, Fourth Edition, Prentice Hall, 2011.
2. Foley van Dam, Feiner Hughes, “Computer Graphics Principles and Practice”, Third Edition, Addison Wesley, 2014.
3. Alan Watt, Mark Watt, “Advanced Animation and Rendering Techniques: Theory and Practice”, Addison Wesley, 1992.
4. Rick Parent, “Computer Animation – Algorithms and Techniques”, Third Edition, Morgan Kaufman, 2012.
5. Edward Angel, Dave Shreiner, “Interactive Computer Graphics: A Top-Down Approach with OpenGL”, Sixth Edition, Addison Wesley, 2012.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
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| **CO1** | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 1 | 1 | 2 | 2 | 2 | 1 |
| **CO3** | 2 | 1 | 3 | 3 | 3 | 1 |
| **CO4** | 3 | 2 | 2 | 1 | 1 | 1 |
| **CO5** | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO6** | 1 | 1 | 2 | 2 | 1 | 1 |

**MM5073** **MULTIMEDIA CODING TECHNIQUES** **L T P C**
**3 0 2 4**

**OBJECTIVES:**

- To enrich student learning in fundamentals of multimedia coding and standards.
- To train the students to acquire knowledge in text coding.
- To acquire knowledge behind theory of image and video coding & decoding with standards.
- To learn principles of audio coding and standards.
- To get comprehensive learning in multimedia standard content description and formats.

**UNIT I LOSSLESS AND LOSSY CODING 9**

Components of Multimedia – Basics of Information Theory – Entropy – Lossless Compression – Text Compression – Run Length Coding – Variable Length Coding – Shannon Fano Coding – Huffman and Adaptive Huffman Coding – Dictionary Based Coding – Arithmetic Coding – Lossy Compression Algorithms – Rate Distortion Theory – Quantization – Transform Coding – Wavelet Based Coding.

**Suggested Activities:**

- Flipped classroom on text coding concepts.
- Practical - Implement basic text coding and decoding algorithm using Python.
- Case study of WinZip, RAR.

**Suggested Evaluation Methods:**

- Estimate complexity and coding efficiency of a given algorithm.
- Assignment on numerical problem solving in coding theory.
- Assignment on numerical problems in coding theory.

**UNIT II IMAGE PROCESSING AND CODING 9**

Image Formation – CIE Chromaticity Diagram – Color Models: RGB, CMY, LMS, HSV, HSL – Color Balancing – Gamma Correction – Image Coding and Decoding Standards: JPEG, JPEG-2000, JPEG-LS, GIF, PNG, TIFF, EXIF, BMP.

**Suggested Activities:**

- Flipped classroom on different image coding techniques.
- Practical - Demonstration of EXIF format for given camera.
- Practical - Implementing effects quantization, color change.
- Analyze effects of change in RGB components in a digital color image.
- Case study of Google's WebP image format.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementations.
- Assignment on image file formats.
- Quizzes on colour models.

**UNIT III VIDEO PROCESSING AND CODING 9**

Video Color Transform: YUV, YIQ, YCbCr – Chroma Subsampling – Standard Digital Video Formats – CIF – QCIF – HDTV – UHDTV – Resolutions – 4K, 8K, 16K – Video Compression Based on Motion Compensation – Search for Motion Vectors – H.261 – H.264 – Motion Compensation in MPEG – MPEG–1, MPEG–2 – MPEG–4.

**Suggested Activities:**

- Flipped classroom on concepts of video coding standards.
- Assignment on calculation of file size in different resolution and standards.
- Assignment on complexity estimation of different motion vector search methods.
- Assignment on measurement of video quality using tools.
- Practical - Implementation of effects quantization, Chroma sub-sampling etc.
- Case study of Google's WebM video format.
- Mini project on processing of coded video.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementation.
- Evaluation of the mini project.
- Quizzes on MPEG standards.

**UNIT IV AUDIO PROCESSING AND CODING 9**

Digitization of Audio: PCM, ADPCM – Waveform Audio File Format – Synthetic Sounds – Musical Instrument Digital Interface – Vocoders – MPEG Audio – MP3 – Advance Audio Coding – High-Efficiency Advanced Audio Coding – MPEG4 – Home Theatre Systems.

**Suggested Activities:**

- Flipped classroom on audio coding standards.
- External learning - Dolby, DTS systems in Cinema theatres.
- Assignment on numerical problems on digital audio.
- Practical - Implementation of surround sound.
- Case study of a multi-channel home theatre system.

**Suggested Evaluation Methods:**

- Assignment on numerical problems on digital audio.
- Real-time demonstration of surround sound.
- Quizzes on Surround audio.

**UNIT V MULTIMEDIA CONTENT DESCRIPTION AND FRAMEWORK 9**

Hypermedia Coding – Multimedia and Hypermedia Expert Group – Multimedia Content Description Interface – MPEG-7 – Multimedia Framework – MPEG-21 – High Efficiency Coding and Media Delivery in Heterogeneous Environments – MPEG-H – Dynamic Adaptive Streaming over HTTP – MPEG-DASH.

**Suggested Activities:**

- Designing the structure and user interface.
- Case study of media coding used by YouTube, Netflix.
- External learning - Media streaming for TV.

**Suggested Evaluation Methods:**

- Responsive web design using hypermedia.
- Demonstration of media streaming through internet.
- Quizzes on multimedia frameworks.

**PRACTICAL EXERCISES: 30**

1. Implement Shannon Fano, Huffman, and adaptive Huffman coding techniques.
2. Develop and implement Dictionary based coding and decoding methods.
3. Implement Arithmetic coding and decoding algorithms.
4. Develop and implement transform coding with DCT / Wavelet based algorithm.
5. Implement color balancing and Gamma correction methods.

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6. Implement different modules of JPEG algorithms.
7. Implement color processing in video.
8. Implement different modules of MPEG–1 / H.261 standards.
9. Develop tool for editing MIDI musical files.
10. Implement different modules of MP–3, AAC standards.
11. Create multimedia contents with standard multimedia content description interface and frameworks.

**TOTAL: 75 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to:

1. Articulate the concepts and techniques used in multimedia basics and standard coding techniques.
2. Develop competence in implementing text coding.
3. Design and implement algorithms for image and video coding.
4. Choose and analyze suitable audio coding for a given multimedia application.
5. Design and develop multimedia projects with standard content formats and frameworks.

**REFERENCES:**


1. Mark S. Drew, Zee Nian Li, “Fundamentals of multimedia”, Prentice Hall, 2014.
2. Ralf Steinmetz, Klara Nahrstedt, “Multimedia Computing, Communications and Applications”, Innovative Technology Series, Prentice Hall, 1995.
3. Jerry D. Gibson, Toby Berger, Tom Lookabaugh, Dave Lindergh, Richard L. Baker, “Digital Compression for Multimedia: Principles and Standards”, Elsevier, 2006.
4. Ranjan Parekh, “Principles of Multimedia”, McGraw-Hill, Second Edition, 2017.
5. Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson Education, 2002.


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| **CO3** | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 1 | 2 | 1 | 1 | 3 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO6** | 2 | 1 | 1 | 3 | 1 | 3 |

**OE5091** **BUSINESS DATA ANALYTICS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- 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.

**Suggested Activities:**

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

**Suggested Evaluation Methods:**

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

**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.

**Suggested Activities:**

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

**Suggested Evaluation Methods:**

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

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

Modeling 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.

**Suggested Activities:**

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

**Suggested Evaluation Methods:**

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

**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.

**Suggested Activities:**

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

**Suggested Evaluation Methods:**

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and 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.

**Suggested Activities:**

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

**Suggested Evaluation Methods:**

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

**TOTAL: 45 PERIODS**

**OUTCOMES**:

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

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

**REFERENCES:**


1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, 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. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.


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| **CO4** | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO5** | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO6** | 1 | 1 | 1 | 3 | 2 | 1 |

**OE5092** **INDUSTRIAL SAFETY** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- 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:**

**Students will be able to:**

CO1: Ability to summarize basics of industrial safety

CO2: Ability to describe fundamentals of maintenance engineering

CO3: Ability to explain wear and corrosion

CO4: Ability to illustrate fault tracing

CO5: Ability to identify preventive and periodic maintenance

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| CO1 | ✓ | | | | | | | | | | | |
| CO2 | ✓ | | | | | | | | | | | |
| CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| CO4 | ✓ | ✓ | ✓ | | | | | | | | | |
| CO5 | ✓ | ✓ | ✓ | | | | | | | | | |

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**REFERENCES:**


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


**OE5093 OPERATIONS RESEARCH L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- 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:**

**Students will be able to:**

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | | | | | | | | | | | |
| CO2 | ✓ | | | | | | | | | | | |
| CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| CO4 | ✓ | ✓ | ✓ | | | | | | | | | |
| CO5 | ✓ | ✓ | ✓ | | | | | | | | | |

**REFERENCES**:


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


**OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C**
**3 0 0 3**

**OBJECTIVES:**

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

**UNIT I INTRODUCTION TO COSTING CONCEPTS 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 TO PROJECT MANAGEMENT 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 AND COSTING CONCEPTS 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.

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**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY 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:**

**Students will be able to:**

CO1 – Understand the costing concepts and their role in decision making

CO2–Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| **CO1** | ✓ | ✓ | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | ✓ |
| **CO2** | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | | ✓ | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | | ✓ | ✓ |
| **CO5** | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ |

**REFERENCES:**


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




**OE5095 COMPOSITE MATERIALS L T P C**

**3 0 0 3**

**OBJECTIVES:**

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- 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:**

**Students will be able to:**

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| CO2 | | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | |
| CO3 | | | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | |
| CO4 | | | ✓ | ✓ | ✓ | | ✓ | | | | ✓ | |
| CO5 | | | ✓ | ✓ | ✓ | | ✓ | | | | | |

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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.


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**OE5096** **WASTE TO ENERGY** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- 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 BIO ENERGY 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:**

**Students will be able to:**

CO1 – Understand the various types of wastes from which energy can be generated

CO2 – Gain knowledge on biomass pyrolysis process and its applications

CO3 – Develop knowledge on various types of biomass gasifiers and their operations

CO4 – Gain knowledge on biomass combustors and its applications on generating energy

CO5 – Understand the principles of bio-energy systems and their features

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| **CO1** | ✓ | | ✓ | | | | | | | | | ✓ |
| **CO2** | ✓ | | ✓ | | | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | ✓ | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | | | ✓ |
| **CO5** | ✓ | ✓ | ✓ | | ✓ | | | | | | | ✓ |

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**REFERENCES:**


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.


## AUDIT COURSES (AC)

**AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C**
**2 0 0 0**

**OBJECTIVES**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- 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**

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | ✓ | | ✓ |
| CO2 | | | | | | | | | | ✓ | | ✓ |
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| CO4 | | | | | | | | | | ✓ | | ✓ |
| CO5 | | | | | | | | | | ✓ | | ✓ |

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**REFERENCES**


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


**AX5092 DISASTER MANAGEMENT L T P C**
**2 0 0 0**

**OBJECTIVES**

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

**UNIT I INTRODUCTION 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**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| CO2 | ✓ | | | | | | | | | | | |
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| CO4 | ✓ | ✓ | ✓ | | | | | | | | | |
| CO5 | ✓ | ✓ | ✓ | | | | | | | | | |

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


**AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C**
**2 0 0 0**

**OBJECTIVES**

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- 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

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**UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6**

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

**TOTAL: 30 PERIODS**

**OUTCOMES**

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| CO2 | | | | | | | | | | ✓ | | ✓ |
| CO3 | | | | | | | | | | | | ✓ |
| CO4 | | | | | | | | | | | | ✓ |
| CO5 | | | | | | | | | | | | ✓ |

**REFERENCES**


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


**AX5094 VALUE EDUCATION L T P C**
**2 0 0 0**

**OBJECTIVES**

Students will be able to

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

**UNIT I**

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

**UNIT II**

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**

Personality and Behavior 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. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

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**UNIT IV**

Character and Competence–Holy books vs Blind faith. 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**

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

**SUGGESTED READING**

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

**AX5095 CONSTITUTION OF INDIA L T P C**
**2 0 0 0**

**OBJECTIVES**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- 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:**

History, Drafting Committee, (Composition & Working)

**UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:**

Preamble, Salient Features

**UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:**

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 IV ORGANS OF GOVERNANCE:**

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 V LOCAL ADMINISTRATION:**

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 Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT VI ELECTION COMMISSION:**

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**

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

**SUGGESTED READING**


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.


**AX5096 PEDAGOGY STUDIES L T P C**
**2 0 0 0**

**OBJECTIVES**

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**UNIT I INTRODUCTION AND METHODOLOGY:**

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**

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**

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.

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**UNIT IV PROFESSIONAL DEVELOPMENT**

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**

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

**TOTAL: 30 PERIODS**

**OUTCOMES**

Students will be able to understand:

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

**SUGGESTED READING**


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. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf


**AX5097 STRESS MANAGEMENT BY YOGA** **L T P C 2 0 0 0**

**OBJECTIVES**

- To achieve overall health of body and mind
- To overcome stress

**UNIT I**

Definitions of Eight parts of yoga.(Ashtanga)

**UNIT II**

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

**UNIT III**

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**

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**OUTCOMES**

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**SUGGESTED READING**

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

| AX5098 | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS | L T P C 2 0 0 0 |
|---|---|---|

**OBJECTIVES**

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

**UNIT I**

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 - Shrimad Bhagwad Geeta: 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 - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

**TOTAL: 30 PERIODS**

**OUTCOMES**

Students will be able to

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

**SUGGESTED READING**

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.

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