KSR College of Engineering

NAAC ACCREDITED A++ | NBA ACCREDITED PROGRAMMES

AN AUTONOMOUS INSTITUTION

# M.E. - COMMUNICATION SYSTEMS

## Curriculum &
## Syllabus for Semester I and II

## REGULATIONS 2024

## (Academic Year 2024-25 Onwards)

**K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE - 637 215**

**(Autonomous)**

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**M.E. – Communication Systems**

**(REGULATIONS 2024)**

**Vision of the Institution**

| | |
|---|---|
| **IV** | We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world. |

**Mission of the Institution**

| | |
|---|---|
| **IM 1** | To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs. |
| **IM 2** | To foster and maintain a mutually beneficial partnership with global industries and institutions through knowledge sharing, collaborative research and innovation. |

**Vision of the Department / Programme:** (ME - COMMUNICATION SYSTEMS)

| | |
|---|---|
| **DV** | We envision as a center of excellence in the field of Electronics and Communications Engineering to produce technically competent graduates with diverse teaching and research environments. |

**Mission of the Department / Programme:** (ME - COMMUNICATION SYSTEMS)

| | |
|---|---|
| **DM 1** | To educate the students with the state of art technologies to meet the growing challenges of the industries. |
| **DM 2** | To develop an innovate, competent and ethical Electronics and Communication Engineer with strong foundations to enable them for continuing education. |

**Programme Educational Objectives (PEOs) :**( ME - COMMUNICATION SYSTEMS)

| **The graduates of the programme will be able to** | |
|---|---|
| **PEO 1** | **Professional Skill Development:** Apply concepts of Statistics, Linear Algebra and Residue Calculus in Communication, Signal processing and Electromagnetics domain. |
| **PEO 2** | **Core Competence:** Solve issues in real world communication sectors, and develop feasible and viable communication systems. |
| **PEO 3** | **Interpersonal Skill and teamwork:** Inculcate effective communication skills, produce effective teamwork, professional ethics and pursue research. |

**Programme Outcomes (POs) of ME - COMMUNICATION SYSTEMS**

| | |
|---|---|
| **Program Outcomes (POs)** | |
| **M.E. Communication Systems graduates will be able to:** | |
| **PO1** | **Conduct Investigations of complex Problems:** An ability to independently carry out research /investigation and development work to solve practical problems. |
| **PO2** | **Presentation Skill:** An ability to write and present a substantial technical report/document. |
| **PO3** | **Scholarship of Knowledge:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program. |
| **Program Specific Outcomes (PSOs)** | |
| **PSO1** | **Research Culture:** Use the knowledge of signal processing, communications, networks and Electromagnetics to simulate algorithms in virtual environments and to perform research to implement embedded and VLSI platforms. |
| **PSO2** | **Core Values:** Contribute core Universal values and social good in the community**.** |

| | | |
|---|---|---|
| KSR College of Engineering | **K.S.R. COLLEGE OF ENGINEERING (Autonomous)**<br>**(Approved by AICTE & Affiliated to Anna University)**<br>**K.S.R. Kalvi Nagar, Tiruchengode - 637 215** | **CURRICULUM**<br>**PG**<br>**R - 2024** |
| **Department** | **Department of Electronics and Communication Engineering** | |
| **Programme** | **M.E – Communication Systems** | |

## SEMESTER I

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **THEORY COURSES** | | | | | | | | | | | |
| 1 | CU24T11 | Advanced Radiation Systems | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24T12 | Advanced Wireless Communication | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | CU24T13 | Advanced Communication Network | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | MA24T17 | Applied Mathematics | FC | 3 | 1 | 0 | 4 | **4** | 40 | 60 | 100 |
| 5 | | Professional Elective – I | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 6 | | Professional Elective – II | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| **LABORATORY COURSES** | | | | | | | | | | | |
| 7 | CU24P11 | Antennas and Radiating Systems Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| 8 | CU24P12 | Advanced Communication Networks Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| | | | **TOTAL** | **18** | **1** | **8** | **27** | **23** | **800** | | |

## SEMESTER II

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **THEORY COURSES** | | | | | | | | | | | |
| 1 | CU24T21 | Research Methodology and IPR | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24T22 | Modern Digital Communication Techniques | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | CU24T23 | Advanced Digital Signal Processing | PCC | 3 | 1 | 0 | 4 | **4** | 40 | 60 | 100 |
| 4 | CU24T24 | Digital Communication Receivers | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5 | | Professional Elective – III | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 6 | | Professional Elective – IV | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| **LABORATORY COURSES** | | | | | | | | | | | |
| 7 | CU24P21 | Advanced Digital Signal Processing Lab | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| 8 | CU24P22 | Technical Presentation | PCC | 0 | 0 | 2 | 2 | **1** | 60 | 40 | 100 |
| | | | **TOTAL** | **18** | **1** | **6** | **25** | **22** | **800** | | |

| | K.S.R. COLLEGE OF ENGINEERING (Autonomous)<br>(Approved by AICTE & Affiliated to Anna University)<br>K.S.R. Kalvi Nagar, Tiruchengode – 637 215 | CURRICULUM<br>PG<br>R – 2024 |
|---|---|---|
| **Department** | **Department of Electronics and Communication Engineering** | |
| **Programme** | **M.E – Communication Systems** | |

**SEMESTER III**

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **THEORY COURSES** | | | | | | | | | | | |
| 1 | CU24T31 | mm Wave Communication | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24T32 | Ultra-Wide Band Communications | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | | Professional Elective – V | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | | Open Elective | OEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| **LABORATORY COURSES** | | | | | | | | | | | |
| 5 | CU24P31 | Project Work Phase - I | EEC | 0 | 0 | 12 | 12 | **6** | 60 | 40 | 100 |
| **AUDIT COURSE** | | | | | | | | | | | |
| 6 | | Audit Course | AC | 2 | 0 | 0 | 2 | **0** | 100 | - | - |
| | | | **TOTAL** | **14** | **0** | **12** | **26** | **18** | **500** | | |

**SEMESTER IV**

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| **LABORATORY COURSE** | | | | | | | | | | | |
| 1 | CU24P41 | Project Work Phase II | EEC | 0 | 0 | 24 | 24 | **12** | 60 | 40 | 100 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** | **100** | | |

**TOTAL NO. OF CREDITS = 75**

**TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 75**

**Note:** FC – Foundation Courses, AC – Audit Courses, PCC – Professional Core Courses, and PEC – Professional Elective Courses, EEC – Employability Enhancement Courses.

| | K.S.R. COLLEGE OF ENGINEERING (Autonomous)<br>(Approved by AICTE & Affiliated to Anna University)<br>K.S.R. Kalvi Nagar, Tiruchengode - 637 215 | CURRICULUM<br>PG<br>R - 2024 |
|---|---|---|
| **Department** | **Department of Electronics and Communication Engineering** | |
| **Programme** | **M.E – Communication Systems** | |

**PROFESSIONAL ELECTIVE COURSE (I & II)**

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1 | CU24E01 | DSP Processor Architecture and Programming | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24E02 | Cognitive Radio Network | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | CU24E03 | Optical Communication Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | CU24E04 | Wireless Sensor Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5 | CU24E05 | Microstrip Patch Antenna Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 6 | CU24E06 | Communication Protocol Engineering | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 7 | CU24E07 | Signal Integrity for High Speed Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 8 | CU24E08 | Pattern Recognition and Machine Learning | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 9 | CU24E09 | MIMO Systems | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 10 | CU24E10 | Advanced Satellite Communication and Navigation Systems | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| | | | **Total** | **30** | **0** | **0** | **30** | **30** | **1000** | | |

**PROFESSIONAL ELECTIVE COURSE (III & IV)**

| S.No | Course Code | Course Title | Category | Periods/ Week | | | | Credit | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | | CA | ES | Tot |
| 1 | CU24E11 | Machine Learning | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24E12 | Communication Network Security | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | CU24E13 | RF MEMS for Wireless Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | CU24E14 | Multimedia Compression Techniques | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5 | CU24E15 | High Performance Computer Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 6 | CU24E16 | Voice and Data Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | CU24E17 | Spread Spectrum Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 8 | CU24E18 | High Speed Switching Architecture | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 9 | CU24E19 | Speech and Audio Processing | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 10 | PE24T21 | Soft Computing Techniques | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| | | | **Total** | **30** | **0** | **0** | **30** | **30** | **1000** | | |

| **PROFESSIONAL ELECTIVE COURSE (V)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No** | **Course Code** | **Course Title** | **Category** | **Periods/ Week** | | | | **Credit** | **Max. Marks** | | |
| | | | | **L** | **T** | **P** | **Tot** | | **CA** | **ES** | **Tot** |
| 1 | CU24E20 | Signal Detection and Estimation | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2 | CU24E21 | VLSI for Wireless Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3 | CU24E22 | Wavelets and Subband Coding | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4 | CU24E23 | Microwave Integrated Circuits | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5 | CU24E24 | RF System Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| | | | **Total** | **15** | **0** | **0** | **15** | **15** | **500** | | |

| **AUDIT COURSES (SEMESTER – III)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Name** | **Category** | **Hours/ Week** | | | | **Credit** | **Maximum Marks** | | |
| | | | | **L** | **T** | **P** | **Tot** | **C** | **CA** | **ES** | **Tot** |
| **THEORY COURSES** | | | | | | | | | | | |
| 1. | AX24A01 | Disaster Management | AC | 2 | 0 | 0 | 2 | 100 | - | - | - |
| 2. | AX24A02 | Value Education | AC | 2 | 0 | 0 | 2 | 100 | - | - | - |
| 3. | AX24A03 | Constitution of India | AC | 2 | 0 | 0 | 2 | 100 | - | - | - |

| FOUNDATION COURSES (FC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Name** | **Category** | **Hours/Week** | | | | **Credit** | **Maximum Marks** | | |
| | | | | **L** | **T** | **P** | **Tot** | **C** | **CA** | **ES** | **Total** |
| 1. | MA24T17 | Applied Mathematics | FC | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 |
| | | | **Total** | **3** | **1** | **0** | **4** | **4** | **100** | | |

| PROFESSIONAL CORE COURSES (PCC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Name** | **Category** | **Hours/Week** | | | | **Credit** | **Maximum Marks** | | |
| | | | | **L** | **T** | **P** | **Tot** | **C** | **CA** | **ES** | **Total** |
| 1. | CU24T11 | Advanced Radiation Systems | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2. | CU24T12 | Advanced Wireless Communication | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3. | CU24T13 | Advanced Communication Network | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4. | CU24P11 | Antennas and Radiating Systems Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| 5. | CU24P12 | Advanced Communication Networks Laboratory | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| 6. | CU24T21 | Research Methodology and IPR | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 7. | CU24T22 | Modern Digital Communication Techniques | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 8. | CU24T23 | Advanced Digital Signal Processing | PCC | 3 | 1 | 0 | 4 | **4** | 40 | 60 | 100 |
| 9. | CU24T24 | Digital Communication Receivers | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 10. | CU24P21 | Advanced Digital Signal Processing Lab | PCC | 0 | 0 | 4 | 4 | **2** | 60 | 40 | 100 |
| 11. | CU24P22 | Technical Presentation | PCC | 0 | 0 | 2 | 2 | **1** | 60 | 40 | 100 |
| 12. | CU24T31 | mm Wave Communication | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 13. | CU24T32 | Ultra-Wide Band Communications | PCC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| | | | **Total** | **27** | **1** | **14** | **42** | **35** | **1300** | | |

| PROFESSIONAL ELECTIVE COURSES (PEC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Course Code | Course Name | Category | Hours/Week | | | | Credit | Maximum Marks | | |
| | | | | L | T | P | Tot | C | CA | ES | Total |
| 1. | CU24E01 | DSP Processor Architecture and Programming | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 2. | CU24E02 | Cognitive Radio Network | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 3. | CU24E03 | Optical Communication Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 4. | CU24E04 | Wireless Sensor Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 5. | CU24E05 | Microstrip Patch Antenna Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 6. | CU24E06 | Communication Protocol Engineering | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 7. | CU24E07 | Signal Integrity for High Speed Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 8. | CU24E08 | Pattern Recognition and Machine Learning | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 9. | CU24E09 | MIMO Systems | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 10. | CU24E10 | Advanced Satellite Communication and Navigation Systems | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 11. | CU24E11 | Machine Learning | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 12. | CU24E12 | Communication Network Security | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 13. | CU24E13 | RF MEMS for Wireless Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 14. | CU24E14 | Multimedia Compression Techniques | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 15. | CU24E15 | High Performance Computer Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 16. | CU24E16 | Voice and Data Networks | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 17. | CU24E17 | Spread Spectrum Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 18. | CU24E18 | High Speed Switching Architecture | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 19. | CU24E19 | Speech and Audio Processing | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 20. | PE24T21 | Soft Computing Techniques | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 21. | CU24E20 | Signal Detection and Estimation | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 22. | CU24E21 | VLSI for Wireless Communication | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 23. | CU24E22 | Wavelets and Subband Coding | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 24. | CU24E23 | Microwave Integrated Circuits | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |
| 25. | CU24E24 | RF System Design | PEC | 3 | 0 | 0 | 3 | **3** | 40 | 60 | 100 |

| EMPLOYABILITY ENHANCEMENT COURSES (EEC) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Course Code | Course Name | Category | Hours/Week | | | | Credit | Maximum Marks | | |
| | | | | L | T | P | Tot | C | CA | ES | Total |
| 1. | CU24P31 | Project Work Phase - I | EEC | 0 | 0 | 12 | 12 | **6** | 60 | 40 | 100 |
| 2. | CU24P41 | Project Work Phase II | EEC | 0 | 0 | 24 | 24 | **12** | 60 | 40 | 100 |
| | | | **Total** | **0** | **0** | **36** | **36** | **18** | **200** | | |

| OPEN ELECTIVE COURSES OFFERED BY OTHER DEPARTMENTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Course Code | Course Name | Category | Hours/ Week | | | | Credit | Maximum Marks | | |
| | | | | L | T | P | Tot. | C | CA | ES | Total |
| **THEORY COURSES** | | | | | | | | | | | |
| 1. | CS24O01 | Machine learning and Deep Learning | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 2. | CS24O02 | Blockchain and Crypto Currency | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 3. | CS24O03 | Multimedia Technologies | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 4. | BD24O01 | Big Data Analytics | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 5. | BD24O02 | Internet of Things and Cloud | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 6. | BD24O03 | Big Data Visualization | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 7. | ET24O01 | Embedded Systems | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 8. | ET24O02 | Embedded Control | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 9. | ET24O03 | Embedded Automation | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 10. | IT24O01 | IoT for Smart System | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 11. | IT24O02 | Machine Learning for Intelligent Multimedia Analytics | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 12. | IT24O03 | DevOps and Microservices | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 13. | IT24O04 | Cyber security and Digital Awareness | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 14. | CN24O01 | Energy Efficient Building | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 15. | CN24O02 | Economics and Finance Management in Construction | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 16. | CN24O03 | Stress management | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 17. | ST24O01 | Principles of Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 18. | ST24O02 | Failure Analysis of Structures | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 19. | ST24O03 | Smart materials and Smart Structures | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 20. | PE24O01 | Switching Concepts and Power Semiconductor Devices | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 21. | PE24O02 | Smart Grid Technology | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 22. | PE24O03 | Renewable Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23. | PE24O04 | Energy Management and Conservation | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 24. | CC24O01 | Digital Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 25. | CC24O02 | Design for Manufacturing and Assembly | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 26. | CC24O03 | Smart Materials and Structures | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 27. | IS24O01 | Industrial Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 28. | IS24O02 | Fire Engineering and Protection | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 29. | IS24O03 | Food and Bio-safety | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |

**OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENT (OEC)**

| Sl. No. | Course Code | Course Name | Category | Hours/Week | | | | Credit | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Tot | C | CA | ES | Total |
| 1. | CU24O01 | Principles of Multimedia | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 2. | CU24O02 | IoT for Smart Systems | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 3. | CU24O03 | MEMS & NEMS | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |
| 4. | CU24O04 | Introduction to Cognitive Radio Network | OEC | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 |

## COURSE COMPONENT SUMMARY

| S.No. | Category | Credits Per Semester | | | | Credits Total | Percentage Credits |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | | |
| 1. | **FC** | 4 | - | - | - | **4** | **5.3** |
| 2. | **PCC** | 13 | 16 | 6 | - | **35** | **46.6** |
| 3. | **PEC** | 6 | 6 | 3 | - | **15** | **20** |
| 4. | **EEC** | - | - | 6 | 12 | **18** | **24** |
| 5. | **OEC** | - | - | 3 | - | **3** | **4** |
| **TOTAL** | | **23** | **22** | **18** | **12** | **75** | **100** |

| CU24T11 | ADVANCED RADIATION SYSTEMS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**
Students should have a basic knowledge in Electromagnetics, including Maxwell's equations, wave propagation, radiation and the interaction of electromagnetic waves with different media. Knowledge of different types of radiation and their effects on matter. Familiarity with the principles of antenna design, radiation patterns, polarization, impedance matching, and gain.

**OBJECTIVES:**

- To explore the design and analysis of antenna with its parameters.
- To study the spatial distribution of radiation from an antenna, including concepts like beam width, main lobe, and side lobes.
- To understand the basic principles of how apertures in a conductor or dielectric material emit or scatter electromagnetic waves.
- To explore antennas designed with metamaterials to achieve unique properties and measuring antenna impedance.
- To make the students to comprehend the cutting-edge developments in antenna design.

| UNIT - I | ANTENNA FUNDAMENTALS | (9) |
|---|---|---|

Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions –dipole, monopole, loop antenna; Mobile phone antenna – base station, handset antenna: Image; Induction, reciprocity theorem, Broadband antennas and Matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

| UNIT - II | ARRAY ANTENNA | (9) |
|---|---|---|

Linear array – uniform array, end fire and broad side array, gain, beam width, side lobe level, Two dimensional uniform array, Phased array, beam scanning, grating lobe, feed network. Three dimensional characteristics, binomial array and Dolph - Tchebycheff arrays, Circular array.

| UNIT - III | RADIATION FROM APERTURES | (9) |
|---|---|---|

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane, Slot antenna, Horn antenna, Reflector antenna, aperture blockage and design consideration.

| UNIT - IV | MODERN ANTENNAS & MEASUREMENT TECHNIQUES | (9) |
|---|---|---|

Base station antennas, PIFA, Antennas for WBAN, RFID Antennas, Automotive antennas, MIMO Antennas, Diversity techniques, Antenna impedance and radiation pattern measurements.

| UNIT - V | RECENT TRENDS IN ANTENNA DESIGN | (9) |
|---|---|---|

UWB antenna arrays, Vivaldi antenna arrays, Artificial magnetic conductors/High impedance surfaces, Antennas in medicine – Plasma antennas, Antennas for millimeter wave communication, optimization techniques, Numerical methods.

**Total = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Analyze various antenna parameters for a given antenna. | Analyze |
| **CO2** | Design different types of antenna arrays. | Apply |
| **CO3** | Design an aperture antenna for a given specifications | Apply |
| **CO4** | Measure and analyze the various antennas and its measurement techniques. | Analyze |
| **CO5** | Describe the cutting-edge developments in antenna design. | Understand |

**REFERENCES:**

1. K.Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, Third Edition, 2011
2. Krauss.J.D, "Antennas and wave propagation", John Wiley and sons, Fifth Edition, 2017.
3. Frank B. Gross, "Frontiers in Antennas", Mc Graw Hill, First Edition, 2011.
4. W.L.Stutzman and G.A.Thiele, "Antenna Theory and Design", John Wiley & Sons Inc, Third Edition, 2012.
5. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Springer Publications, Second Edition, 2007.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24T12 | ADVANCED WIRELESS COMMUNICATION | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have familiar in communication systems fundamentals of wireless communication, Digital Communication, Network protocols, Electromagnetics, Software defined radio.

**OBJECTIVES:**

- To gain knowledge about the propagation of electromagnetic signals in wireless channels.
- To explore the concept of channel capacity in various wireless environments, including AWGN, flat fading, and frequency-selective fading channels.
- To understand the importance of diversity in combating fading in wireless channels. Study different diversity techniques at the receiver and transmitter.
- To delve into Multiple Input Multiple Output (MIMO) systems, focusing on narrowband MIMO models, channel capacity, and diversity gain.
- To learn about Multi-User Detection (MUD) techniques, including linear decorrelator, MMSE MUD and adaptive MUD.

| UNIT - I | WIRELESS CHANNEL PROPAGATION AND MODEL | (9) |
|---|---|---|

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, 5G Channel model requirements and Measurements, propagation scenarios, METIS channel models, Map-based model, stochastic model.

| UNIT - II | CAPACITY OF WIRELESS CHANNELS | (9) |
|---|---|---|

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of MISO, SIMO systems.

| UNIT - III | DIVERSITY | (9) |
|---|---|---|

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

| UNIT - IV | MIMO COMMUNICATIONS | (9) |
|---|---|---|

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding: STBC, STTC, Spatial Multiplexing and BLAST Architectures.

| UNIT - V | MULTI USER SYSTEMS | (9) |
|---|---|---|

Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, MIMO-MUD Application of convex optimization to wireless design.

**Total = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the wireless channel characteristics and identify appropriate channel models. | **Understand** |
| **CO2** | Explain the mathematics behind the capacity calculation under different channel conditions | **Analyze** |
| **CO3** | Describe the implication of diversity combining methods and the knowledge of channel | **Apply** |
| **CO4** | Apply the concepts in MIMO Communications | **Understand** |
| **CO5** | Describe multiple access techniques and their use in different multi-user scenarios. | **Understand** |

**REFERENCES:**


1. David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, UK, First Edition, 2012.
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, UK, First Edition, 2007.
3. Harry R. Anderson, Fixed Broadband Wireless System Design, John Wiley, India, First Edition, 2003.
4. Simon Haykin & Michael Moher, Modern Wireless Communications, Pearson Education, New Delhi, First Edition, 2007.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

<table>
<tr><td rowspan="2">CU24T13</td><td rowspan="2" colspan="2">ADVANCED COMMUNICATION NETWORK</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PCC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE:**

Students should have familiar in communication systems fundamentals of wireless communication, Digital Communication, Network protocols, Electromagnetics and Software defined radio.

**OBJECTIVES:**

- To provide the students to gain the concepts of Internet communication, focusing on TCP/IP, its challenges, and advanced topics like congestion control, flow control.
- To delve into the complexities of TCP in high-bandwidth and high-latency networks, including fairness issues and real-time communication challenges.
- To provide design of packet scheduling algorithms, active queue management, and the theoretical underpinnings of latency.
- To disseminate the challenges and solutions in packet classification, IP address lookup, and flow identification, with a focus on efficient algorithms.
- To explore the concepts of admission control, effective bandwidth, and the architecture of Differentiated Services.

**UNIT - I | TCP AND RSVP | (9)**

Overview of Internet – Concepts and challenges - Overview of ATM - TCP/IP Congestion and Flow Control -Throughput analysis of TCP - TCP for high bandwidth delay networks - Fairness issues in TCP - Real Time Communications over Internet - Latency and throughput issues - Resource reservation in Internet - RSVP - Leaky bucket algorithm and its properties.

**UNIT - II | TRAFFIC SCHEDULING AND QUEUE MANAGEMENT | (9)**

Packet Scheduling Algorithms - Requirement - Scheduling guaranteed service connections - GPS, WFQ and Rate proportional algorithms - High speed scheduler design - Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP) - Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic - Active Queue Management - RED, WRED and Virtual clock - Control theoretic analysis of active queue management.

**UNIT - III | PACKET CLASSIFICATION ALGORITHM | (9)**

IP address lookup - challenges - Packet classification algorithms and Flow Identification - Grid of Tries - Cross producing and controlled prefix expansion algorithms.

**UNIT - IV | DIFFERENTIATED SERVICES | (9)**

Admission control in Internet - Concept of Effective bandwidth - Measurement based admission control - Differentiated Services in Internet (DiffServ) - DiffServ architecture and framework.

**UNIT - V | P SWITCHING AND TRAFFIC ENGINEERING | (9)**

IPV4, IPV6, IP tunneling – IP switching and MPLS - Overview of IP over ATM and its evolution to IP switching - MPLS architecture and framework - MPLS Protocols – Traffic engineering issues in MPLS.

**Total = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the fundamentals of TCP/IP, including its challenges and advanced topics such as congestion control and flow control. | **Understand** |
| **CO2** | Apply TCP performance issues in high-bandwidth and high-latency networks, including fairness and real-time communication challenges. | **Apply** |
| **CO3** | Design packet scheduling algorithms and active queue management strategies, and understand the theoretical aspects of latency. | **Apply** |
| **CO4** | Describe the challenges and solutions in packet classification, IP address lookup, and flow identification, with a focus on efficient algorithms. | **Understand** |
| **CO5** | Discuss admission control, effective bandwidth, and the architecture of Differentiated Services. | **Understand** |

**REFERENCES:**


1. David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, UK, First Edition, 2012.
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, UK, First Edition, 2007.
3. Harry R. Anderson, Fixed Broadband Wireless System Design, John Wiley, India, First Edition, 2003.
4. Simon Haykin& Michael Moher, Modern Wireless Communications, Pearson Education, New Delhi, First Edition, 2007.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

<table>
<tr><td rowspan="2">MA24T17</td><td rowspan="2">APPLIED MATHEMATICS</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>FC</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="7">(Common to CS, EST and PED)</td></tr>
</table>

**PREREQUISITE:**

Students should have the strong foundation in mathematical concepts including Linear Algebra, Probability theory and Statistics, familiarity with Mathematical modeling and Numerical methods techniques.

**OBJECTIVES:**

- To equip students to apply matrix decomposition methods.
- To enable students to translate real-world problems into linear programming problems and implement solutions effectively.
- To provide insights into methods to analyze discrete and continuous random variables.
- To develop the ability to analyze the basic components and behavior of queuing systems.
- To acquire the skills to apply and formulate to solve boundary value problems in ordinary differential equations.

| **UNIT - I** | **MATRIX THEORY** | **(9 + 3)** |
|---|---|---|

Matrix factorizations – The Cholesky decomposition – QR factorization – Least squares method – Singular value decomposition – Toeplitz matrices and some applications.

| **UNIT - II** | **LINEAR PROGRAMMING PROBLEMS** | **(9 + 3)** |
|---|---|---|

Formulation of LPP – Graphical Method – Simplex Method – Big M Method – Two Phase Simples Method – Dual Simplex method.

| **UNIT - III** | **ONE-DIMENSIONAL RANDOM VARIABLE** | **(9 + 3)** |
|---|---|---|

One dimensional Random Variable – Discrete and continuous random Variables – Probability mass function and probability density function – Expectations – Moments – Moment generating functions and their properties – Binomial, Poisson, Uniform, Exponential and Normal distributions.

| **UNIT - IV** | **QUEUING MODELS** | **(9 + 3)** |
|---|---|---|

Characteristics of Queuing Models – Kendall’s notations – Little’s formula – (M/M/1): $(\infty/FIFO)$ Single Server with infinite capacity – (M/M/C): $(\infty/FIFO)$ Multi Server with infinite capacity – (M/M/1): $(N/FIFO)$ Single Server with finite capacity – (M/M/C): $(N/FIFO)$ Multi server with finite capacity.

| **UNIT - V** | **COMPUTATIONAL METHODS IN ENGINEERING** | **(9 + 3)** |
|---|---|---|

Boundary value problems for ODE – Classification of PDE – Solution of Laplace and Poisson Equations – Liebmann's Iteration Process – Solution of Heat Conduction Equation by Bender Schmidt Explicit Formula and Crank Nicolson Implicit Scheme – Solution of Wave Equation.

**LECTURE: 45, TUTORIAL: 15, TOTAL: 60 PERIODS**

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

| COs | Course Outcome | Cognitive Level |
|---|---|---|
| **CO1:** | Apply and decompose matrices effectively. | Apply |
| **CO2:** | Create models and formulate linear programming problems. | Analyze |
| **CO3:** | Analyze and work with a single random variable. | Analyze |
| **CO4:** | Analyze and interpret the key features of various queuing systems. | Analyze |
| **CO5:** | Set up and solve boundary value problems for ODEs. | Apply |

**TEXT BOOKS**

1. Johnson R. A. and Gupta C. B., 'Miller & Freund's Probability and Statistics for Engineers', Pearson Education, Eighth Edition, 2015.
2. Grewal, B.S., 'Higher Engineering Mathematics', Khanna Publishers, Forty-Fourth Edition, 2017.

**REFERENCES:**

1. Bronson, R., 'Schaum's Outline Series of Matrix Operations', McGraw-Hill Education, Second Edition, 2011.
2. Hamdy A Taha., 'Operations research. An introduction', Pearson Edition, Tenth Edition, 2017.
3. Donald Gross and Carl M. Harris, 'Fundamentals of Queuing Theory', John Wiley and Sons, Fourth Edition, 2013.
4. Kandasamy, P., Thilagavathy and Gunavathy, K., 'Numerical Methods', S. Chand & Company Ltd, Third Edition, 2003.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 3 | - |
| **CO2** | 3 | - | - | 3 | - |
| **CO3** | 3 | - | - | 3 | - |
| **CO4** | 3 | - | - | 3 | - |
| **CO5** | 3 | - | - | 3 | - |
| **Avg.** | **3** | **-** | **-** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24P11 | ANTENNAS AND RADIATING SYSTEMS LABORATORY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 4 | 2 |

**PREREQUISITE:**

Students should have a fundamental knowledge in antennas, about different types of antennas, radiation patterns, impedance matching, and antenna arrays. Understanding of Maxwell's equations, wave propagation, and basic electromagnetic concepts is essential.

**OBJECTIVE:**

- To make the students to develop and analyse AM and FM antennas with targeted performance specs.
- To provide knowledge in design and simulate a broadband Yagi-Uda antenna for wide frequency coverage.
- To provide insight in to Design micro strip patch and dipole antennas optimized for mobile applications.
- To explore the design reflector antennas for satellite and TV reception.
- To build design skills in various dipole array configurations to meet specific needs.

**List of Experiments:**

1. Design and Simulate an antenna to receive AM and FM radio
2. Design and simulate Yagi-Uda Antenna at very high frequency band
3. Design Microstrip patch antenna for mobile applications
4. Design and develop Microstrip dipole antenna
5. Design reflector antenna for satellite - TV reception
6. Simulation of a half wave dipole antenna array.
7. Study the effect of change in distance between elements of array on radiation pattern of dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.

**Total = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Design and simulate AM & FM antennas. | Apply |
| **CO2** | Design and simulate Broadband Yagu uda antenna. | Apply |
| **CO3** | Design Microstrip patch antenna and Microstrip dipole for mobile applications. | Apply |
| **CO4** | Design and simulate reflector types of antenna for satellite and TV reception. | Apply |
| **CO5** | Design and simulate dipole Array antenna and its types. | Apply |

**REFERENCES:**

1. J.D. Krauss, "Antennas for all applications", Fourth Edition, MH publication, 2010
2. C. Balanis, "Antenna Theory: Analysis and design", Third Edition, Wiley India, 2009

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24P12 | ADVANCED COMMUNICATION NETWORKS LABORATORY | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 0 | 0 | 4 | 2 |

**PREREQUISITE:**

Students should have familiar in communication systems fundamentals of wireless communication, Digital Communication, Network protocols, Electromagnetics, Software defined radio.

**OBJECTIVES:**

- To make the students apply various network commands and configure network files to manage and troubleshoot network settings.
- To delve into build expertise in sub-netting and implement routing mechanisms to efficiently manage and direct network traffic.
- To develop the students to show proficiency in basic computer network protocols and their functions within a network.
- To apply networking protocols to the design and implementation of functional and efficient network systems.
- To Explore the concepts of admission control, effective bandwidth, and the architecture of Differentiated Services.

**List of Experiments:**

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, net stat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
   a. Configuring NIC's IP Address.
   b. Determining IP Address and MAC Address using if-config command.
   c. Changing IP Address using if-config.
   d. Static IP Address and Configuration by Editing.
   e. Determining IP Address using DHCP.
   f. Configuring Hostname in /etc/hosts file.
3. Design TCP iterative Client and Server application to reverse the given input sentence.
4. Design a TCP concurrent Server to convert a given text in to upper case using multiplexing system call "select".
5. Design UDP Client Server to transfer a file.
6. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java Client to send and receive mails.
7. Configure FTP Server on a Linux/ Windows machine using a FTP client/ SFTP client characterize file transfer rate for a cluster of small files 100k each and a video file of 700mb. Use a TFTP client and repeat the experiment.
8. Signaling and QoS of labeled paths using RSVP in MPLS.
9. Find shortest paths through provider network for RSVP and BGP.

**Total = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Apply different types of network commands and configure files. | **Apply** |
| **CO2** | Build the skills of sub-netting and routing mechanisms. | **Apply** |
| **CO3** | Demonstrate basic protocols of computer networks. | **Apply** |
| **CO4** | Apply the protocols to design and implementation of network. | **Apply** |
| **CO5** | Simulate the QoS and Shortest path algorithms to estimate network parameters | **Apply** |

**REFERENCES:**

1. David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, First Edition, 2012.
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, First Edition, 2007.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24T21 | RESEARCH METHODOLOGY AND IPR | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a basic understanding of research methodologies and techniques, including problem identification, data collection, and analysis. Familiarity with academic writing and literature review practices is also essential. Knowledge of intellectual property concepts and patenting processes will be beneficial. Additionally, students should be acquainted with the fundamentals of intellectual property rights, including patents, copyrights, and trademarks, as well as current issues and advancements in this field.

**OBJECTIVES:**

- To make the student to understand how to define and identify research problems, including their sources, characteristics.
- To develop skills in writing effective research papers, including conducting literature reviews, avoiding plagiarism, adhering to research ethics, and creating well-structured research proposals.
- To provide the students to gain knowledge about various forms of intellectual property, such as patents, designs, trademarks, and copyrights.
- To disseminate the scope of patent rights, the processes of licensing, technology transfer and the use of patent information.
- To make the students to stay updated on recent developments in intellectual property rights, including advancements in patent administration, IPR issues related to biological systems and computer software.

| UNIT - I | INTRODUCTION | (9) |
|---|---|---|

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 | RESEARCH PAPER WRITING | (9) |
|---|---|---|

Effective literature studies approaches, analysis Plagiarism , Research ethics, 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 - III | INTELLECTUAL PROPERTY RIGHTS | (9) |
|---|---|---|

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 - IV | PATENT RIGHTS | (9) |
|---|---|---|

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications

| UNIT - V | RECENT ADVANCEMENTS IN IPR | (9) |
|---|---|---|

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Effectively define and identify research problems, understanding their sources and characteristics. | **Understand** |
| **CO2** | Demonstrate proficiency in writing research papers, conducting literature reviews, and creating well-structured research proposals while adhering to ethical standards and avoiding plagiarism. | **Understand** |
| **CO3** | Comprehensive understanding of various forms of intellectual property, including patents, designs, trademarks, and copyrights. | **Understand** |
| **CO4** | Interpret patent rights, manage licensing and technology transfer, utilize patent information and databases, and understand the concept of geographical indications. | **Understand** |
| **CO5** | Describe the latest advancements in intellectual property rights, including developments in patent systems, IPR issues related to new technologies, and case studies on traditional knowledge. | **Understand** |

**REFERENCES:**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Juta & Company, Reprint 2007.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta Academic, 2014.
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", Pearson Education, USA, 2005.
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | - | 3 | 3 | 3 | - |
| **CO2** | - | 3 | 3 | 3 | - |
| **CO3** | - | 3 | 3 | 3 | - |
| **CO4** | - | 3 | 3 | 3 | - |
| **CO5** | - | 3 | 3 | 3 | - |
| **Avg.** | **-** | **3** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24T22 | MODERN DIGITAL COMMUNICATION TECHNIQUES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a solid understanding of basic mathematics, including calculus, which is essential for understanding the principles of signal analysis and system design. In addition, a fundamental understanding of digital signal processing techniques such as Fourier transforms and filtering is essential. Basic concepts in digital and analog communication, including modulation and noise are also critical for grasping modern communication methods.

**OBJECTIVES:**

- To compare the performance of coherent and non-coherent receivers in terms of error rates, bandwidth efficiency, and complexity and also analyze how each receivers performs under Rayleigh and Rician channel conditions.
- To explore different equalization algorithms to reduce ISI in digital communication receives.
- To equip the students to perform various Shannon's channel codes and block codes in digital communication.
- To develop skills in designing various convolution coding algorithms and analyzing its performance.
- To make the students to gain insight into the design and optimization of modern communication systems.

**UNIT - I COHERENT AND NON-COHERENT COMMUNICATION (9)**

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – QAM modulation and demodulation - Non-coherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization Bit synchronization.

**UNIT - II EQUALIZATION TECHNIQUES (9)**

Band Limited Channels - ISI – Nyquist Criterion - Controlled ISI-Partial Response signals- Equalization algorithms – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

**UNIT - III BLOCK CODES (9)**

Architecture and performance – Binary block codes; – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

**UNIT - IV CONVOLUTIONAL CODES (9)**

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram –Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

**UNIT - V MULTICARRIER AND MULTIUSER COMMUNICATIONS (9)**

Single vs Multicarrier modulation, Orthogonal Frequency Division Multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Analyze and compare the performance of coherent and non-coherent receivers under Rayleigh and Rician channel conditions. | **Analyze** |
| **CO2** | Proficient in applying and comparing various equalization algorithms to reduce ISI in digital communication systems. | **Apply** |
| **CO3** | Assess the effectiveness of different block codes in improving communication reliability and error resilience. | **Apply** |
| **CO4** | Analyze the performance of convolutional codes using metrics such as the Viterbi algorithm for decoding. | **Analyze** |
| **CO5** | Design and optimization of modern communication systems like OFDM and CDMA. | **Apply** |

**REFERENCES:**


1. John G. Proakis and Masoud Salehi, "Digital Communication", McGraw Hill Publication, Fifth Edition, 2014.
2. Simon Haykin, "Digital Communication Systems", John Wiley and sons, First Edition, 2014.
3. Bernard Sklar and Pabitra Kumar Ray, "Digital Communications Fundamentals & Applications", Pearson Education, Second Edition, 2009.
4. Lathi B P and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press, First Edition, 2011.
5. Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications", Artech House Publication, First Edition, 2001.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

| CU24T23 | ADVANCED DIGITAL SIGNAL PROCESSING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PCC | 3 | 1 | 0 | 4 |

**PREREQUISITE:**

Students should have a strong foundation in basic probability and statistics, including random variables and covariance. They should be familiar with discrete-time signal processing concepts such as convolution and Fourier transforms. Knowledge of linear algebra, including matrix operations and solving linear systems, is essential. A basic understanding of digital signal processing, including the Discrete Fourier Transform and sampling theory, is also required. Additionally, familiarity with estimation theory and practical programming skills in tools like MATLAB.

**OBJECTIVES:**

- To make the students to analyze discrete random processes, apply Parseval's theorem and filter white noise using power spectral density and spectral factorization.
- To Estimate spectra from finite signals using non-parametric and parametric methods and evaluate the performance of different spectral estimators.
- Gain skills in linear prediction, solve normal equations with Levinson recursion, and apply Wiener filters and Kalman filters for filtering and prediction.
- Design and implement adaptive FIR and RLS filters, and apply adaptive algorithms for channel equalization, echo cancellation, and noise cancellation.
- To provide the insights to implement sampling rate conversion techniques, including interpolation and decimation for subband coding and wavelet transforms.

| UNIT - I | DISCRETE RANDOM SIGNAL PROCESSING | (9) |
|---|---|---|

Discrete random processes – Ensemble averages – Stationary processes: Bias and Estimation, Auto covariance, Autocorrelation - Parseval's theorem – Wiener Khintchine relation – White noise - Power spectral density, Spectral factorization Theorem – Filtering random processes – Low pass filtering of white noise.

| UNIT - II | SPECTRUM ESTIMATION | (9) |
|---|---|---|

Estimation of spectra from finite duration signals -Non-Parametric methods: Correlation method – Periodogram estimator – Performance analysis of estimators - Unbiased, Consistent estimators – Modified periodogram –Bartlett and Welch methods – Blackman – Tukey method - Parametric methods: AR, MA and ARMA model based spectral estimation, Yule- Walker equations-Solutions using Durbin's algorithm.

| UNIT - III | LINEAR ESTIMATION AND PREDICTION | (9) |
|---|---|---|

Linear prediction – Forward and backward predictions, Solutions of the normal equations - Levinson recursion algorithms – Least mean squared error criterion – Wiener filter for filtering and prediction – FIR Wiener filter and IIR Wiener filters – Discrete Kalman filter.

| UNIT - IV | ADAPTIVE FILTERS | (9) |
|---|---|---|

FIR adaptive filters – Adaptive filter based on steepest descent method – Widrow Hoff LMS adaptive algorithm –Normalized LMS – Adaptive channel equalization – Adaptive echo cancellation–Adaptive noise cancellation –Adaptive recursive filters – RLS adaptive filters – Exponentially weighted RLS sliding window RLS.

| **UNIT - V** | **MULTIRATE DIGITAL SIGNAL PROCESSING** | **(9)** |
|---|---|---|

Mathematical description of change of sampling rate – Interpolation and decimation – Decimation by an integer factor – Interpolation by an integer factor – Sampling rate conversion by a rational factor–Filter implementation for sampling rate conversion – Direct form FIR structures – Polyphase filter structures-Time-variant structures –Multistage implementation of multirate system – Application to sub band coding -Wavelet transform and filter bank implementation of wavelet expansion of signals.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| **Course Outcome** | **Description** | **Bloom's Taxonomy Level** |
|---|---|---|
| **CO1** | Analyze and filter discrete random processes, and compute auto covariance and autocorrelation. | **Analyze** |
| **CO2** | Estimate power spectra accurately using various methods and assess performance. | **Apply** |
| **CO3** | Implement linear prediction and Wiener filtering techniques and apply discrete Kalman filtering. | **Apply** |
| **CO4** | Design adaptive filters, apply LMS and RLS algorithms, and solve practical filtering problems. | **Apply** |
| **CO5** | Apply sampling rate conversion techniques effectively and implement multirate DSP systems, including wavelet transforms. | **Apply** |

**REFERENCES:**

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons,Inc., First Edition, 2008
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, Fourth Edition, 2007.
3. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Artech House Publishers, First Edition, 2005.
4. John G. Proakis, Charles M. Rader, Fuyun Ling, Marc Moonen, Ian K. Proudler, Chrysostomos L. Nikias, "Algorithms for Statistical Signal Processing", Prentice Hall, First Edition, 2002.

**Mapping of COs with POs and PSOs**

| **COs/ POs** | **PO1** | **PO2** | **PO3** | **PSO1** | **PSO2** |
|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 3 | - |
| **CO2** | 3 | - | - | 3 | - |
| **CO3** | 3 | - | - | 3 | - |
| **CO4** | 3 | - | - | 3 | - |
| **CO5** | 3 | - | - | 3 | - |
| **Avg.** | **3** | **-** | **-** | **3** | **-** |

1 - Low, 2 - Medium, 3 - High

<table>
<tr><td rowspan="2">CU24T24</td><td rowspan="2">DIGITAL COMMUNICATION RECEIVERS</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PCC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE:**
Student should have fundamental knowledge in communication theory, signal processing, Probability and Random Processes, Modulation Techniques, Communication System Architecture and Electronics.

**OBJECTIVES:**

- To enable the students to understand the basic principles of digital communication techniques.
- To explore the concept of optimization process in receivers for AWGN channel.
- To expose the students to analyze the performance of receivers for fading channels.
- To equip the students to perform various techniques used in synchronization process.
- To develop skills in designing of adaptive equalization algorithms.

| | | |
|---|---|---|
| **UNIT - I** | **REVIEW OF DIGITAL COMMUNICATION TECHNIQUES** | **(9)** |
| Baseband and band pass communication; Signal space representation, linear and nonlinear modulation techniques and spectral characteristics of digital modulation. | | |
| **UNIT - II** | **OPTIMUM RECEIVERS FOR AWGN CHANNEL** | **(9)** |
| Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, M- ary orthogonal signals, envelop detectors for M-ary and correlated binary signals. | | |
| **UNIT - III** | **RECEIVERS FOR FADING CHANNELS** | **(9)** |
| Characterization of fading multiple channels, statistical models, slow fading, frequency selective fading, diversity technique, RAKE demodulator, coded waveform for fading channel. | | |
| **UNIT - IV** | **SYNCHRONIZATION TECHNIQUES** | **(9)** |
| Carrier and signal synchronization, carrier phase estimation – PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation. | | |
| **UNIT - V** | **ADAPTIVE EQUALIZATION** | **(9)** |
| Zero forcing algorithm, LMS algorithm, adaptive decision–feedback equalizer and Equalization of Trellis –coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm. | | |
| | | **Total (L: 45) = 45 PERIODS** |

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the basic principles of digital communication techniques. | **Understand** |
| **CO2** | Apply the concept of optimization process in receivers for AWGN channel. | **Apply** |
| **CO3** | Analyze the performance of receivers for Fading channel. | **Analyze** |
| **CO4** | Apply various techniques used in synchronization process. | **Apply** |
| **CO5** | Design adaptive equalization algorithms to satisfy the evolving demands in digital communication | **Apply** |

**REFERENCES:**

1 K.Hein rich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, Digital Communication Receivers, Vol I & Vol II, John Wiley, First Edition, 1997.

2 John.G.Proakis, Digital communication, McGraw-Hill, Fourth Edition, 2001.

3 E.A.Lee and D.G.Messerschmitt, Digital communication, Allied Publishers, Second Edition, 1994.

4 Simon Marvin, Digital communication over fading channel; An unified approach to performance Analysis, John Wiley, First Edition, 2000.

5 N.Benuveruto & G.Cherubini, Algorithms for Communication Systems and their Applications, Wiley, First Edition, 2002.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| **CU24P21** | **ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY** | **Category** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|---|
| | | **PCC** | **0** | **0** | **4** | **2** |

**PREREQUISITE:**

Students should have a foundational understanding of signal processing principles, including discrete-time signals and systems, as well as basic knowledge of linear algebra, such as matrix operations and eigenvalues. Familiarity with digital filter design, including Butterworth and Chebyshev filters, is essential. Additionally, students should be comfortable with transforms and algorithms, particularly the Fast Fourier Transform (FFT) and convolution, as well as the Z-transform for analyzing and designing digital systems.

**OBJECTIVES:**

- To make the students to Compute auto-correlation and cross-correlation functions to analyze and interpret signal relationships and properties.
- To develop the students to apply the Routh-Hurwitz criterion to assess the stability of linear time-invariant systems.
- To provide the knowledge on designing a Butterworth and Chebyshev filters for various signal processing applications.
- To Utilize FFT for frequency analysis and inverse Z-transform for time-domain signal processing.
- To provide insights to Implement and optimize cascade digital IIR filters, and apply decimation and interpolation techniques.

**LIST OF EXPERIMENTS:**

1. Basic signal representation
2. Auto Correlation and Cross Correlation
3. Stability Using Routh Hurwitz Criteria
4. Sampling FFT of Input Sequence
5. Butterworth Lowpass and High pass Filter Design
6. Chebychev Type I, Type II Filter
7. Cascade Digital IIR Filter Realization
8. Decimation and Interpolation Using Rationale Factors
9. Convolution and M Fold Decimation
10. Normal Equation Using Levinson Durbin
11. Estimation of PSD
12. Inverse Z Transform

**Total (P: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Compute and analyze auto-correlation and cross-correlation functions to understand signal behavior. | **Analyze** |
| **CO2** | Determine system stability using the Routh-Hurwitz criterion and interpret its implications on system performance. | **Apply** |
| **CO3** | Design and evaluate Butterworth and Chebyshev filters, demonstrating the ability to meet specific frequency response criteria. | **Apply** |
| **CO4** | Perform FFT sampling, convolution, and apply decimation and interpolation techniques effectively. | **Apply** |
| **CO5** | Use the Levinson-Durbin algorithm for parameter estimation and apply inverse Z-transform for digital filter analysis and design | **Apply** |

**REFERENCES:**


1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons,Inc., First Edition, 2008
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, Fourth Edition, 2007.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | **3** | **-** | **-** | **3** | **-** |
| **CO2** | **3** | **-** | **-** | **3** | **-** |
| **CO3** | **3** | **-** | **-** | **3** | **-** |
| **CO4** | **3** | **-** | **-** | **3** | **-** |
| **CO5** | **3** | **-** | **-** | **3** | **-** |
| **Avg.** | **3** | **-** | **-** | **3** | **-** |

# PROFESSIONAL ELECTIVE COURSES

<table>
<tr><td rowspan="2">CU24E01</td><td rowspan="2">DSP PROCESSOR ARCHITECTURE AND PROGRAMMING</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE:**

Students should have a foundational understanding of digital signal processing concepts, including discrete-time signals, Fourier transforms, and filtering techniques. They should also be familiar with digital electronics and computer architecture, as well as possess programming skills in assembly language and high-level languages such as C or C++. A solid grasp of mathematical principles, signal transformations and filter design. Additionally, basic knowledge of microprocessors and microcontrollers will help students understand how DSP processors integrate into broader embedded systems and microprocessor-based designs.

**OBJECTIVES:**

- To make the students to comprehend essential DSP concepts including basic operations, bus structures, memory access and on-chip peripherals, to understand their role in efficient signal processing.
- To incorporate the students to develop assembly language syntax and addressing modes of the TMS320C5X processor.
- To equip the students to examine the architecture, data formats and addressing modes of the DSP processor.
- To build up the skills to analyze the architecture and addressing modes of the of DSP processors.
- To explore to investigate the architectures of advanced DSP processors, compare the features and capabilities of different DSP families.

| **UNIT - I** | **FUNDAMENTALS OF PROGRAMMABLE DSPs** | **(9)** |
|---|---|---|

Multiplier and multiplier accumulator – Modified bus structures and memory access in PDSPs– Multiple access memory – Multi-port memory – VLIW architecture- Pipelining –Special addressing modes in P-DSPs – On chip peripherals.

| **UNIT - II** | **TMS320C5X PROCESSOR -Fixed** | **(9)** |
|---|---|---|

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block diagram of DSP starter kit – Application programs for processing real time signals.

| **UNIT - III** | **TMS320C3X PROCESSOR -Floating** | **(9)** |
|---|---|---|

Architecture – Data formats - Addressing modes – Groups of addressing modes- Instruction sets - Operation – Block diagram of DSP starter kit – Application programs for processing real time signals - Generating and finding the sum of series, Convolution of two sequences, Filter design.

| **UNIT - IV** | **ADSP PROCESSORS** | **(9)** |
|---|---|---|

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

| **UNIT - V** | **ADVANCED PROCESSORS** | **(9)** |
|---|---|---|

Architecture of TMS320C54X: Pipe line operation, Code composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe DSP basic operations, bus structures, memory access, and on-chip peripherals, and their impact on signal processing efficiency. | Understand |
| **CO2** | Write assembly language syntax and addressing modes for the TMS320C5X processor. | Apply |
| **CO3** | Analyze the architecture, data formats and addressing modes of DSP processors. | Analyze |
| **CO4** | Compare and analyse the architecture with addressing modes of various DSP processors. | Analyze |
| **CO5** | Investigate and compare the features and capabilities of advanced DSP processor families. | Analyze |

**REFERENCES:**


1. Venkataramani B. and Bhaskar M., "Digital Signal Processors – Architecture, Programming and Applications", Tata McGraw – Hill Publishing Company Limited, Second Edition, 2011.
2. Sen.M.Kuo, Woon–Seng S.Gan, "Digital Signal Processors: Architecture, Implementation and Applications", Pearson, First Edition, 2012.
3. Avtar Singh and S. Srinivasan, "Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx", Cengage Learning India Private Limited, 2012.
4. User guides Texas Instrumentation, Analog Devices and Motorola.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 2 | 3 | - |
| **CO2** | 3 | - | 2 | 3 | - |
| **CO3** | 3 | - | 2 | 3 | - |
| **CO4** | 3 | - | 2 | 3 | - |
| **CO5** | 3 | - | 2 | 3 | - |
| **Avg.** | **3** | **-** | **2** | **3** | **-** |

| CU24E02 | COGNITIVE RADIO NETWORK | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have familiar in communication systems, wireless networks, digital communication principles (modulation, coding, signal processing), network protocols, spectrum management, software-defined radio (SDR) and fundamental optimization and game theory concepts.

**OBJECTIVES:**

- To introduce the basic concepts of cognitive radio, including the need for cognitive radios, their functionality, hardware and software architecture.
- To make the students to analyze the technologies to allow an efficient use of TVWS for radio communication based on two spectrum sharing business models.
- To provide the insight into design the cognitive radio network architectures and protocols.
- To disseminate understand the basic concept of dynamic spectrum access radio resource management and learning algorithms.
- To learn the various applications and advanced features of cognitive radio.

| UNIT - I | COGNITIVE RADIO TECHNOLOGY | (9) |
|---|---|---|

Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, SDR as a platform for Cognitive Radio – Hardware and Software Architectures.

| UNIT - II | SPECTRUM SENSING AND SPECTRUM SHARING | (9) |
|---|---|---|

Spectrum sensing-detection of spectrum holes (TVWS), Primary user detection techniques–Fundamental Tradeoffs in spectrum sensing. Unlicensed and Licensed Spectrum Sharing, Secondary Spectrum Access - Non-Real-Time SSA – Real-Time SSA-Models of Dynamic Spectrum Access - Fundamental Limits of Cognitive Radio- spectrum trading.

| UNIT - III | COGNITIVE RADIO NETWORK ARCHITECTURES AND PROTOCOLS | (9) |
|---|---|---|

Cognitive Radio Network Architectures-Topology Aware CRN Architecture-Cognitive radio for broadband wireless access in TV bands- IEEE 802.22 Standard-IEEE 1900 standards.

| UNIT - IV | DYNAMIC SPECTRUM | (9) |
|---|---|---|

Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

| UNIT - V | RESEARCH CHALLENGES AND APPLICATIONS | (9) |
|---|---|---|

Optimization Techniques of Dynamic Spectrum Allocation, Security issues in cognitive radio, Game theory in Cognitive radio, cross layer design issues in cognitive radio networks, public safety and cognitive radio applications: cognitive radio for Internet of Things-Vehicular communication-satellite communication.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Articulate the need for cognitive radios, functionality and their hardware and software architectures. | **Understand** |
| **CO2** | Employ technologies for efficient utilization of TV White Space (TVWS) and analyze spectrum sharing business models. | **Analyze** |
| **CO3** | Access cognitive radio network architectures and protocols, including their design and implementation. | **Apply** |
| **CO4** | Utilize dynamic spectrum access techniques, radio resource management strategies and learning algorithms. | **Understand** |
| **CO5** | Describe the advanced features and applications of cognitive radios in various contexts. | **Understand** |

**REFERENCES:**

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, First Edition, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., First Edition, 2009.
3. Bruce A Fette, "Cognitive Radio Technology", Elsevier publication, Burlington, First Edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, Verlag, First Edition, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems", Springer, Verlag, First Edition, 2009.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E03 | OPTICAL COMMUNICATION AND NETWORKING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

A solid understanding of basic mathematics, including calculus and linear algebra, is required for analyzing signal processing, network performance. Students also need basic knowledge of optical fibers, including their properties, types and fundamental operation principles is essential. Familiarity with fundamental concepts in communication systems, such as modulation, signal processing, and data transmission, is necessary. An understanding of basic networking concepts and protocols is important for comprehending network design and functionality.

**OBJECTIVES:**

- To apply the principles of optical system components effectively in the design and implementation of optical networks, ensuring optimized performance and reliability.
- To apply the knowledge and skills to implement various optical network architectures in order to meet specific communication needs.
- To perform various wavelength routing networks for effective managing wavelength resources.
- To optimize packet switching mechanisms and access network architectures, focusing on efficient data transmission, network performance, and resource management.
- To implement effective network management strategies and survivability techniques.

| UNIT – I | OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN | (9) |
|---|---|---|

Optical system components: Couplers, Isolators and circulators, Multiplexers and filters, Optical amplifiers, switches wavelength converters –Transmission system engineering system model power penalty – Transmitter, receiver, optical amplifiers, cross talk, dispersion, Wave length stabilization: Overall design considerations.

| UNIT – II | OPTICAL NETWORK ARCHITECTURES | (9) |
|---|---|---|

Introduction to optical networks; SONET/SDH, Metropolitan Area Networks, Layered architecture; Broad cast and select Networks– Topologies, Media Access Control protocols and test beds.

| UNIT – III | WAVELENGTH ROUTING NETWORKS | (9) |
|---|---|---|

WDM network elements: WDM network design – Cost tradeoffs, Routing and wavelength assignment, Virtual topology design, Wavelength routing test beds, Architectural variations.

| UNIT – IV | PACKET SWITCHING AND ACCESS NETWORKS | (9) |
|---|---|---|

Photonic packet switching: OTDM, Multiplexing and De-multiplexing, Synchronization, Broadcast OTDM networks, Switch based networks – Access Networks – Network architecture overview, Future access networks, Optical access network architectures and OTDM networks.

| UNIT – V | NETWORK MANAGEMENT AND SURVIVABILITY | (9) |
|---|---|---|

Control and Management: Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Apply the principles of optical system components in the design and implementation of optical networks. | **Apply** |
| **CO2** | Implement various optical network architectures in order to meet specific communication requirements and optimize network performance. | **Apply** |
| **CO3** | Apply different multiplexing techniques in optical networks to enhance data transmission efficiency and optimize bandwidth utilization. | **Apply** |
| **CO4** | Analyze different accessing techniques by comparing their efficiency, scalability, and suitability for various network scenarios to identify the most appropriate technique for specific use cases. | **Analyze** |
| **CO5** | Apply network management strategies and survivability techniques to ensure continuous operation and quick recovery of optical networks during failures. | **Apply** |

**REFERENCES:**


1 Max Ming-Kang Liu, Principles and Applications of Optical Communication, Tata McGraw Hill Education Pvt., Ltd., First Edition 2010.

2 Rajiv Ramaswami and Kumar N.Sivarajan, Optical Networks: A Practical Perspective, Harcourt Asia Pvt.Ltd, Second Edition, 2006.

3 C.Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice HallofIndia, Second Edition, 2002.

4 Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multi wavelength Optical Networks - Architecture, Design and control ", Cambridge University Press, Second Edition, 2009.

5 Biswanath Mukherjee, Optical WDM Networks, Springer, First Edition, 2006.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E04 | WIRELESS SENSOR NETWORKS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students need a basic knowledge in networking, Mobile Networks wireless Networks, Computer network sand Data Communication Networks.

**OBJECTIVES:**

- To make students to understand the basics of wireless sensor networks.
- To provide the design principles of architecture and placement strategies of Sensors.
- To equip the students to perform various protocols.
- To make the students to establish WSN infrastructure.
- To introduce the procedure to analyze network platforms and tools.

| UNIT - I | OVERVIEW OF WIRELESS SENSOR NETWORKS | (9) |
|---|---|---|

Challenges for wireless sensor networks – Characteristics requirements –Required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks–Enabling technologies for wireless sensor networks.

| UNIT - II | ARCHITECTURES | (9) |
|---|---|---|

Single node Architecture – Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, Network architecture – Sensor network scenarios, Optimization goals and figures of merit, Gate way concepts.

| UNIT - III | NETWORKING OF SENSORS | (9) |
|---|---|---|

Physical layer and transceiver design considerations, MAC protocols for wireless sensor networks, Low duty cycle protocols and wakeup concepts- S-MAC, The mediation device protocol, Wakeup radio concepts, Address and name management, Assignment of MAC addresses, Routing protocols – Energy – efficient routing, Geographic routing.

| UNIT - IV | INFRASTRUCTURE ESTABLISHMENT | (9) |
|---|---|---|

Topology control, Clustering, Time synchronization, Localization and localization services, Sensor tasking and control – Information based joint routing and information aggregation.

| UNIT - V | SENSOR NETWORK PLATFORMS AND TOOLS | (9) |
|---|---|---|

Operating systems for wireless sensor networks, Sensor node hardware – Berkeley motes, Programming challenges, Node- level software platforms, Node – level simulators, State-centric programming.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Identify the Challenges and technologies of wireless sensor networks. | **Understand** |
| **CO2** | Design WSN architectures based on its principles and operating systems for simulating environment situations | **Apply** |
| **CO3** | Examine the various concepts for assignment of MAC addresses. | **Apply** |
| **CO4** | Choose the appropriate infrastructure, topology, joint routing and information aggregation for wireless sensor networks | **Apply** |
| **CO5** | Analyze the sensor network platform and tools state-centric programming. | **Analyze** |

**REFERENCES:**


1 Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2011.

2 Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks – An Information Processing Approach", Elsevier, Reprint 2012.

3 KazemSohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks -Technology, Protocols, and Applications", John Wiley, Reprint 2012.

4 Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks - Theory And Practice", John Wiley & Sons Publications, 2011.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E05 | MICROSTRIP PATCH ANTENNA DESIGN | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a solid understanding of electromagnetics, including wave propagation and basic antenna theory. Knowledge of circuit theory, including impedance matching and electronic components, is also essential. Familiarity with signal processing concepts, such as frequency analysis, will help in evaluating antenna performance. Additionally, a good grasp of mathematical principles, including algebra and calculus, is necessary for effective problem-solving and design analysis in antenna systems.

**OBJECTIVES:**

- To develop the students to design patch antenna, feeding techniques and Learn different types of patch antennas with their specific applications.
- To make the students to Gain insight into broadband microstrip antennas by examining how substrate parameters affect bandwidth and design advanced antennas with tunable and dual-frequency capabilities.
- To equip the students to perform various design strategies for planar multiresonators and compact broadband microstrip antennas.
- To explore different polarization techniques including linear, elliptical and circular polarization.
- To develop skills in designing and analyzing microstrip antenna arrays.

| UNIT - I | BASICS OF MICROSTRIP PATCH ANTENNA | (9) |
|---|---|---|

Introduction – Radiation mechanism of micro strip antenna – Feeding techniques – Printed slot antennas - Design considerations of rectangular patch – Substrate selection – Radiation pattern and radiation resistance – Characteristics of patch antennas – Circular disc and ring antennas.

| UNIT - II | BROADBAND MICROSTRIP ANTENNAS | (9) |
|---|---|---|

Introduction – Effects on substrate parameters on Bandwidth – Selection of feeding techniques – Multimoding techniques – Tunable and dual frequency microstrip antennas – Broadband circularly polarized microstrip antennas.

| UNIT - III | PLANAR MULTIRESONATORS AND COMPACT BROADBAND MICROSTRIP ANTENNAS | (9) |
|---|---|---|

Introduction – Mechanism of parasitic coupling – Gap coupled MSA – radiating and non-radiating edge coupled MSAs – Compact shorted RMSAs – slot loaded RMSAs – U slot RMSAs.

| UNIT - IV | CIRCULARLY POLARIZED MICROSTRIP ANTENNAS AND TECHNIQUES | (9) |
|---|---|---|

Introduction – Linear elliptical and circularly polarized antennas – Dual feed circularly polarized antennas - various types of circularly polarized microstrip antennas – Design Procedure for Single-Feed Circularly Polarized MSAs - Bandwidth enhancement techniques.

| UNIT - V | DESIGN AND ANALYSIS OF MICROSTRIP ANTENNA ARRAYS | (9) |
|---|---|---|

Parallel and series feed systems – Mutual coupling – design of linear arrays – Design of planar arrays – Monolithic integrated phased arrays and its design considerations

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Design various types of microstrip patch antennas, including rectangular, circular, and ring patches, tailored to specific applications. | **Apply** |
| **CO2** | Analyze how substrate parameters impact the bandwidth of microstrip antennas and design advanced broadband antennas with tunable and dual-frequency capabilities. | **Analyze** |
| **CO3** | Perform various design strategies for planar multiresonators and compact broadband microstrip antennas. | **Apply** |
| **CO4** | Implement different polarization techniques, including linear, elliptical, and circular polarization. | **Apply** |
| **CO5** | Design and analyze microstrip antenna arrays, including linear and planar configurations. | **Analyze** |

**REFERENCES:**


1. J.R James & P.S.Hall, Handbook of Microstrip Antennas, IEEE Electromagnetic Waves Series, First Edition, 1989.
2. Ramesh Garg and Prakash Bhartia, Microstrip Antenna Design Hand Book, Artech house, First Edition, 2001.
3. G.Kumar and K.P.Ray, Broad band Microstrip Antennas, Artech house, Fist Edition, 2003.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E06 | COMMUNICATION PROTOCOL ENGINEERING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

To engage in Communication Protocol Engineering, students need a basic knowledge in networking concepts, such as the OSI model, TCP/IP model, network topologies, routing, switching, and addressing.

**OBJECTIVES:**

- To model networks for the communication Protocol engineering process
- To be exposed to Protocol specifications
- To explore knowledge on verification and validation process
- To be aware of performance testing
- To understand the synthesis and implementation of the Protocols

| UNIT - I | NETWORK REFERENCE MODEL | (9) |
|---|---|---|

Communication model-software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model layer Functions , TCP/IP protocol suite, Application Protocols.

| UNIT - II | PROTOCOL SPECIFICATIONS | (9) |
|---|---|---|

Components of protocol, Specifications of communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol other protocol specification languages.

| UNIT- III | PROTOCOL VERIFICATION / VALIDATION | (9) |
|---|---|---|

Protocol verification, Verification of a protocol using finite state machines,, Protocol validation, Protocol design errors, Protocol validation approaches, SDL based protocol verification: ABP Verification and ABP validation.

| UNIT-IV | PROTOCOL CONFORMANCE / PERFORMANCE TESTING | (9) |
|---|---|---|

Conformance testing methodology and framework, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controllable interfaces- RIP, SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, Scalability testing.

| UNIT-V | PROTOCOL SYNTHESIS AND IMPLEMENTATION | (9) |
|---|---|---|

Synthesis methods, Interactive Synthesis Algorithm, Automatic Synthesis Algorithm, Automatic Synthesis of SDL from MSC, Protocol Re-synthesis, Requirements of Protocol Implementation, Objects Based Approach To Protocol Implementation, Protocol Compilers, Code generation from Estelle, LOTOS, SDL and CVOPS.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Understand and articulate the layered architecture of communication systems and the protocols associated with each layer. | **Understand** |
| **CO2** | Identify and explain various types of communication protocols used in networking. | **Understand** |
| **CO3** | Analyze and evaluate the protocols used in specific applications, understanding their impact on performance and functionality. | **Analyze** |
| **CO4** | Develop and implement a methodology for performance testing of communication protocols. | **Apply** |
| **CO5** | Apply various protocol synthesis techniques to design and optimize communication networks. | **Apply** |

**REFERENCES:**


1. Pallapa Venkataram, Sunilkumar S.Manvi, and B.sathish Babu, "Communication protocol Engineering", PHI Learning Private Limited, Second Edition, 2014.
2. Drago Hercog, "Communication Protocols Principles, Methods and Specifications", Springer, First Edition 2020.
3. Richard Lai, Ajin Jirachiefpattana, "Communication Protocol Specification and Verification" Springer - Verlag New York Inc.; Softcover reprint of the original First Edition, 2013.
4. Hartmut Konig, "Protocol Engineering", Springer Heidelberg New York Dordrecht London, First Edition, 2012.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 3 | - |
| **CO2** | 3 | 1 | 3 | 3 | - |
| **CO3** | 3 | 1 | 3 | 3 | - |
| **CO4** | 3 | 1 | 3 | 3 | - |
| **CO5** | 3 | 1 | 3 | 3 | - |
| **Avg.** | **3** | **1** | **3** | **3** | **-** |

<table>
<tr><td rowspan="2">CU24E07</td><td rowspan="2">SIGNAL INTEGRITY FOR HIGH SPEED DESIGN</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE:**

Student should have fundamental concepts in Basic Electrical systems, Transmission Line Theory, Signal Waveform Analysis, PCB Design Fundamentals, Electromagnetic Compatibility (EMC), Power Integrity, High-Speed Signal Modeling and Simulation, Termination Techniques, Signal Integrity Testing and Design for Manufacturability.

**OBJECTIVES:**

- To make the students to understand the principles of signal propagation on transmission lines.
- To provide the insights in to apply the principles of multi-conductor transmission lines.
- To identify and address non-ideal effects in signal transmission.
- To propose and optimize power delivery systems and manage power considerations in electronic circuits.
- To implement effective clock distribution techniques and oscillators.

| UNIT - I | SIGNAL PROPAGATION ON TRANSMISSION LINES | (9) |
|---|---|---|

Basics charge, energy, Time and distance- Circuit boards and debugging- Gates packaging and boards properties- Circuit elements resistance, Capacitance and inductance- Ground bounce and ringing- Distributed analysis transmission lines Zo reflections and termination.

| UNIT - II | MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK | (9) |
|---|---|---|

Multi-conductor transmission lines, Coupling physics, Per unit length parameters, Near and far-end cross-talk, Minimizing cross-talk (stripline and microstrip), Differential signaling, Termination, balanced circuits, S-parameters, Lossy and lossless models.

| UNIT - III | NON-IDEAL EFFECTS | (9) |
|---|---|---|

Non-ideal signal return paths, gaps, BGA fields via transitions, Parasitic inductance and capacitance, Transmission line losses- Rs, tanδ, Routing parasitic, Common-mode current, Differential-mode current, Connectors.

| UNIT - IV | POWER CONSIDERATIONS AND SYSTEM DESIGN | (9) |
|---|---|---|

SSN/SSO, DC power bus design, Layer stack up, SMT decoupling, Logic families, Power consumption, and system power delivery, Logic families and speed, Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, Jitter, Inter-symbol interference bit-error rate, Timing analysis.

| UNIT - V | CLOCK DISTRIBUTION AND CLOCK OSCILLATORS | (9) |
|---|---|---|

Timing margin, Clock slew, Low impedance drivers, Terminations, Delay Adjustments, Canceling parasitic capacitance, Clock jitter.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the source of circuit board and transmission line properties. | **Understand** |
| **CO2** | Propose and minimize cross-talk in multi-conductor transmission lines. | **Apply** |
| **CO3** | Diagnose and mitigate non-ideal effects such as parasitic inductance and capacitance and transmission line losses. | **Analyze** |
| **CO4** | Design effective DC power systems and analyze power consumption. | **Apply** |
| **CO5** | Design and optimize clock distribution networks. | **Apply** |

**REFERENCES:**


1. Samuel H. Russ, Signal Integrity: Applied Electromagnetics and Professional Practice, Springer Nature AG, Second Edition 2022.
2. Howard W. Johnson and Martin Graham, High-Speed Digital Design: A Handbook of Black Magic, Publisher: Pearson, First Edition, 1993.
3. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, First Edition, 2012.
4. Stephen H. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley; First Edition. 2014.
5. Eric Bogatin, Signal Integrity - Simplified (Prentice Hall Modern Semiconductor Design Series) Prentice Hall, Second Edition, 2009.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 2 | 3 | 2 |
| **Avg.** | **3** | **2** | **2** | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CU24E08** | **PATTERN RECOGNITION AND MACHINE LEARNING** | **Category** | **L** | **T** | **P** | **C** |
| | | **PEC** | **3** | **0** | **0** | **3** |

**PREREQUISITE:**

A solid understanding of mathematics, including linear algebra, calculus, and probability, along with statistical knowledge. Proficiency in programming languages like Python is essential for implementing algorithms and handling data. Additionally, familiarity with fundamental algorithms and basic machine learning concepts.

**OBJECTIVES:**

- To make the students to understand the fundamental concepts, problem domains, and methodologies of pattern recognition.
- To equip the students with linear models for regression and classification.
- To explore neural networks, including perceptron's, multi-layer perceptron's and back propagation neural networks
- To develop the skills in linear discriminant functions and their application in creating decision surfaces for both binary and multi-class classification.
- To investigate algorithm-independent machine learning techniques and clustering methods.

| | | |
|---|---|---|
| **UNIT - I** | **INTRODUCTION TO PATTERN RECOGNITION** | **(9)** |

Problems, applications, design cycle, learning and adaptation, examples, Probability distributions, Parametric learning, Maximum likelihood and Bayesian decision theory, Bayes rule, discriminant functions, loss functions and Bayesian error analysis

| | | |
|---|---|---|
| **UNIT - II** | **LINEAR MODELS** | **(9)** |

Linear models for regression, linear regression, logistic regression, Linear models for classification.

| | | |
|---|---|---|
| **UNIT - III** | **NEURAL NETWORK** | **(9)** |

Perceptron, multi-layer perceptron, back propagation algorithm, error surfaces, practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep learning.

| | | |
|---|---|---|
| **UNIT - IV** | **LINEAR DISCRIMINANT FUNCTIONS** | **(9)** |

Decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine.

| | | |
|---|---|---|
| **UNIT - V** | **ALGORITHM INDEPENDENT MACHINE LEARNING AND UNSUPERVISED LEARNING AND CLUSTERING** | **(9)** |

Lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers, k- means clustering, fuzzy k-means clustering, hierarchical clustering.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the basics and methodologies of pattern recognition. | **Understand** |
| **CO2** | Design the various types of linear models involved in pattern classification. | **Apply** |
| **CO3** | Explore the neural network architectures for complex pattern recognition. | **Apply** |
| **CO4** | Implement the decision boundaries for classification using optimization techniques. | **Apply** |
| **CO5** | Evaluate the classifier performance and clustering methods for data analysis. | **Analyze** |

**REFERENCES:**


1 Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons, Second Edition, 2007.

2 Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, The Elements of Statistical Learning, Springer, Second Edition, 2009.

3 C. Bishop, Pattern Recognition and Machine Learning, Springer, First Edition, 2009.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

| CU24E09 | MIMO SYSTEMS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a solid understanding of mathematics including linear algebra, probability & statistics and calculus. Knowledge of fourier and laplace transforms, convolution, and filtering is also essential. Familiarity with signal processing concepts, such as frequency analysis. Additionally, some knowledge of electromagnetic and antenna theory can be beneficial, particularly in understanding antenna characteristics and wave propagation which are relevant in MIMO systems.

**OBJECTIVES:**

- To develop the students to design patch antenna, feeding techniques and Learn different types of patch antennas with their specific applications.
- To explore the different equalization techniques and functions are involved in MIMO systems.
- To make the students to gain insight into beamforming techniques to cancel interference in MIMO.
- To equip the students to study different channel model implicated in MIMO systems.
- To build up skills in designing and analyzing channel estimation techniques in MIMO.

| UNIT - I | OVERVIEW OF MIMO | (9) |
|---|---|---|

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.

| UNIT - II | MIMO FUNCTIONS AND EQUALIZATION TECHNIQUES | (9) |
|---|---|---|

The generic MIMO problem, Singular Value Decomposition, Eigen values and Eigen vectors, Equalising MIMO systems, Disadvantages of equalizing MIMO systems, Pre distortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of pre coding and combining, Channel state information.

| UNIT - III | BEAMFORMING TECHNIQUES IN MIMO | (9) |
|---|---|---|

Codebooks for MIMO, Beam forming, Beam forming principles, Increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrow band beam former, Wideband beam former.

| UNIT - IV | MIMO CHANNEL MODEL AND CODE WORDS | (9) |
|---|---|---|

Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beam forming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models.

| UNIT - V | MIMO ESTIMATION TECHNIQUES | (9) |
|---|---|---|

Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Proficient in describing and analyzing channel models and diversity techniques involved in MIMO systems. | **Apply** |
| **CO2** | Evaluate various equalization techniques involved in MIMO systems. | **Analyze** |
| **CO3** | Implement beamforming strategies to manage and mitigate interference in MIMO system environments. | **Apply** |
| **CO4** | Design and implement code words that are tailored to the specific characteristics of MIMO channels. | **Apply** |
| **CO5** | Construct the various estimation techniques in MIMO systems. | **Apply** |

**REFERENCES:**

1 Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design", Academic Press, First Edition, 2010.

2 Mohinder Janakiraman, "Space - Time Codes and MIMO Systems", Artech House Publishers, First Edition, 2004.

3 N. Costa and S. Haykin, "Multiple-input multiple-output channel models", John Wiley & Sons, First Edition, 2010.

4 T. M. Duman and A. Ghrayeb, "Coding for MIMO communication systems", John Wiley and Sons, First Edition, 2007.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E10 | ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE**

Students should have a solid foundation in basic mathematics and statistics, including proficiency in calculus, linear algebra, and probability/statistics which is essential for understanding signal processing, error analysis and system design. Further understanding of electronic circuits, analog and digital communication systems, modulation methods, and signal processing in the fields of electronics and communication theory is essential. In addition, understanding of electromagnetic wave propagation, antenna theory, and radio frequency (RF) principles is crucial for satellite communication.

**OBJECTIVES:**

- To explore link budget calculation in satellite communication and orbital mechanics particularly with respect to link budget parameters.
- To examine the insight knowledge on how Internet of Things (IoT) & Machine-to-Machine (M2M) communication technologies integrate and impact modern communication systems and their satellite applications
- To make use of IPv6 environment to design and integrate satellite network.
- To equip the students with a thorough understanding of satellite navigation and .
- To identify key the components & subsystems involved in the design, functionality and operation of planetary exploration missions.

| UNIT - I | OVERVIEW OF SATELLITE COMMUNICATION | (9) |
|---|---|---|

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

| UNIT - II | M2M DEVELOPMENTS AND SATELLITE APPLICATIONS | (9) |
|---|---|---|

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators-Ultra HD Video/TV and Satellite Implications-High Throughput Satellites (HTS) and Ka/Ku Spot Beam Technologies-Aeronautical, Maritime and other Mobility Services.

| UNIT - III | SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT | (9) |
|---|---|---|

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence-- Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 – Impact of IPv6 on Satellite Network architecture and services Detailed transitional plan- IPv6 demonstration over satellites - Key results and recommendations.

| UNIT - IV | SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM | (9) |
|---|---|---|

Overview of Radio and Satellite Navigation, GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data , GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS and Galileo

| UNIT - V | DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS | (9) |
|---|---|---|

Introduction – Functional description - Design procedure and performance criterion-Mars exploration Rover- Mission and spacecraft summary-Telecommunication subsystem overview Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and spacecraft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance. Mangalyaan Mission - Mission and spacecraft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Investigate the link budget parameters which are essential for satellite link design. | **Apply** |
| **CO2** | Analyze the characteristics and requirements of IoT/M2M technologies in satellite applications. | **Analyze** |
| **CO3** | Build satellite network in IPv6 environment. | **Apply** |
| **CO4** | Describe satellites for navigation and global positioning system. | **Understand** |
| **CO5** | Interpret deep space networks and inter planetary missions. | **Apply** |

**REFERENCES:**


1. Anil K. Maini, Varsha Agrawal, Satellite Technology: Principles and Applications, Wiley Publication, New Jersey, Third Edition, 2014.
2. Daniel Minoli, Innovations in Satellite Communication and Satellite Technology, Wiley Publication, New Jersey, First Edition, 2015
3. Daniel Minoli,Satellite Systems Engineering in an IPv6 Environment, CRC Press, Florida , 2009.
4. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, Global Navigational Satellite Systems, Springer-Verlag, First Edition, 2008.
5. Jim Taylor, Deep Space Communications, John Wiley & Sons, New Jersey, First Edition, 2016.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | **3** | **-** | **3** | **3** | **-** |

| CU24E11 | MACHINE LEARNING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a solid background in mathematics, particularly linear algebra, calculus, and probability. Familiarity with statistical concepts for model evaluation and a working knowledge of programming, especially in languages like Python or R, are also essential. Additionally, a grasp of basic algorithms and data structures will aid in implementing machine learning models, and prior knowledge of introductory machine learning concepts will help in tackling more advanced topics.

**OBJECTIVES:**

- To provide students with a solid understanding of the fundamental concepts and principles of machine learning, and different types of Machine learning.
- To introduce a wide range of machine learning algorithms, such as linear regression, decision trees, support vector machines and clustering algorithms to understand their theoretical underpinnings.
- To ensure that students can understand and can implement the backpropagation algorithm, which is essential for training MLPs, and to understand the mathematical derivation behind it.
- To provide students with a solid foundation in the principles and structure of probabilistic graphical models, including Bayesian networks and Markov random fields.
- To enable students to apply reinforcement learning techniques to real-world problems in various domains, such as robotics, game playing, autonomous systems, and finance.

| UNIT - I | FUNDAMENTALS OF MACHINE LEARNING | (9) |
|---|---|---|

Machine Learning–Types of Machine Learning: Supervise d Learning, Unsupervised Learning –Machine Learning process- Testing machine learning algorithms - Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance.

| UNIT - II | SUPERVISED LEARNING METHODS | (9) |
|---|---|---|

Regression: Linear Regression - Least Squares - Under fitting and Overfitting – Cross Validation - Logistic Regression; Classification: Linear and Non-linear models - Support Vector Machines - Kernel Methods; K-Nearest Neighbours, Decision Tree - Classification and regression trees (CART); Ensemble Methods - Bagging - Boosting - Random Forest, Evaluation of Classification Algorithms.

| UNIT - III | MULTILAYER PERCEPTRON | (9) |
|---|---|---|

Introduction - The Perceptron - Training a Perceptron - Learning Boolean Functions - Multilayer Perceptrons - MLP as a Universal Approximator - Backpropagation Algorithm - Training Procedures - Tuning the Network Size - Dimensionality Reduction - Learning Time.

| UNIT - IV | PROBABILISTIC GRAPHICAL MODELS AND EVOLUTIONARY LEARNING | (9) |
|---|---|---|

Graphical Models – Undirected Graphical Models: Markov Random Fields – Directed Graphical Models: Bayesian Networks – Conditional Independence properties – Markov Random Fields, Evolutionary Learning: The Genetic Algorithm.

| UNIT - V | REINFORCEMENT LEARNING | (9) |
|---|---|---|

Introduction - Single State Case - Elements of Reinforcement Learning - Model-Based Learning - Temporal Difference Learning - Generalization - Partially Observable States

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Explain the basic concepts of machine learning | **Understand** |
| **CO2** | Describe linear and non-linear techniques for classification problems | **Understand** |
| **CO3** | Apply neural networks to solve real world problems | **Applying** |
| **CO4** | Develop importance of neural networks in machine learning | **Applying** |
| **CO5** | Summarize the concepts of reinforcement learning. | **Understand** |

**REFERENCES:**


1. Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning series)", The MIT Press, Cambridge, Fourth Edition, 2020.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition, 2015.
3. Tom M Mitchell, "Machine Learning", McGraw-Hill Education Private Limited, India, First Edition, 2017.
4. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, Second Edition, 2011.
5. Kevin Murphy, "Machine Learning: An Probabilistic Perspective", MIT Press, Cambridge, First Edition, 2012.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | - | - | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | - | 2 | 3 | 2 |
| **Avg.** | **3** | **1.6** | **1.6** | **2.4** | **2** |

<table>
<tr><td rowspan="2">CU24E12</td><td rowspan="2">COMMUNICATION NETWORK SECURITY</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE:**

**S**tudents should have a solid foundation in computer science principles, including data structures and algorithms. They should also understand basic networking concepts such as IP addressing and protocols. Familiarity with mathematical concepts used in cryptography, like modular arithmetic, is essential. Proficiency in at least one programming language is needed for implementing security measures, and a basic understanding of operating systems is important.

**OBJECTIVES:**

- To explore techniques such as cryptography and steganography, and review necessary mathematical concepts for cryptography.
- To develop the students to implement substitution and transposition ciphers, stream and block ciphers, and key algorithms including DES, AES, RC4, and RSA.
- To make the students to apply the hash functions, digital signatures, authentication methods, biometrics and key management techniques.
- To explore firewall types and configurations, IP security architecture, web security requirements, and protocols such as SSL/TLS and SET.
- To analyze security issues in wireless networks, including attacks and defenses for Wi-Fi and 4G networks, and secure ad-hoc and sensor networks.

| **UNIT - I** | **INTRODUCTION ON SECURITY** | **(9)** |
|---|---|---|

Security goals, Types of attacks: Passive attack, Active attack, Attacks on confidentiality, Attacks on Integrity and Availability. Security services and mechanisms, Techniques: Cryptography, Steganography, Revision on Mathematics for cryptography.

| **UNIT - II** | **SYMMETRIC & ASYMMETRIC KEY ALGORITHMS** | **(9)** |
|---|---|---|

Substitution Ciphers, Transposition ciphers, Stream and block ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, Principle of asymmetric key algorithms, RSA cryptosystem.

| **UNIT - III** | **INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT** | **(9)** |
|---|---|---|

Message integrity, Hash functions: SHA, Digital signatures: Digital signature standards. Authentication: Entity authentication, Biometrics, Key management techniques.

| **UNIT - IV** | **NETWORK SECURITY, FIREWALLS AND WEB SECURITY** | **(9)** |
|---|---|---|

Introduction on firewalls, Types of firewalls, Firewall configuration and Limitation of firewall. IP security overview, IP security architecture, Authentication header, Security pay load, Security associations, Key management. Web security requirement, Secure sockets layer, Transport layer security, Secure electronic transaction, Dual signature.

| **UNIT - V** | **WIRELESS NETWORK SECURITY** | **(9)** |
|---|---|---|

Security attack issues specific to wireless systems: Wormhole, Tunneling, DoS, WEP for Wi-Fi network, Security for 4G networks: Secure adhoc network, Secure sensor network.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Apply cryptography and steganography techniques and understand mathematical foundations. | **Apply** |
| **CO2** | Implement and evaluate symmetric and asymmetric key algorithms, including DES, AES, RC4, and RSA for securing data. | **Analyze** |
| **CO3** | Apply hash functions and digital signatures for message integrity and authentication. Utilize key management techniques for secure communication. | **Apply** |
| **CO4** | Configure and evaluate firewalls, understand IP security components, and implement web security protocols like SSL/TLS. | **Apply** |
| **CO5** | Identify and mitigate security threats specific to wireless networks, including WEP, and secure 4G, ad-hoc, and sensor networks. | **Apply** |

**REFERENCES:**


1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network security", Tata McGraw Hill, Third Edition, 2015.
2. William Stallings, "Cryptography and Network security: Principles and Practice", Pearson Education, Seventh Edition, 2018.
3. Atul Kahate, "Cryptography and Network security", Tata Mc-Graw Hill, Fourth Edition, 2019.
4. Lidong Zhou; Z.J. Haas, "Securing Ad Hoc Networks", IEEE Network Magazine, Vol.13, No. 6, pp 24-30, December , 1999.
5. H. Yang, Fan Ye, Songwu Lu, "Security in Mobile Ad Hoc Networks: Challenges and Solution", IEEE Wireless Communications, Vol.11, No.1, pp38- 47, March 2004.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

| CU24E13 | RF MEMS FOR WIRELESS COMMUNICATION | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a foundational understanding of electronics and circuit theory, including basic component functions and circuit analysis. They should also be familiar with electromagnetic theory, covering wave propagation and transmission lines. Knowledge of microwave engineering principles, such as S-parameters and resonators, is important. Additionally, students need a grasp of signal processing techniques for analyzing and manipulating signals, as well as an introductory understanding of MEMS technology, including basic fabrication processes and components.

**OBJECTIVES:**

- To provide insights to design and evaluate transceiver systems across various platforms.
- To explore physical and practical aspects of RF circuit design, including impedance mismatch and packaging considerations.
- To disseminate the design principles and operations of MEMS switches, capacitors, inductors, and their applications in RF circuits.
- To make students to examine and design MEMS-based reconfigurable circuits, resonators and switchable RF front ends.
- To equip the students to develop phase shifters, FBAR filters and micro-machined or reconfigurable antennas for various RF applications.

| UNIT - I | WIRELESS TRANSCEIVER ARCHITECTURES | (9) |
|---|---|---|

Introduction Spheres of wireless activities - The home and office -The ground fixed/mobile platform - The space platform - Wireless standards - Systems and architectures, wireless standards, conceptual wireless systems, wireless transceiver architectures, power and bandwidth-efficient wireless systems & challenges, MEMS based wireless appliances enable ubiquitous connectivity. Physical aspects of RF circuit design, skin effect, transmission lines on thin substrates, self- resonance frequency, quality factor packaging, practical aspects of RF circuit design, dc biasing, and impedance mismatch effect in RF MEMS

| UNIT - II | MEM SWITCHES AND ITS APPLICATIONS | (9) |
|---|---|---|

Enabled circuit elements and models - RF/Microwave substrate properties - Micro machined enhanced elements - Capacitors, inductors, varactors - MEM switches - Shunt MEM switch - Low voltage hinged MEM switch approaches - Push-pull series switch - Folded beam springs suspension series switch - Resonators - Transmission line planar resonators, cavity resonators - Micromechanical resonators - Film bulk acoustic wave resonators - MEMS modeling - Mechanical modeling, electromagnetic modeling.

| UNIT - III | RF APPLICATIONS OF MEMS | (9) |
|---|---|---|

Enabled circuits - Reconfigurable circuits - The resonant MEMS switch – Capacitors – Inductors - Tunable CPW resonator- MEMS microswitch arrays - Reconfigurable circuits - Double - Stub tuner, Nth – stub tuner, filters, resonator tuning system-Massively parallel switchable RF front ends -True time-delay digital phase shifters.

| UNIT - IV | PHASE SHIFTERS & FILTERS | (9) |
|---|---|---|

Phase shifters –Fundamentals - X-Band RF MEMS phase shifter for phased array applications - Ka- Band RF MEMS Phase shifter for radar systems applications - Film bulk acoustic wave filters – FBAR filter fundamentals, FBAR filter for PCS applications.

| UNIT - V | RF MEMS ANTENNA | (9) |
|---|---|---|

Micro machined antenna - Micro electro mechanical system antennas - Reconfigurable Antennas - Tunable dipole antennas - Tunable microstrip patch - Array antenna. Integrates antenna selection - Photonic band gap antennas.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Design and assess wireless transceiver systems tailored for different platforms and apply appropriate wireless standards to optimize system performance. | **Apply** |
| **CO2** | Design and analyze RF circuits, impedance matching circuits, packaging, and the effects of physical phenomena like skin effect. | **Analyze** |
| **CO3** | Designing and implementing MEMS-based components and integrating them into RF circuits to meet specific application needs. | **Apply** |
| **CO4** | Designing MEMS-based reconfigurable circuits, including resonators and switchable RF front ends. | **Apply** |
| **CO5** | Design and implement phase shifters, FBAR filters and advanced antennas for a variety of RF applications. | **Apply** |

**REFERENCES:**


1. Hector J. De Los Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House, First Edition, 2002.
2. Vijay K.Varadan, K.J. Vinoy, K.A. Jose., "RF MEMS and their Applications", John Wiley and sons, LTD, First Edition, 2002.
3. Gabriel M. Rebeiz, "RF MEMS Theory, Design & Technology", Wiley Inter science, First Edition, 2002.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

| CU24E14 | MULTIMEDIA COMPRESSION TECHNIQUES | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have basic concepts in general data compression principles, encompassing both lossless and lossy methods, is also essential for understanding specific multimedia compression techniques. Proficiency in mathematics, particularly linear algebra, probability, and statistics, as well as a basic understanding of algorithms and data structures, is crucial as many compression methods rely on these principles. Additionally, familiarity with signal processing concepts, such as Fourier transforms and filtering, is important for understanding data transformation and compression.

**OBJECTIVES:**

- To gain a foundational understanding of the principles and need for multimedia compression.
- To explore various multimedia compression algorithms and standards used for text compression.
- To make the students to gain insight into different audio compression standards.
- To build up skills in designing image compression techniques.
- To investigate different techniques involved in video compression.

| UNIT - I | INTRODUCTION | (9) |
|---|---|---|

Special features of multimedia, Graphics and image data representations – Fundamental concepts in text, images, graphics, video and digital audio – Storage requirements for multimedia applications – Need for compression – Lossy & Lossless compression techniques – Overview of source coding, information theory & source models– Kraft McMillan in equality.

| UNIT - II | TEXT COMPRESSION | (9) |
|---|---|---|

Compaction techniques – Run length coding – Huffmann coding–Adaptive Huffmann coding – Arithmetic coding – Shanon-fano coding- Dictionary techniques – LZW family algorithms.

| UNIT - III | AUDIO COMPRESSION | (9) |
|---|---|---|

Audio compression techniques – μLaw and A-Law companding frequency domain and filtering– Basic sub–band coding – Application to speech coding – G.722 – Application to audio coding – MPEG audio, Progressive encoding for audio – Silence compression, speech compression techniques – Formant and CELP vocoders.

| UNIT - IV | IMAGE COMPRESSION | (9) |
|---|---|---|

Contour based compression – Transform coding – JPEG standard – Sub-band coding algorithms: Design of filter banks–Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards, JBIG, JBIG2 standards.

| UNIT - V | VIDEO COMPRESSION | (9) |
|---|---|---|

Video compression techniques and standards – MPEG Video coding: MPEG–1 and 2 – MPEG Video coding II : MPEG– 4 and 7– Motion estimation and compensation techniques – H.261standard – DVI technology – DVI real-time compression - Packet video.

**Total (L: 45) = 45 PERIODS**

## COURSE OUTCOMES:

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Exhibit the special features, principles and need for multimedia compression. | **Understand** |
| **CO2** | Construct different multimedia coding techniques for text compression. | **Analyze** |
| **CO3** | Design the different audio compression techniques to compress audio signals. | **Apply** |
| **CO4** | Apply the knowledge to compress the image signals using various image compression standards. | **Apply** |
| **CO5** | Apply the various standards involved in compress the video signals. | **Apply** |

## REFERENCES:

1 Khalid Sayood, "Introduction to Data Compression", Morgan Kauffman Harcourt, Fourth edition, 2012.

2 Mark S.Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, First edition, 2003.

3 David Salomon, "Data Compression–The Complete Reference", Springer Verlag, Second edition, 2001.

4 Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering–Fundamentals Algorithms & Standards", CRC press, Third edition, 2019.

5 Peter Symes, "Digital Video Compression", McGraw Hill Publications, First edition, 2004.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

| CU24E15 | HIGH PERFORMANCE COMPUTER NETWORKS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

Students should have a foundational understanding of basic networking concepts, including the OSI and TCP/IP models. Familiarity with network protocols, switching, routing, and multimedia streaming principles is essential. Knowledge of fundamental security concepts, including cryptography and access control, is also required. Basic skills in traffic modeling and network performance evaluation will be beneficial. Additionally, practical experience with network configuration and management tools is recommended.

**OBJECTIVES:**

- To provide insights in to Key network protocols and architectures, including OSI and TCP/IP models and various technologies such as SONET, DSL, and ATM.
- To explore multimedia networking applications, focusing on streaming audio and video, best-effort and real-time services, and protocols like RSVP.
- To delve into advanced networking technologies such as VPNs, MPLS, and overlay networks.
- To make the students to apply traffic modeling techniques, including Little's theorem and Poisson versus non-Poisson models, and to evaluate network performance.
- To develop the students to implement network security, including cryptography, authentication, access control, and management frameworks.

| UNIT - I | INTRODUCTION | (9) |
|---|---|---|

Review of OSI,TCP/IP: Multiplexing, modes of communication, switching, routing, SONET,DWD, DSL,ISDN,BISDN, ATM

| UNIT - II | MULTIMEDIA NETWORKING APPLICATIONS | (9) |
|---|---|---|

Streaming stored audio and video, Best effort service, Protocols for real time interactive applications, Beyond best effort, Scheduling and policing mechanism, Integrated services, RSVP, Differentiated services.

| UNIT - III | ADVANCED NETWORKS CONCEPTS | (9) |
|---|---|---|

VPN, Remote - Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN, MPLS Operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, Overlay Networks - P2P Connections.

| UNIT - IV | TRAFFIC MODELLING | (9) |
|---|---|---|

Little's theorem, Need for modeling, Poisson modeling and its failure, Non- Poisson models, Network performance evaluation.

| UNIT - V | NETWORK SECURITY AND MANAGEMENT | (9) |
|---|---|---|

Principles of cryptography, Authentication, Integrity, Key distribution and certification, Access control and fire walls, Attacks and counter measures, Security in many layers, Infrastructure for network management, The internet standard management framework, SMI, MIB, SNMP, Security and administration, ASN.1.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Explain key network protocols and technologies, and describe their functions and interrelationships within OSI and TCP/IP models. | **Understand** |
| **CO2** | To manage multimedia data streams, optimizing network performance for real-time applications, and implementing protocols for improved service quality. | **Apply** |
| **CO3** | Design and implement VPN solutions, understand MPLS operations for efficient routing and traffic engineering, and manage overlay networks for enhanced connectivity. | **Apply** |
| **CO4** | Apply traffic modeling techniques to evaluate network performance, use Little's theorem to analyze network behavior, and identify the limitations of various modeling approaches. | **Apply** |
| **CO5** | Implement network security measures, manage network infrastructure using standard management frameworks, and address security threats with appropriate countermeasures. | **Apply** |

**REFERENCES:**


1. J.F.Kurose & K.W.Ross, "Computer Networking – A top down approach featuring the internet", Pearson, Third edition, Ninth impression 2011.
2. Walrand. J.Varatya, Morgan Kauffman, "High Performance Communication Network", Harcourt Asia Pvt. Ltd. Second Edition, Reprint 2011.
3. Aunurag kumar.D, Anjunath. M,JoyKuri, "Communication Networking", Morgan Kaufmann Publishers, First edition, Reprint 2012.
4. Hersent Gurle & Petit, IP Telephony, "Packet Pored Multimedia Communication Systems", Pearson Education, Reprint 2011.
5. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", Fifth Edition, Pearson education, Reprint 2012.


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 3 | - |
| **CO2** | 3 | - | - | 3 | - |
| **CO3** | 3 | - | - | 3 | - |
| **CO4** | 3 | - | - | 3 | - |
| **CO5** | 3 | - | - | 3 | - |
| **Avg.** | 3 | - | - | 3 | - |

| **CU24E16** | **VOICE AND DATA NETWORKS** | **Category** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|---|
| | | **PEC** | **3** | **0** | **0** | **3** |

**PREREQUISITE:**

Students should have a solid understanding of basic discrete mathematics, including concepts of sets, relations, functions, and graphs are essential for understanding network topologies. In addition, a fundamental understanding of digital signal processing techniques such as sampling, quantization, and modulation techniques helps understand data transmission over physical media and also Probability and Statistics are essential for understanding queuing models, performance metrics, and multiple access protocols.

**OBJECTIVES:**

- To make the students to comprehend the terms and concepts used in network design and operation.
- To provide the knowledge on designing data link layer and protocols.
- To equip the students to perform various concepts of queuing and its role in analyzing network performance.
- To enhance knowledge about the key concepts and issues related to inter-networking, including the global Internet, IP addressing, routing and end-to-end protocols.
- To make the students gain insight into the key concepts and issues related to congestion avoidance, quality of service (QoS) in packet networks and packet scheduling algorithms.

| **UNIT - I** | **NETWORK BASICS AND SWITCHING** | **(9)** |
|---|---|---|

Network Design Issues, Network Performance Issues, and Network Terminology, centralized and distributed approaches for network design and Issues in the design of voice and data networks. Layered and Layer less Communication, Cross-layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, and Statistical Multiplexing.

| **UNIT - II** | **DATA LINK LAYER** | **(9)** |
|---|---|---|

Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

| **UNIT - III** | **QUEUING AND MULTIPLE ACCESS TECHNIQUES** | **(9)** |
|---|---|---|

Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, and Examples of Local Area Networks.

| **UNIT - IV** | **NETWORK LAYER** | **(9)** |
|---|---|---|

Inter-networking, Bridging, Global Internet, IP protocol and addressing, Subnetting, Classless Interdomain Routing (CIDR), IP address lookup and Routing in the Internet. End-to-end Protocols, TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery.

| **UNIT - V** | **QoS IN NETWORKS** | **(9)** |
|---|---|---|

Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms – DPI Packet inspection

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the terms and concepts used in network design and operation. | **Understand** |
| **CO2** | Design data link layer and protocols. | **Apply** |
| **CO3** | Design and analyze the queuing models and multiple access. | **Analyze** |
| **CO4** | Illustrate the functions of the network layer | **Understand** |
| **CO5** | Discuss the concepts and issues related to congestion avoidance, quality of service (QoS) in packet networks and packet scheduling algorithms. | **Understand** |

**REFERENCES:**



| | |
|---|---|
| 1 | D. Bertsekas and R. Gallager, "Data Networks", Pearson, India, Second Edition, 2015. |
| 2 | L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufman, Sixth Edition, 2021. |
| 3 | Anurag Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", Morgan Kaufman, First Edition, 2004. |
| 4 | Jean Walrand, "Communications Network: A First Course", McGraw Hill, Second Edition, 2002. |
| 5 | Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, Second Edition, 1993. |



**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | - | 3 | 3 |
| **CO2** | 2 | 3 | - | 3 | 3 |
| **CO3** | 2 | 3 | - | 3 | 3 |
| **CO4** | 2 | 3 | - | 3 | 3 |
| **CO5** | 2 | 3 | - | 3 | 3 |
| **Avg.** | **2** | **3** | **-** | **3** | **3** |

<table>
<tr><td rowspan="2">CU24E17</td><td rowspan="2">SPREAD SPECTRUM COMMUNICATION</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">PREREQUISITE:<br>A strong background in digital communication systems, probability theory, and basic coding techniques is recommended. Familiarity with signal processing, modulation, and the mathematical tools of linear algebra and calculus will be beneficial for understanding the course material.</td></tr>
<tr><td colspan="7">OBJECTIVES:</td></tr>
<tr><td colspan="7">• To make the students to understand the detection of binary signals in AWGN and the impact of imperfections on system performance.<br>• To provide the insights in to apply the frequency hop techniques, and various spread spectrum methods to counter act noise and jamming.<br>• To explore the fundamentals of PN sequence generators, maximal length sequences, and their application in spread spectrum systems.<br>• To develop skills in the techniques for optimal tracking and synchronization of wideband signals in spread spectrum systems.<br>• To analyze the performance of spread spectrum systems under various conditions and also to investigate the error correction techniques.</td></tr>
<tr><td>UNIT - I</td><td colspan="4">INTRODUCTION TO SPREAD SPECTRUM SYSTEMS</td><td colspan="2">(9)</td></tr>
<tr><td colspan="7">Detection of binary signals in AWGN, Quadrature multiplexed signaling schemes, Signaling through band limited channels, Equalization of digital data transmission system, Realization imperfections, Degradations in performance.</td></tr>
<tr><td>UNIT - II</td><td colspan="4">SPREAD SPECTRUM SYSTEMS TECHNIQUES</td><td colspan="2">(9)</td></tr>
<tr><td colspan="7">Communication in the presence of pulse noise jamming, Low probability detection scheme, Direct Sequence Spread Spectrum (DSSS) and frequency hop spread spectrum systems and examples of spread spectrum systems. Direct sequence spread spectrum methods employing BPSK, QPSK and MSK, Frequency hop spread spectrum methods, Coherent slow frequency hop technique, Non coherent slow and fast frequency hop spread spectrum techniques, Hybrid DS/FH spread spectrum, Complex envelope representation of spread spectrum systems.</td></tr>
<tr><td>UNIT - III</td><td colspan="4">SPREADING CODE GENERATION</td><td colspan="2">(9)</td></tr>
<tr><td colspan="7">Binary Shift Register Sequences For Spread Spectrum Systems: Definition, PN sequence generator fundamentals, Maximal length sequences, Properties, Power spectrum and polynomial tables for maximal length sequences, Gold codes, Rapid acquisition systems, Non-linear code generators.</td></tr>
<tr><td>UNIT - IV</td><td colspan="4">SYNCHRONIZATION OF SPREAD SPECTRUM SYSTEMS</td><td colspan="2">(9)</td></tr>
<tr><td colspan="7">Optimal tracking of wide band signals, Early-late tracking loops, Code tracking loops for FHSS, Optimum synchronization techniques, Multipled well and sequential detectors, Synchronization using matched filter, Synchronization by estimating the received spreading code.</td></tr>
<tr><td>UNIT - V</td><td colspan="4">PERFORMANCE OF SPREAD SPECTRUM SYSTEM</td><td colspan="2">(9)</td></tr>
<tr><td colspan="7">Spread Spectrum Systems communications models, Performance without coding under AWGN and different jamming environments, spread spectrum systems performances with forward error correction, Block coding, Convolutional coding and specific error correcting codes, Inter leaving, Random coding bounds.</td></tr>
<tr><td colspan="7" align="right">Total (L: 45) = 45 PERIODS</td></tr>
</table>

## COURSE OUTCOMES:

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the principles and challenges of signal detection and transmission in band-limited channels. | **Understand** |
| **CO2** | Explore the various spread spectrum techniques and interference. | **Apply** |
| **CO3** | Apply the knowledge of sequence generation techniques in spread spectrum systems. | **Apply** |
| **CO4** | Implement the proficiency in synchronization techniques for effective spread spectrum communication. | **Analyze** |
| **CO5** | Analyze the performance of spread spectrum systems and error correction methods. | **Analyze** |

## REFERENCES:

1 Ziemer RE and Peterson RL, Digital Communication and Spread Spectrum Systems, Macmillan Publishing Co., First Edition, 1985.

2 Dixon R C, Spread Spectrum Systems, John Wiley & Sons, Inter science, Second Edition, 1984.

3 Holms JK, Coherent Spread Spectrum Systems, John Wiley & Sons, Inter science, Second Edition, 1982.

4 Ziemer RE and Peterson RL, Introduction to Spread Spectrum Communications, Prentice Hall of India, First Edition, 1995.

5 Don.J.Yorrieri, Principles of Spread Spectrum Communication Systems, Springer, 2004.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

<table>
<tr><td rowspan="2">CU24E18</td><td rowspan="2">HIGH SPEED SWITCHING ARCHITECTURE</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

**PREREQUISITE**

The students should have the foundational knowledge in computer networks, including LANs and IP addressing, as well as basic knowledge in digital logic and switching techniques.

**OBJECTIVES:**

- To impart the students a thorough exposure to the various LAN switching technologies.
- To develop the ability to design various network topologies, optimize data routing and manage congestion, particularly in complex systems.
- To make the students to evaluate the performance of queued switches.
- To apply knowledge of switching fabric technologies.
- To provide knowledge on implementing the various IP switching techniques.

| | | |
|---|---|---|
| **UNIT - I** | **LAN SWITCHING TECHNOLOGY** | **(9)** |

Switching concepts, Switch forwarding techniques, Switch path control, LAN switching, Cut through forwarding, Store and forward, Virtual LANs.

| | | |
|---|---|---|
| **UNIT - II** | **ATM SWITCHING ARCHITECTURE** | **(9)** |

Blocking networks, Basic and enhanced banyan networks, Sorting networks, Merge sorting, Re-arrangable networks, Full and partial connection networks, Non-blocking networks- Recursive network construction, Comparison of non- blocking network, Switching with deflection routing, Shuffle switch, Tandem banyan switch.

| | | |
|---|---|---|
| **UNIT - III** | **QUEUES IN ATM SWITCHES** | **(9)** |

Internal queuing - Input, output and shared queuing, Multiple queuing networks, Combined input, output and shared queuing - Performance analysis of queued switches.

| | | |
|---|---|---|
| **UNIT - IV** | **PACKET SWITCHING ARCHITECTURES** | **(9)** |

Architectures of internet switches and routers, Buffer less and buffered crossbar switches, Multi-stage switching, Optical packet switching, Switching fabric on a chip, Internally buffered crossbars.

| | | |
|---|---|---|
| **UNIT - V** | **IP SWITCHING** | **(9)** |

Addressing model, IP Switching types, Flow driven and topology driven solutions, IP over ATM address and next hop resolution, Multicasting, IPV6 over ATM.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Describe the difference between various LAN switching technologies. | **Understand** |
| **CO2** | Analyze and compare various ATM switching architectures | **Analyze** |
| **CO3** | Implement various queuing strategies within ATM switches | **Apply** |
| **CO4** | Expertise in Packet Switching Architectures | **Apply** |
| **CO5** | Implement different addressing models and switching types | **Apply** |

**REFERENCES:**

1 Achille Pattavina, "Switching Theory: Architectures and Performance in Broadband ATM Networks", John Wiley & Sons Ltd, Reprint, 2012.

2 Elhanany M.Hamdi, "High Performance Packet Switching Architectures", Springer Publications, 2010.

3 Christopher Y Metz, "Switching Protocols & Architectures", McGraw–Hill Professional Publishing, Reprint, 2012.

4 Rainer Handel, Man fred N Huber, Stefan Schroder, "ATM Networks – Concepts Protocols, Applications", Third Edition, Addison Wesley, 2009.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 3 | - |
| **CO2** | 3 | - | - | 3 | - |
| **CO3** | 3 | - | - | 3 | - |
| **CO4** | 3 | - | - | 3 | - |
| **CO5** | 3 | - | - | 3 | - |
| **Avg.** | 3 | - | - | 3 | - |

| CU24E19 | SPEECH AND AUDIO PROCESSING | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | PEC | 3 | 0 | 0 | 3 |

**PREREQUISITE:**

A basic understanding of calculus, algebra, and Fourier transforms, along with knowledge of digital signal processing (DSP) concepts like filtering and signal analysis. Familiarity with how linear systems work, basic probability and statistics are essential. Additionally, a basic grasp of acoustics, speech science will help to better understand the mechanisms of speech production, signal representation, and the algorithms used in speech recognition and synthesis.

**OBJECTIVES:**

- To explore the processes of speech production, signal representation, and auditory perception.
- To examine techniques for analyzing speech signals based on time-domain parameters.
- To investigate methods for speech analysis and synthesis using frequency domain techniques.
- To apply linear predictive coding (LPC) methods for speech analysis and pitch detection.
- To utilize algorithms for speech recognition, synthesis, and other applications in speech processing.

| UNIT - I | MECHANICS OF SPEECH | (9) |
|---|---|---|

Speech production mechanism, Nature of speech signal, Discrete time modeling of speech production, Representation of speech signals, Classification of speech sounds, Phones, Phonemes, Phonetic and phonemic alphabets, Articulatory features, Music production, Auditory perception, Anatomical pathways from the ear to the perception of sound, Peripheral auditory system psychoacoustics.

| UNIT - II | TIME DOMAIN METHODS FOR SPEECH PROCESSING | (9) |
|---|---|---|

Time domain parameters of speech signal, Methods for extracting the parameters energy, Average magnitude, Zero crossing rate, Silence discrimination using ZCR and energy, Short time auto correlation function, Pitch period estimation using auto correlation function.

| UNIT - III | FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING | (9) |
|---|---|---|

Short time fourier analysis, Filter bank analysis, Formant extraction, Pitch extraction, Analysis by synthesis, Analysis synthesis systems, Phase vocoder, Channel vocoder, Homomorphic speech analysis: Cepstral analysis of speech, Formant and pitch estimation, Homomorphic vocoders.

| UNIT - IV | LINEAR PREDICTIVE ANALYSIS OF SPEECH | (9) |
|---|---|---|

Formulation of linear prediction problem in time domain, Basic principle, Auto correlation method, covariance method, Solution of LPC equations, Cholesky method, Durbin's recursive algorithm, Lattice formation and solutions, Comparison of different methods, Application of LPC parameters, Pitch detection using LPC parameters– Formant analysis – VELP – CELP

| UNIT - V | APPLICATIONS | (9) |
|---|---|---|

Algorithms: Spectral estimation, Dynamic time warping, Hidden Markov model, Music analysis, Pitch detection, Feature analysis for recognition, Music synthesis, Automatic speech recognition, Feature extraction for ASR, Deterministic sequence recognition, Statistical sequence recognition, ASR Systems, Speaker identification and verification, Voice response system, Speech synthesis: Text to speech, Voice over IP.

**Total (L: 45) = 45 PERIODS**

**COURSE OUTCOMES:**

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

| Course Outcome | Description | Bloom's Taxonomy Level |
|---|---|---|
| **CO1** | Explain how speech is produced and perceived, including the basic features and classifications of speech sounds. | **Understand** |
| **CO2** | Apply methods to analyze speech signals by extracting parameters like energy and zero-crossing rate and use these parameters for tasks like detecting silence and estimating pitch. | **Apply** |
| **CO3** | Analyze speech signals using frequency-domain methods like short-time Fourier analysis and filter banks and evaluate techniques for extracting formants and pitch. | **Analyze** |
| **CO4** | Apply linear predictive coding (LPC) techniques to speech analysis, compare different methods for solving LPC equations, and use LPC parameters for pitch detection and formant analysis. | **Apply** |
| **CO5** | Implement algorithms and models for speech processing tasks such as speech recognition and synthesis, and evaluate their performance in practical applications. | **Analyze** |

**REFERENCES:**

1 LR Rabiner and RW Schaffer, "Digital Processing of Speech signals", Prentice Hall, First Edition, 2003.

2 Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music"**,** John Wiley and Sons, Inc, Second Edition, 2011.

3 Quatieri, "Discrete-Time Speech Signal Processing: Principles and Practice", Prentice Hall, Second Edition, 2021.

4 John L Flanagan, Speech analysis Synthesis and Perception, Springer, Third Edition, 2021.

5 Ian H Witten, Principles of Computer Speech, Academic Press, First Edition, 1982.

**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | 3 | - |
| **CO2** | 3 | - | 3 | 3 | - |
| **CO3** | 3 | - | 3 | 3 | - |
| **CO4** | 3 | - | 3 | 3 | - |
| **CO5** | 3 | - | 3 | 3 | - |
| **Avg.** | 3 | - | 3 | 3 | - |

| **PE24T21** | **SOFT COMPUTING TECHNIQUES** | **Category** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|---|
| | | **PCC** | **3** | **0** | **0** | **3** |

**PREREQUISITE:**

Familiarity with basic machine learning concepts (such as supervised and unsupervised learning, classification, regression, clustering) is helpful as soft computing techniques often deal with these areas and it crates strong foundation in basic algorithms (sorting, searching, optimization) and) will help in grasping more complex algorithms like genetic algorithms and neural networks.

**OBJECTIVES:**

- To understand the basic concepts of soft computing and its difference from traditional computing techniques.
- To gain knowledge about the fundamentals of artificial neural networks, including their architectures, learning mechanisms, and applications.
- To acquire the skills to learn the concepts of fuzzy logic, fuzzy sets, and their use in dealing with uncertainty and imprecision in real-world problems.
- To develop the ability to analyze and learn the concepts of fuzzy logic, fuzzy sets, and their use in dealing with uncertainty and imprecision in real-world problems.
- To enable the students to understand evolutionary algorithms, particularly genetic algorithms, and their applications in solving optimization and search problems.

| **UNIT - I** | **ARTIFICIAL NEURAL NETWORK** | **(9)** |
|---|---|---|
| Biological neural networks – Artificial neural networks – Common activation functions – McCulloch-pitts neuron – Hebb Net – Perceptron – Linear separability – Perceptron learning rule – Delta rule. | | |
| **UNIT-II** | **NEURAL NETWORK ARCHITECTURE AND ALGORITHMS** | **(9)** |
| Back propagation Neural Net: Standard and counter back propagation – Hopfield neural net: Discrete and Continuous – Associative memory neural networks – Boltzman machine – Case study: Power system voltage Stability assessment through artificial neural network. | | |
| **UNIT-III** | **COMPETITIVE NEURAL NETWORKS** | **(9)** |
| Fixed-weight competitive nets – Maxnet – Mexican Hat Net – Kohonen self-organizing Maps – Adaptive Resonance Theory – Neuro controllers – Functional diagram – Inverse dynamics. | | |
| **UNIT-IV** | **FUZZY LOGIC SYSTEM** | **(9)** |
| Fuzzy sets – Properties of classical and fuzzy sets – Operations on fuzzy sets – Fuzzy relations – Linguistic variables – Linguistic hedges – Fuzzy rule base – Fuzzy logic controller – Fuzzification – Membership functions – Defuzzification – Case study: Control of electrical drives based on fuzzy logic. | | |
| **UNIT-V** | **EVOLUTIONARY PROGRAMMING** | **(9)** |
| Optimization methods – Genetic algorithm – Real coded GA – Particle swarm optimization – Lion optimization. | | |
| | | **TOTAL = 45 PERIODS** |

**COURSE OUTCOMES:**

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

| COs | Course Outcome | Cognitive Level |
|---|---|---|
| **CO1** | Infer the concepts of artificial neural network. | Understand |
| **CO2** | Explicate the architecture and algorithms of BPN, Hopfield and apply the knowledge to voltage stability problem. | Apply |
| **CO3** | Understand the concept competitive neural networks and apply the knowledge to develop neuro controller. | Apply |
| **CO4** | Discuss the concepts of fuzzy logic system with classical system; apply the knowledge of fuzzy logic controller for classical applications. | Apply |
| **CO5** | Illustrate the fundamentals of genetic algorithm, Particle swarm optimization, Lion optimization and its various functionalities. | Understand |

**TEXT BOOKS:**


| | |
|---|---|
| 1 | Sivanandam, S.N and Deepa S.N, Principles of Soft Computing, John Wiley and Sons Ltd, United States, Third Edition, 2018. |
| 2 | Jacek.M.Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, Third Edition, 2006. |


**REFERENCES:**


| | |
|---|---|
| 1 | Lawrence Faussett, Fundamental of neural networks, Prentice Hall, First Edition, 2004. |
| 2 | J. Ross, Fuzzy Logic with Engineering Applications, John Wiley and Sons, Third Edition, 2011 |
| 3 | S, Rajasekaran, G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy systems and evolutionary algorithms: Synthesis and Applications, PHI Publication, Second Edition 2017. |
| 4 | David E. Goldberg, Genetic Algorithm in Search Optimization and Machine Learning, Pearson Education, New Delhi, Thirteenth Edition, 2013. |


**Mapping of COs with POs and PSOs**

| COs/ POs | PO1 | PO2 | PO3 | PSO1 | PSO2 |
|---|---|---|---|---|---|
| **CO1** | **-** | **-** | **-** | **-** | **-** |
| **CO2** | **-** | **-** | **-** | **-** | **-** |
| **CO3** | 3 | 1 | - | 1 | 1 |
| **CO4** | 3 | 1 | - | 1 | 1 |
| **CO5** | 3 | 1 | - | 1 | 1 |
| **Avg.** | **3** | **1** | **-** | **1** | **1** |

1- Low, 2- Medium, 3- High