**SRI VENKATESWARA COLLEGE OF ENGINEERING**
**(An Autonomous Institution, Affiliated to Anna University, Chennai)**
**SRIPERUMBUDUR TK - 602 117**

**REGULATION – 2018**
**M.E. COMMUNICATION SYSTEMS**
**Choice Based Credit System**
**CURRICULUM & SYLLABI (I-IV Semesters)**

**SEMESTER I**

| S.NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C | Prerequisites | Fixed/Movable |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| 1. | MA18181 | Applied Mathematics for Engineers (Common to AL,CU and PD) | FC | 4 | 3 | 1 | 0 | 4 | - | F |
| 2. | CU18101 | Advanced Radiation Systems | PC | 3 | 3 | 0 | 0 | 3 | - | F |
| 3. | CU18102 | Signal Processing and Baseband Techniques | PC | 3 | 3 | 0 | 0 | 3 | - | F |
| 4. | CU18103 | Advanced Modulation and Coding Techniques | PC | 3 | 3 | 0 | 0 | 3 | - | F |
| 5. | | Elective I | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **PRACTICAL** | | | | | | | | | | |
| **6.** | CU18111 | Antennas and Radiating Systems Laboratory | PC | 4 | 0 | 0 | 4 | 2 | - | F |
| **7.** | CU18112 | Advanced Digital Signal Processing Laboratory(Common to AL & CU) | PC | 4 | 0 | 0 | 4 | 2 | - | F |
| **TOTAL** | | | | **33** | **19** | **1** | **8** | **20** | - | - |

**SEMESTER II**

| S.NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C | Prerequisites | Fixed/Movable |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| **1.** | CU18201 | Advanced Communication Networks | PC | 3 | 3 | 0 | 0 | 3 | - | F |
| **2.** | CU18202 | Wireless Communication Engineering | PC | 3 | 3 | 0 | 0 | 3 | - | F |
| **3.** | | Elective II | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **4.** | | Elective III | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **5.** | MC18081 | Introduction to Research Methodology and IPR | MC | 2 | 2 | 0 | 0 | 2 | - | F |
| **PRACTICAL** | | | | | | | | | | |
| **6.** | CU18211 | Communication Systems Laboratory | PC | 4 | 0 | 0 | 4 | 2 | - | F |
| **7.** | CU18212 | Advanced Communication Networks Laboratory | PC | 4 | 0 | 0 | 4 | 2 | - | F |
| **8.** | CU18213 | Mini Project | EEC | 4 | 0 | 0 | 4 | 2 | - | F |
| **TOTAL** | | | | **30** | **14** | **0** | **12** | **20** | - | - |

**SEMESTER III**

| S.NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C | Prerequisites | Fixed/Movable |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| **1.** | | Elective IV | PE | 4 | 3 | 0 | 0 | 3 | - | M |
| **2.** | | Elective V | PE | 4 | 3 | 0 | 0 | 3 | - | M |
| **3.** | | Elective VI | PE | 4 | 3 | 0 | 0 | 3 | - | M |
| **PRACTICAL** | | | | | | | | | | |
| **4.** | CU18311 | Project Work Phase I | EEC | 12 | 0 | 0 | 12 | 6 | - | F |
| | | | **TOTAL** | **24** | **9** | **0** | **12** | **15** | - | - |

**SEMESTER IV**

| S.NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C | Prerequisites | Fixed/Movable |
|---|---|---|---|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | | | | | |
| **1.** | CU18411 | Project Work Phase II | EEC | 30 | 0 | 0 | 30 | 15 | - | F |
| | | | | | | | | | | |
| **TOTAL** | | | | **30** | **0** | **0** | **30** | **15** | **-** | **-** |

**Total Credits: 70**

## PROFESSIONAL ELECTIVES (PE)

| S.NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C | Prerequisites | Fixed/Movable |
|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | CU18001 | MIC and RF system Design | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **2.** | CU18002 | Optical Switching and Networking | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **3.** | CU18003 | Advanced Wireless Networks | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **4.** | CU18004 | Wireless Transceiver Design | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **5.** | CU18005 | Micro Electro Mechanical System | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **6.** | CU18006 | Advanced Fiber Optic Technologies | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **7.** | CU18007 | Multimedia Communication | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **8.** | CU18008 | Electromagnetic Interference and Compatibility in System Design | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **9.** | CU18009 | Communication Network Security | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **10.** | CU18010 | Satellite Communication | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **11** | AL18012 | Wireless Sensor Networks (Common to AE & CU) | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **12** | CU18011 | Advanced Microwave Communication | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **13** | CU18012 | Advanced Wireless Communication | PE | 3 | 3 | 0 | 0 | 3 | Wireless Communication Engineering | M |
| **14** | CU18013 | Cognitive Radio Networks | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **15** | CU18014 | Communication Network Design | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **16** | CU18015 | Mobile Adhoc | PE | 3 | 3 | 0 | 0 | 3 | - | M |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Networks | | | | | | | | |
| **17** | CU18016 | MIMO Systems | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **18** | CU18017 | Speech Processing and synthesis for Communication Systems | PE | 3 | 3 | 0 | 0 | 3 | Signal Processing and Baseband Techniques | M |
| **19** | AL18019 | Advanced Digital Image Processing (Common to AE & CU) | PE | 3 | 3 | 0 | 0 | 3 | - | M |
| **20** | CU18018 | Ultra-Wide Band Communication | PE | 3 | 3 | 0 | 0 | 3 | Wireless Communication Engineering | M |

**Summary**

| **Subject Area** | **Credits per semester** | | | | **Total** |
|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | |
| Foundation Course | 4 | - | - | - | **4** |
| Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required) | 13 | 10 | - | | **23** |
| Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch | 3 | 6 | 9 | - | **18** |
| Mandatory Subjects - (MC) | - | 2 | - | - | **2** |
| Project Work, Seminar and/or Internship in Industry or Elsewhere (EEC) | - | 2 | 6 | 15 | **23** |
| **Total Credits** | **22** | **18** | **15** | **15** | **70** |

## SEMESTER I

| MA18181 | APPLIED MATHEMATICS FOR ENGINEERS | L | T | P | C |
|---|---|---|---|---|---|
| | **(Common to PED, Communication systems and Applied Electronics)** | **3** | **1** | **0** | **4** |

**OBJECTIVES**:

- To develop the ability to use the concepts of Linear algebra and Special functions for solving problems related to Networks.
- To formulate and construct a mathematical model for a linear programming problem in real life situation.
- To expose the students to solve ordinary differential equations by various techniques.

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| **UNIT I** | **LINEAR ALGEBRA** | **12** |

Vector spaces – norms – Inner Products – Eigen values using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

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| **UNIT II** | **LINEAR PROGRAMMING** | **12** |

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

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| **UNIT III** | **ORDINARY DIFFERENTIAL EQUATIONS** | **12** |

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

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| **UNIT IV** | **TWO DIMENSIONAL RANDOM VARIABLES** | **12** |

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

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|---|---|---|
| **UNIT V** | **QUEUEING MODELS** | **12** |

Poisson Process – Markovian queues – Single and Multi-server Models – Little's formula - Machine Interference Model – Steady State analysis – Self Service queue.

**TOTAL: (L:45 + T:15 ): 60 PERIODS**

**OUTCOMES:**

- To achieve an understanding of the basic concepts of algebraic equations and method of solving them.
- To familiarize the students with special functions and solve problems associated with Engineering applications.

**TEXT BOOKS:**


1. Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley, (1999)
2. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition,

| | |
|---|---|
| | Laxmi Publications Pvt Ltd., (2011). |
| 3 | Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, (2011). |
| | |

**REFERENCES:**


1. 1.Richard Bronson, Gabriel B.Costa, "Linear Algebra", Academic Press, Second Edition,
2. 2007.
3. 2.Richard Johnson, Miller & Freund, "Probability and Statistics for Engineers", 7th Edition,
4. Prentice – Hall of India, Private Ltd., New Delhi (2007).Taha H.A., "Operations Research: An
5. introduction", Pearson Education Asia, New Delhi, Ninth Edition, 2012.
6. 3.Donald Gross and Carl M. Harris, "Fundamentals of Queueing Theory", 2nd edition, John
7. Wiley and Sons, New York (1985).
8. 4.Moon, T.K., Sterling, W.C., Mathematical methods and algorithms for signal
9. processing,Pearson Education, 2000.

| CU18101 | ADVANCED RADIATION SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enhance the students knowledge in the area of various antenna design and to make them understand their radiation mechanism.
- To impart knowledge about the state of art in antenna technology.

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| **UNIT I** | **ANTENNA FUNDAMENTALS** | **9** |

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell's equations - Antenna fundamental parameters - Radiation integrals - Radiation from surface and line current distributions – dipole, monopole, loop antenna; Mobile phone antenna-base station, hand set antenna; Image; Induction ,reciprocity theorem, Balance to unbalance transformer.

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| **UNIT II** | **ANTENNA ARRAYS** | **9** |

Review of One Dimensional and Two dimensional Arrays, General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beamforming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self phased arrays.

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| **UNIT III** | **RADIATION FROM APERTURES** | **9** |

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

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| **UNIT IV** | **MICROSTRIP ANTENNA** | **9** |

Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch, Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Reconfiguration Mechanisms; Computer Aided Design of Microstrip Antennas, Microstrip Reflectarray Antennas.

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| **UNIT V** | **MODERN ANTENNAS** | **9** |

IFA – Vivaldi Antennas - UWB Antennas - Antennas in Medicine – Leaky Wave Antennas –Plasma Antennas – Wearable Antennas – RFID Antennas - Automotive antennas, Reconfigurable antennas - Meta materials

**TOTAL : 45 PERIODS**

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

- Describe the fundamentals to recent techniques in antenna technology.
- Design and assess the performance of various antennas.

**REFERENCES:**


1. Balanis.A, ―Antenna Theory Analysis and Design, 3rd Edition, John Wiley and Sons, New York, 1982.
2. Frank B. Gross, ―Frontiers in Antennas, Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, ―Modern

| | |
|---|---|
| | Antennas, IIEdition, Springer Publications, 2007. |
| 4. | Krauss.J.D, ―Antennas, II edition, John Wiley and sons, New York, 1997. |
| 5. | I.J. Bahl and P. Bhartia, Microstrip Antennas, Artech House,Inc.,1980 |
| 6. | W.L.Stutzman and G.A.Thiele, ―Antenna Theory and Design, 2nd edition, John Wiley& Sons Inc.,1998. |
| 7. | Jim R. James,P.S.Hall ,"Handbook of Microstrip Antennas" IEE Electromagnetic wave series 28, Volume 2,1989. |

| CU18102 | SIGNAL PROCESSING AND BASE BAND TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the basic principles of random signal processing , spectral estimation methods and adaptive filter algorithms and their applications.
- To enable the student to understand the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.

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| **UNIT I** | **DISCRETE RANDOM SIGNAL PROCESSING** | **9** |

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations.

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| **UNIT II** | **SPECTRAL ESTIMATION** | **9** |

Estimation of spectra from finite duration signals, Nonparametric methods – Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods – ARMA, AR and MA model based spectral estimation, Solution using Levinson-Durbin algorithm.

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| **UNIT III** | **ADAPTIVE FILTERS** | **9** |

FIR adaptive filters – Steepest descent method- LMS algorithm, LMS algorithm, RLS adaptive algorithm – Application: channel equalization, noise cancellation, prediction.

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| **UNIT IV** | **DETECTION AND ESTIMATION** | **9** |

Detection criteria : Bayes detection techniques, MAP, ML,– detection of M-ary signals, Neyman Peason, minimax decision criteria. Estimation: linear estimators, non-linear estimators, Bayes, Kalman, MAP,ML, properties of estimators, phase and amplitude estimation.

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| **UNIT V** | **SYNCHRONIZATION** | **9** |

Signal parameter estimation, carrier phase estimation, symbol timing estimator, joint estimation of carrier phase and symbol timing.

**TOTAL :45 PERIODS**

**OUTCOMES:**

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

- The student would be able to demonstrate an understanding of the basic principles of random signal processing, spectral estimation methods and adaptive filter algorithms and their applications.
- The student would be able to demonstrate an understanding of the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.
- The student would be in a position to apply his knowledge for designing a baseband system addressing the channel impairments.

| **REFERENCES:** | |
|---|---|
| 1. | Monson H. Hayes, _Statistical Digital Signal Processing and Modeling, John Wiley andSons, Inc, Singapore, 2002 |
| 2. | John J. Proakis, Dimitris G. Manolakis, : Digital Signal Processing‘, Pearson Education,2002. |
| 3. | John G. Proakis., _Digital Communication‘, 4 th edition, Mc Graw Hill Publication, 2001. |
| 4. | Bernard Sklar and Pabitra Kumar Roy, Digital Communications:Fundamentals & Applications, 2E, Pearson Education India, 2009 |
| 5. | John G. Proakis, Masoud Salehi, ―Communication Systems Engineering, Prentice Hall, 1994. |

| CU18103 | ADVANCED MODULATION AND CODING TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To understand the role of the communication medium in the design approaches for coding and modulation techniques.
- To know the trade-offs involved in the design of basic and advanced coding and modulation techniques.
- To learn the advanced baseband signal conditioning methods evolved for exploiting the channel and user application characteristics
- To familiarize on the system design approaches.

| UNIT I | REVIEW OF DIGITAL MODULATION TECHNIQUES | 9 |
|---|---|---|

Base band and band pass communication; Signal space representation, Linear and nonlinear modulation techniques, M-ary modulation techniques; Spectral characteristics of digital modulation, Spread spectrum modulation techniques.

| UNIT II | RECEIVERS FOR AWGN AND FADING CHANNELS | 9 |
|---|---|---|

Optimum receivers for AWGN channel -Correlation demodulator, matched filter, maximum likelihood sequence detector, envelope detectors for M-ary signals; Characterization of fading multipath channels, RAKE demodulator, Multiuser detection techniques.

| UNIT III | MULTICARRIER SYSTEMS | 9 |
|---|---|---|

OFDM- Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Windowing; Peak to Average Power reduction schemes; Multicarrier CDMA- System design, Performance parameters.

| UNIT IV | TRELLIS CODED MODULATION | 9 |
|---|---|---|

Coded modulation for bandwidth-constrained channels-Trellis coded modulation; Set Partitioning, Four –state Trellis-coded modulation with 8-PSK signal constellation, Eight-state Trellis code for coded 8-PSK modulation, Eight-state Trellis for rectangular QAM signal constellations, Decoding methods and implementation issues.

| UNIT V | TURBO CODING | 9 |
|---|---|---|

Introduction-Turbo Encoder, Turbo Decoder, Iterative Turbo Decoding Principles; Modifications of the MAP Algorithm-The Soft-Output Viterbi Algorithm(SOVA); Turbo Coding for AWGN channels, Turbo Coding for Rayleigh Channels, LDPC Codes.

**TOTAL : 45 PERIODS**

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

- Demonstrate an understanding of the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods evolved for exploiting the channel and user application characteristics.
- Analyze the user requirements and the type of channel over which the system has to function.
- Apply the knowledge for designing the baseband signaling waveforms that would address

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|---|---|---|
| | the channel impairments. | |
| | | |

**REFERENCES:**


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|---|---|
| 1. | Bernard Sklar., Digital Communications‘, second edition, Pearson Education,2001. |
| 2. | John G. Proakis., Digital Communication‘, 4 th edition, Mc Graw Hill Publication, 2001 |
| 3. | Theodore S.Rappaport., Wireless Communications‘, 2nd edition, Pearson Education, 2002. |
| 4. | Richard Van Nee & Ramjee Prasad., OFDM for Multimedia Communications‘ Artech HousePublication,2001. |
| 5. | Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, " Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997. |
| 6. | Sergio Verdu, Multiuser Detection, Cambridge University Press, 1998. |
| 7. | Andrea Goldsmith , Wireless Communication , Cambridge Univ. Press, 2006. |

| CU18111 | ANTENNAS AND RADIATING SYSTEMS LAB | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To familiarize the simulation tools for antenna design
- To understand the radiation characteristics of various antennas

**LIST OF EXPERIMENTS:**

| | |
|---|---|
| 1 | Simulation of half wave dipole antenna. |
| 2 | Simulation of quarter wave, full wave antenna and comparison of their parameters. |
| 3 | Simulation of monopole antenna with and without ground plane. |
| 4 | Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna. |
| 5 | Simulation of a half wave dipole antenna array. |
| 6 | Simulation of IFA antenna. |
| 7 | Simulation of UWB antenna. |
| 8 | Simulation of Wearable antenna. |

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

- Determine specifications, design, construct and test antenna.
- Explore and use tools for designing, analyzing and testing antennas. These tools include Antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques

**TOTAL: 60 PERIODS**

**List of Equipment for Batch of 25 students:**

| Sl No | Description of equipment | Quantity required |
|---|---|---|
| 1. | Antenna Simulation Software | 13 |
| 2. | Network analyzer with test cables connectors, adaptors and termination | 2 |
| 3 | Computers | 13 |

| CU18112 | ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objective:**

- To introduce simulation tools and software to represent a signal in various forms
- To familiarize in using various digital filters
- To perform the power spectrum analysis

**LIST OF EXPERIMENTS:**

| | |
|---|---|
| 1. | Basic Signal Representation |
| 2. | Correlation Auto And Cross |
| 3. | Stability Using Hurwitz Routh Criteria |
| 4. | Sampling FFT Of Input Sequence |
| 5. | Butterworth Lowpass And Highpass Filter Design |
| 6. | Chebychev Type I,II Filter |
| 7. | State Space Matrix from Differential Equation |
| 8. | Normal Equation Using Levinson Durbin |
| 9. | Decimation And Interpolation Using Rationale Factors |
| 10. | Maximally Decimated Analysis DFT Filter |
| 11. | Cascade Digital IIR Filter Realization |
| 12. | Convolution And M Fold Decimation &PSD Estimator |
| 13 | Estimation Of PSD |
| 14. | Inverse Z Transform |

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

- Design different digital filters in software
- Apply various transforms in time and frequency
- Perform decimation and interpolation

**TOTAL:60 PERIODS**

**List of Equipment for Batch of 25 students:**

| Sl No | Description of equipment | Quantity required |
|---|---|---|
| 1. | PCs | 15 |
| 2. | MATLAB with Simulink and Signal Processing Tool Box or Equivalent Software in desktop systems | 10 |

## SEMESTER II

| CU18201 | ADVANCED COMMUNICATION NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To comprehend the functionalities of OSI layers
- To know the various scheduling algorithms
- To provide insights over MPLS and QoS

**UNIT I** — **9**

Overview of Internet-Concepts, challenges and history. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP. Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.

**UNIT II** — **9**

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks**.** Active Queue Management - RED, WRED

**UNIT III** — **9**

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

**UNIT IV** — **9**

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

**UNIT V** — **9**

IPV4, IPV6, IP tunnelling, IP switching and MPLS, MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

**TOTAL : 45 PERIODS**

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

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.

**REFERENCES:**


1. Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queueing Systems for the Internet", Springer Veriag, 2001.

| | |
|---|---|
| 3. | Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001. |
| 4. | Anurag Kumar, D. Manjunath and Joy Kuri, “Communication Networking: An Analytical Approach” , Morgan Kaufman Publishers, 2004. |

| CU18202 | WIRELESS COMMUNICATION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To learn the concepts of wireless communication.
- To know about the various propagation methods, Channel models, capacity calculations multiple antennas and multiple user techniques used in the mobile communication.

| 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, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading –shadowing Distributions, Link power budget Analysis.

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

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

| 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 |
|---|---|---|

Review of Multiple Access Techniques, Scheduling, power control, Uplink and Downlink channel capacity, multiuser diversity, MIMO-MU systems.

**TOTAL (L: 45): 45 PERIODS**

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

- Analyze the state of art techniques in wireless communication.
- Describe MIMO Communications
- Review mulitiple access techniques

**REFERENCES:**


| | |
|---|---|
| 1. | Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007. |
| 2. | Harry R. Anderson, ―Fixed Broadband Wireless System Design John Wiley – India, 2003. |
| 3. | Andreas.F. Molisch, ―Wireless Communications, John Wiley – India, 2006. |
| 4. | Simon Haykin & Michael Moher, ―Modern Wireless Communications, Pearson Education,2007. |
| 5. | Rappaport. T.S., ―Wireless communications, Pearson Education, 2003. |

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|---|---|
| 6. | Gordon L. Stuber, ―Principles of Mobile Communication, Springer International Ltd., 2001. |
| 7. | Upena Dalal, ―Wireless Communication ― Oxford Higher Education 2009. |

| MC18081 | RESEARCH METHODOLOGY AND IPR | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**OBJECTIVES**:

- To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection.

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| **UNIT I** | **RESEARCH METHODOLOGY** | **6** |

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics

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|---|---|---|
| **UNIT II** | **RESULTS AND ANALYSIS** | **6** |

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.

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

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee

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| **UNIT IV** | **INTELLECTUAL PROPERTY RIGHTS** | **6** |

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

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|---|---|---|
| **UNIT V** | **PATENT RIGTS AND NEW DEVELOPMENTS IN IPR** | **6** |

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

**TOTAL: (L: 30 ): 30 PERIODS**

**OUTCOMES:**

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

- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understand research problem formulation & Analyze research related information and Follow research ethics
- Correlate the results of any research article with other published results. Write a review article in the field of engineering.

| | |
|---|---|
| • Appreciate the importance of IPR and protect their intellectual property. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits | |
| | |
| **TEXT BOOKS:** | |
| 1. | Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005. |
| 2. | Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004. |
| 3. | T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008 |
| | |
| **REFERENCES:** | |
| 1. | Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004. |
| 2. | Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students', Juta & Company, 1996. |
| 3. | Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016. |
| 4 | Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007. |
| 5 | Mayall , "Industrial Design", McGraw Hill, 1992. |
| 6 | Niebel , "Product Design", McGraw Hill, 1974. |
| 7 | Asimov , "Introduction to Design", Prentice Hall, 1962. |

| CU18211 | COMMUNICATION SYSTEMS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES**:

- To acquire knowledge on Transmission line and S- parameter estimation of microwave devices.
- To introduce the basics of Microstrip Patch Antenna and its analysis .
- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

**LIST OF EXPERIMENTS USE NETWORK ANALYSER FOR THE FOLLOWING EXPERIMENTS:**

| | |
|---|---|
| 1. | Measurement of transmission line parameters. |
| 2. | S-parameter estimation of Microwave devices. |
| 3. | Design and testing of a Microstrip coupler. |
| 4. | Characteristics of Microstrip patch antenna. |

| | |
|---|---|
| | **USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:** |
| 1. | Generation & detection of binary digital modulation techniques. |
| 2. | Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS. |
| 3. | Digital Filter Design |
| 4. | Performance evaluation of simulated CDMA system |
| 5. | Channel equalizer design(LMS,RLS) 6. Antenna Radiation Pattern measurement |

**TOTAL : 60 PERIODS**

**OUTCOMES: Upon the completion of course, the student should be able to:**

- Measure and analyze various transmission line parameters.
- Design Microstrip patch antennas.
- Implement the adaptive filtering algorithms
- To generate and detect digital communication signals of various modulation techniques using MATLAB.
- Evaluate cellular mobile communication technology and propagation model.

**List of Equipment for Batch of 25 students:**

| Sl No | Description of equipment | Quantity required |
|---|---|---|
| 1. | Network analyser with test cables connectors, adaptors and termination | 1 |
| 2. | Antenna positioned with controller and position indicator | 2 |
| 3. | CDMA simulation kit | 1 |
| 4. | RF Cable ( Radial) 15mts,5 mts,1 mt | 2 |
| 5. | Mounting bracket | 2 |
| 6. | Standard Gain horn antenna for X band | 2 |
| 7. | Computers with SCI lab / Mat lab / Labview | 10 |

| CU18212 | ADVANCED COMMUNICATION NETWORKS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Objectives**

- To know the functionalities of various networking devices.
- To introduce the configuration process of networking devices.
- To work with the client and server.

**LIST OF EXPERIMENTS:**

| | |
|---|---|
| 1. | Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) |
| 2. | and Network Configuration Files. |
| | 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 into upper case using multiplexing system call "select". |
| 5. | Design UDP Client Server to transfer a file. |
| 6. | Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address. |
| | a. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down. |
| 7. | Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails. |
| 8. | Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise 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. |
| 9. | Signaling and QoS of labeled paths using RSVP in MPLS. |
| 10. | Find shortest paths through provider network for RSVP and BGP. |
| 11. | Understand configuration, forwarding tables, and debugging of MPLS. |
| | **TOTAL:60 PERIODS** |

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

- Identify the different types of network devices and their functions within a network.
- Understand and build the skills of sub-netting and routing mechanisms.
- Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation.

**List of Equipment for Batch of 25 students:**

| Sl No | Description of equipment | Quantity required |
|---|---|---|
| 1. | Wire Shark | 25 |

| CU18213 | MINI PROJECT | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Outcome**

- The student will solve a live problem using software/analytical/computational tools.
- Students will learn to write technical reports.
- Students will develop skills to present and defend their work in front of technically qualified audience.
- To introduce the configuration process of networking devices.
- To work with the client and server.

**SYLLABUS CONTENT:**

Students can take up small problems in the field of communication engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, characterization, studying a software tool for the solution of an engineering problem etc.

**TOTAL:60 PERIODS**

## PROFESSIONAL ELECTIVES

| CU18001 | MIC AND RF SYSTEM DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To understand the fundamentals of RF design and Microwave integrated circuits.
- To understand the various components of RF system for Wireless Communications.
- To know the basic techniques needed for analysis of RF systems.

| UNIT I | CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES | 9 |
|---|---|---|

CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.

| UNIT II | IMPEDANCE MATCHING AND AMPLIFIERS | 9 |
|---|---|---|

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement , High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match , Single ended and Differential schemes.

| UNIT III | FEEDBACK SYSTEMS AND POWER AMPLIFIERS | 9 |
|---|---|---|

Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations , Compensation Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations

| UNIT IV | RF FILTER , OSILLATOR, MIXER | 9 |
|---|---|---|

Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phase locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.

| UNIT V | MIC COMPONENTS | 9 |
|---|---|---|

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.

**TOTAL :45 PERIODS**

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

- Capability to design RF circuits.
- To be able to analyze RF circuits.

**REFERENCES:**


1. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
2. Ingo Wolff," Coplanar Microwave Integrated circuits", John Wiley and sons, New Jersey,

| | |
|---|---|
| | 2006. 3. T. Lee,"Design of CMOS RF Integrated Circuits", Cambridge, 2004. |
| 2. | T. Lee,"Design of CMOS RF Integrated Circuits", Cambridge, 2004. |

| CU18002 | OPTICAL SWITCHING AND NETWORKING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the importance of the backbone infrastructure for our present and future communication needs and familiarize them with the architectures and the protocol stack in use.
- To enable the student to understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.
- To expose the student to the advances in networking and switching domains and the future trends.

| UNIT I | OPTICAL NETWORK ARCHITECTURES | 9 |
|---|---|---|

Introduction to Optical Networks; Need for Multilayered Architecture-, Layers and Sub-layers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays, Generalized Multiprotocol Label Switching.

| UNIT II | NETWORK CONNECTIONS | 9 |
|---|---|---|

Connection Management and Control; Static Networks, Wavelength Routed Networks; Linear Light wave networks; Logically Routed Networks; Routing and Wavelength Assignment , Traffic Grooming in Optical Networks.

| UNIT III | OPTICAL NETWORK SURVIVABILITY | 9 |
|---|---|---|

Protection and Restoration Objectives, Fault Protection and Restoration Techniques in the Logical Layer - Point-to-Point Systems, SONET Self-Healing Rings, Interconnection Techniques, Architectures with Arbitrary Mesh Topologies ,Optical-Layer Protection: Point-to-Point and Ring Architectures, Mesh Architectures, Survivability Techniques for Multicast Connections.

| UNIT IV | OPTICAL PACKET SWITCHED NETWORKS | 9 |
|---|---|---|

Optical Packet-Switched Network Architectures, Contention Resolution, OPS EnablingTechnologies, Optical Burst Switching, Contention Resolution in OBS Networks, Optical LabelSwitching, All-Optical Label Swapping, Contention Resolution in OLS.

| UNIT V | NETWORK PERFORMANCE AND FUTURE TRENDS | 9 |
|---|---|---|

Performance Impairments in an Optical Network Environment, Performance Evaluation: Methodology and Case Studies, The Passive Optical Networks, Metropolitan Area Networks, Long-Haul and Ultra Long-Haul Networks, Introduction to Software Defined Networking.

**TOTAL : 45 PERIODS**

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

- Use the backbone infrastructure for our present and future communication needs
- Discuss the architectures and the protocol stack in use.
- Compare the differences in the design of data plane, control plane, routing, switching, resource allocation methods, network management and protection methods in vogue.
- Describe the advances and recent trends in the networking and switching approaches.

**REFERENCES:**

| | |
|---|---|
| 1. | Thomas E. Stern, Georgios Ellinas, Krishna Bala, ―Multiwavelength Optical Networks – Architecture, Design and control ―, Cambridge University Press, 2nd Edition, 2009. |
| 2. | Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perspective,Harcourt Asia Pte Ltd., Second Edition 2006. |
| 3. | C. Siva Ram Moorthy and Mohan Gurusamy, ―WDM Optical Networks : Concept, Design and Algorithms, Prentice Hall of India, Ist Edition, 2002. |
| 4. | P.E. Green, Jr., ―Fiber Optic Networks, Prentice Hall, NJ, 1993. |
| 5. | Biswanath Mukherjee, ―Optical WDM Networks, Springer, 2006. |

| CU18003 | ADVANCED WIRELESS NETWORK | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To understand the working of WI-fi, 3G systems such as UMTS, CDMA 2000
- To learn 4G networks
- To know about ad hoc and sensor network
- To learn about WLAN, WWAN, Wimax and LTE

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|---|---|---|
| **UNIT I** | **WIRELESS LOCAL AREA NETWORKS** | **9** |

Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer- MAC Management Sublayer- Wireless ATM - HIPERLAN- HIPERLAN-2

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|---|---|---|
| **UNIT II** | **3G OVERVIEW & 2.5G EVOLUTION** | **9** |

Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, CDMA2000 overview- Radio and Network components, Network structure, Radio network, TD-CDMA, TD-SCDMA.

| | | |
|---|---|---|
| **UNIT III** | **ADHOC & SENSOR NETWORKS** | **9** |

Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols.

| | | |
|---|---|---|
| **UNIT IV** | **INTERNETWORKING BETWEEN WLANS AND 3G WWANS** | **9** |

Internetworking objectives and requirements, Schemes to connect WLANs and 3G Networks, Session Mobility, Internetworking Architectures for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution system.

| | | |
|---|---|---|
| **UNIT V** | **4G & BEYOND** | **9** |

4G features and challenges, Technology path, IMS Architecture, WiMAX, LTE, Convergent Devices, 4G technologies, Advanced Broadband Wireless Access and Services, Multimedia, MVNO.

**TOTAL : 45 PERIODS**

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

- Analyze different routing techniques in ad hoc and sensor network
- Demonstrate internetworking between different wireless networks
- Describe 4G features and challenges

**REFERENCES:**


1. Clint Smith. P.E., and Daniel Collins, ―3G Wireless Networks, 2nd Edition, Tata McGraw Hill, 2007.
2. Vijay. K. Garg, ―Wireless Communication and Networking, Morgan Kaufmann Publishers, http://books.elsevier.com/9780123735805:, 2007.
3. Kaveth Pahlavan,. K. Prashanth Krishnamurthy, "Principles of Wireless Networks", Prentice Hall of India, 2006.
4. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hall of India,

| | |
|---|---|
| | 2nd Ed., 2007. |
| 5. | Andrew Richadrson, ―WCDMA design Handbook, Cambridge University Press,2007 |
| 6. | Dharma Prakash Agrawal & Qing-An Zeng, ―Introduction to Wireless and Mobile Systems, Thomson India Edition, 2nd Ed., 2007. |
| 7. | Gary. S. Rogers & John Edwards, ―An Introduction to Wireless Technology, Pearson Education, 2007. |
| 8. | Sumit Kasera and Nishit Narang, ― 3G Networks – Architecture, Protocols and Procedures, Tata McGraw Hill, 2007. |

| CU18004 | WIRELESS TRANSCEIVER DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the intricacies of RF system design using behavior models of the subsystems present in the transceivers

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| **UNIT I** | **FUNDAMENTALS OF SYSTEM DESIGN** | **9** |

Linear systems and transformation, Non-linear system representation, Noise and Random process, elements of Digital base band system: Sampling, jitter, modulation techniques, pulse shaping, error probability detection,

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| **UNIT II** | **RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS** | **9** |

Superheterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture

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|---|---|---|
| **UNIT III** | **RECEIVER SYSTEM ANALYSIS AND DESIGN** | **9** |

Sensitivity and noise figure of receiver, intermodulation characteristics, single tone desensitization, adjacent channel selectivity and blocking characteristics, receiver dynamic range and AGC system, system design and performance evaluation

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| **UNIT IV** | **TRANSMITTER SYSTEM ANALYSIS AND DESIGN** | **9** |

Transmission power and spectrum, modulation accuracy, adjacent and alternate channel power, noise emission.

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|---|---|---|
| **UNIT V** | **CASE STUDY** | **9** |

Multimode and multiband superheterodyne transceiver: selection of frequency plan, receiver system and transmitter system design - Direct conversion transceiver: receiver system and transmitter system design.

**TOTAL : 45 PERIODS**

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

- Design RF system for a given specification
- Discuss the abnormalities present in the transceiver architectures
- Estimate the system performance utilizing the models.

**REFERENCES:**


| | |
|---|---|
| 1. | Qizheng Gu, ―RF System Design of Transceivers for Wireless Communications, Springer, 2005 |
| 2. | K P Pun, J E D Franca and C A Leme, ―Circuit Design For Wireless Communications – Improved Techniques for Image Rejection in Wideband Quadrature Receivers, Springer, 2003. |
| 3. | Kai Chang , RF and Microwave Wireless Systems, John Wiley, 2000 |

| CU18005 | MICRO ELECTRO MECHANICAL SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the basic principles of sensors and actuators, materials and fabrication aspects of MEMS and Microsystems.
- To make the student familiar with the mechanical and the electrostatic design and the associated system issues.
- To introduce the student to the different MEMS applications, the design basics, the design tools and the performance issues.

| | | |
|---|---|---|
| **UNIT I** | **INTRODUCTION TO MEMS** | **9** |

MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Micro-accelerometers and Micro fluidics, MEMS materials, Micro fabrication

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|---|---|---|
| **UNIT II** | **MECHANICS FOR MEMS DESIGN** | **9** |

Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Resonance, Thermo mechanics – actuators, force and response time, Fracture and thin film mechanics.

| | | |
|---|---|---|
| **UNIT III** | **ELECTRO STATIC DESIGN AND SYSTEM ISSUES** | **9** |

Electrostatics: basic theory, electro static instability. Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inchworms, Electromagnetic actuators. bistable actuators. Electronic Interfaces, Feedback systems, Noise , Circuit and system issues,

| | | |
|---|---|---|
| **UNIT IV** | **MEMS APPLICATION** | **9** |

Transmission power and spectrum, modulation accuracy, adjacent and alternate channel power, noise emission.

| | | |
|---|---|---|
| **UNIT V** | **INTRODUCTION TO OPTICAL AND RF MEMS** | **9** |

Optical MEMS, - System design basics – Gaussian optics, matrix operations, resolution. Case studies, MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes – design basics, case study – Capacitive RF MEMS switch, performance issues.

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the different aspects of microsystem design.
- Given the user requirements and the functionality the student would be in a position to apply his knowledge for identifying a suitable MEMS structure, material and fabrication procedure.
- The student would be capable of applying his knowledge and design tools and will be well practiced in design skills.

**REFERENCES:**

| | |
|---|---|
| 1. | Stephen Santeria, Microsystems Design, Kluwer publishers, 2000. |
| 2. | N.P.Mahalik, ―MEMS,Tata McGraw hill, 2007. |
| 3. | Nadim Maluf,An introduction to Micro electro mechanical system design, Artech House, 2000. |
| 4. | Mohamed Gad-el-Hak, editor, The MEMS Handbook, CRC press Baco Raton,2000. |
| 5. | Tai Ran Hsu,MEMS & Micro systems Design and Manufacture, Tata McGraw Hill, New Delhi, 2002. Liu,MEMS, Pearson education, 2007. |

| CU18006 | ADVANCED FIBER OPTIC TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the basic principles of operation of optical system components, the different network architectures and issues associated with network design.
- To enable the student to understand the benefits of coherent system and the limitations and challenges in practical implementation**.**
- To enable the student to understand the differences in the design of TDM and CDM systems when implemented in the optical domain and the challenges involved.

| | | |
|---|---|---|
| **UNIT I** | **OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN** | **9** |

Optical System Components – MZIM, Multiplexers; filters; switches; wavelength converters; optical amplifiers – EDFA, Raman Amplifiers and hybrid; Transmission system Engineering - System Model, Aimer penalty – transmitter, receiver, cross talk, dispersion compensation, wavelength stabilization, FWM.

| | | |
|---|---|---|
| **UNIT II** | **COHERENT SYSTEMS** | **9** |

Basic principles of Coherent detections – Practical constraints – Injection laser line width state of polarization, local oscillator power, fiber limitations; Modulation formats – ASK, FSK, PSK, DPSK and polatization shift keying (POL SK); Demodulation schemes – Homodyne, Heterodyne - Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

| | | |
|---|---|---|
| **UNIT III** | **OPTICAL NETWORK ARCHITECTURES** | **9** |

Introduction: First Generation optical networks –SONET / SDH Network, Second Generation (WDM) Optical Networks – Broad Cast and select, wavelength routing architectures – Media – Access Control protocols.

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|---|---|---|
| **UNIT IV** | **OPTICAL TDM AND SOLITON** | **9** |

Optical Time division Multiplexing – Int Interleaving, Packet Interleaving – Multiplexer and Demultiplexers; AND Gates **–** Non linear optical loop Mirror, Soliton – trapping AND Gate, Synchronization.

| | | |
|---|---|---|
| **UNIT V** | **OPTICAL CDMA** | **9** |

Prime codes and its properties , Generalized and Extended prime codes, Experimental demonstration of Optical CDMA, Synchronization of Optical CDMA Networks, Multiwavelength Optical CDMA Networks.

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.
- The student would be in a position to apply his knowledge for designing a fiber optic system addressing the channel impairments.
- The student would be familiar with the architectures and the protocol stack in use.in optical

| | |
|---|---|
| | networks and would be able to identify a suitable backbone infrastructure for our present and future communication needs. |
| | |

**REFERENCES:**


| | |
|---|---|
| 1. | Max Ming-Kang Liu, ―Principles and Applications of Optical Communication, Tata McGraw Hill Education Pvt., Ltd., New Delhi. |
| 2. | Le Ngyyen Binh , ―Digital Optical Communications, CRC Press – Taylor and Francis Group – Indian reprint 2012. |
| 3. | Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks : A Practical Perspective, Harcourt Asia Pte Ltd., Second Edition 2006. |
| 4. | P.E. Green, Jr., ―Fiber Optic Networks, Prentice Hall, NJ, 1993. |
| 5. | Guu-Chang Yang, ―Prime Codes with Application to Optical and Wireless Networks, Artech House, Inc., 2002. |

| CU18007 | MULTIMEDIA COMMUNICATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To enable the student to understand the basic characteristics of multimedia components and the different methods for compressing audio, video, text and images.
- To expose the students to the challenges of IP based transport and the solution approaches considering the example case of VoIP technology.
- To enable the student to understand the different networking aspects with reference to multimedia transmission.

| | | |
|---|---|---|
| **UNIT I** | **MULTIMEDIA COMPONENTS** | **9** |

Introduction - Multimedia skills - Multimedia components and their characteristics - Text, sound, images, graphics, animation, video, hardware.

| | | |
|---|---|---|
| **UNIT II** | **AUDIO AND VIDEO COMPRESSION** | **9** |

Audio compression–DPCM-Adaptive PCM –adaptive predictive coding-linear Predictive coding-code excited LPC-perceptual coding Video compression –principles-H.261-H.263-MPEG 1, 2, 4.

| | | |
|---|---|---|
| **UNIT III** | **TEXT AND IMAGE COMPRESSION** | **9** |

Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding -text compression –static Huffman coding dynamic coding –arithmetic coding –Lempel ziv-welsh Compression-image compression

| | | |
|---|---|---|
| **UNIT IV** | **VoIP TECHNOLOGY** | **9** |

Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service- CODEC Methods-VOIP applicability.

| | | |
|---|---|---|
| **UNIT V** | **MULTIMEDIA NETWORKING** | **9** |

Multimedia networking -Applications-streamed stored and audio-making the best Effort service-protocols for real time interactive Applications-distributing multimedia-beyond best effort service-scheduling and policing Mechanisms-integrated services-differentiated Services-RSVP.

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the challenges involved in multimedia signal processing and their transmission.
- The student would be in a position to apply his knowledge for identifying a suitable strategy for compression and communication based on the signal characterization and its needs.

**REFERENCES:**


1. Fred Halshall, ―Multimedia communication - applications, networks, protocols and standards‖,Pearson education, 2007.
2. Tay Vaughan, ―Multimedia: making it work, 7/e, TMH, 2007.

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|---|---|
| 3. | Kurose and W.Ross, ―Computer Networking ―a Top down approach, Pearson education, 3rd ed, 2005. |
| 4. | Marcus goncalves ―Voice over IP Networks, McGraw Hill, |
| 5. | KR. Rao,Z S Bojkovic, D A Milovanovic, ―Multimedia Communication Systems: Techniques, Standards, and Networks, Pearson Education 2007 |
| 6. | R. Steimnetz, K. Nahrstedt, ―Multimedia Computing, Communications and Applications‖,Pearson Education, First ed, 1995. |
| 7. | Ranjan Parekh, ―Principles of Multimedia, TMH, 2006. |

| CU18008 | ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN | L | T | P | C |
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**OBJECTIVES**:

- To understand the concepts related to Electromagnetic interference in PCBs
- To provide solutions for minimizing EMI in PCBs
- To learn EMI standards and measurements in the design of PCBs
- To provide knowledge on EMI control techniques and design procedures to make EMI compatible PCBs

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| **UNIT I** | **EMI/EMC CONCEPTS** | **9** |

EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards.

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| **UNIT II** | **EMI COUPLING PRINCIPLES** | **9** |

Conducted, radiated and transient coupling; Common ground impedance coupling ; Common mode and ground loop coupling ; Differential mode coupling ; Near field cable to cable coupling, cross talk ; Field to cable coupling ; Power mains and Power supply coupling.

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| **UNIT III** | **EMI CONTROL TECHNIQUES** | **9** |

Shielding, Filtering, Grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control.

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| **UNIT IV** | **EMC DESIGN OF PCBS** | **9** |

Component selection and mounting; PCB trace impedance; Routing; Cross talk control; Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations.

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| **UNIT V** | **EMI MEASUREMENTS AND STANDARDS** | **9** |

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462.

**TOTAL : 45 PERIODS**

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

- Analyze Electromagnetic interference effects in PCBs
- Propose solutions for minimizing EMI in PCBs
- Analyze Electromagnetic environment, EMI coupling, standards, measurement and control techniques

**REFERENCES:**


1. V.P.Kodali, ―Engineering EMC Principles, Measurements and Technologies, IEEE Press, Newyork, 1996.
2. Henry W.Ott.,Noise Reduction Techniques in Electronic Systems, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.

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| 3. | Bemhard Keiser, Principles of Electromagnetic Compatibility, 3rd Ed, Artech house, Norwood, 1986. |
| 4. | C.R.Paul,Introduction to Electromagnetic Compatibility, John Wiley and Sons, Inc, 1992. |
| 5. | Don R.J.White Consultant Incorporate, ―Handbook of EMI/EMC , Vol I-V, 1988. |

| CU18009 | COMMUNICATION NETWORK SECURITY | L | T | P | C |
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**OBJECTIVES**:

- To make the student understand the importance and goals of communication network and information security and introduce him to the different types of attacks.
- To expose the student to the different approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.
- To enable the student to appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.

| UNIT I | INTRODUCTION ON SECURITY | 9 |
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Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability. Security services and mechanisms, Techniques: Cryptography, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers- Steganography- Revision on Mathematics for Cryptography.

| UNIT II | SYMMETRIC & ASYMMETRIC KEY ALGORITHMS | 9 |
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Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, principle of asymmetric key algorithms, RSA Cryptosystem

| UNIT III | INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT | 9 |
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Message Integrity, Hash functions: SHA 512**,** Whirlpool, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

| UNIT IV | NETWORK SECURITY, FIREWALLS AND WEB SECURITY | 9 |
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Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. E-mail security: PGP, MIME,S/MIME. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature

| UNIT V | WIRELESS NETWORK SECURITY | 9 |
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Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for Broadband networks: Secure Ad hoc Network, Secure Sensor Networks

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the ways in which communication network security may get compromised and the basic principles of security algorithm design.
- The student would be able to implement and analyse the different algorithms and compare their performances.
- The student would be in a position to apply his knowledge for designing or modifying existing algorithms and implementing them atleast by simulation.

**REFERENCES:**


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| 1. | Behrouz A. Forouzan ,Cryptography and Network security, McGraw- Hill, 2011 |
| 2. | William Stallings,"Cryptography and Network security: principles and practice", 2nd Edition,Prentice Hall of India,New Delhi, 2002 |
| 3. | Atul Kahate , Cryptography and Network security, 2nd Edition, Tata McGraw-Hill, 2008. |
| 4. | R.K.Nichols and P.C. Lekkas ,Wireless Security: Models , threats and Solutions, McGraw- Hill, 2001. |
| 5. | H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, Feb. 2004. |
| 6. | Securing Ad Hoc Networks," IEEE Network Magazine, vol. 13, no. 6, pp.24-30, Dec.1999. |
| 7. | "Security of Wireless Ad Hoc Networks,"http://www.cs.umd.edu/~aram/wireless/survey.pdf |
| 8. | David Boel et.al ―Securing Wireless Sensor Networks – Security Architecture ― Journal ofnetworks , Vol.3. No. 1. pp. 65 -76, Jan 2008 |
| 9. | Perrig, A., Stankovic, J., Wagner, D., ―Security in Wireless Sensor **Networks**,Communications of the ACM, 47(6), 53-57, (2004). |

| CU18010 | SATELLITE COMMUNICATION | L | T | P | C |
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**OBJECTIVES**:

- To enable the student to understand the necessity for satellite based communication, the essential elements involved and the transmission methodologies.
- To enable the student to understand the different interferences and attenuation mechanisms affecting the satellite link design.
- To expose the student to the advances in satellite based navigation, GPS and the different application scenarios.

| UNIT I | ELEMENTS OF SATELLITE COMMUNICATION | 9 |
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Satellite Systems- history and overview; Orbital description and locating satellite in the orbit, orbital elements, orbital effects in communication system performance; Satellite antennas- basic antenna types and relationships, satellite antennas in practice; equipment reliability and space qualification – space qualification, reliability and redundancy.

| UNIT II | SATELLITE SPACE SEGMENT AND ACCESS | 9 |
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Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, transponders; antenna subsystem, equipment reliability and space qualification, Multiple Access – FDMA, intermodulation and calculation of C/N with intermodulation TDMA, bits, symbols and channels, frame structure, guard time, synchronization in TDMA networks, CDMA, spread spectrum transmission and reception.

| UNIT III | SATELLITE LINK DESIGN | 9 |
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Basic Transmission theory, Link Design: System noise temperature and G/T ratio, Downlink and uplink design, satellite systems using small earth stations, design for specified C/N- combining C/N and C/I values, uplink and downlink attenuation in rain, satellite communication link design procedure; error correction and detection for digital satellite links.

| UNIT IV | SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM | 9 |
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Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS.

| UNIT V | APPLICATIONS | 9 |
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Satellite Packet Communications , Intelsat series, INSAT series, VSAT Systems: Network architectures , access control protocols, earth station engineering, antennas , link margins, system design procedure , mobile satellite services, Satellite Phones, INMARSAT, Remote Sensing, Satellite and Cable Television, DBS (DTH).

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the basic principles of satellite orbits, placement and control, satellite link design and the communication system components.
- The student would be able to demonstrate an understanding of the different communication, sensing and navigational applications of satellite and their

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| | implementation. | |
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| **REFERENCES:** | |
| 1. | Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, ―Satellite Communication Systems Engineering, Prentice Hall/ Pearson, 2007. |
| 2. | Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 2nd Edition, 2012. |
| 3. | D.Roddy, Satellite Communication, 4th Edition (Reprint), McGraw Hill, 2009. |
| 4. | Tri T Ha, Digital Satellite Communication, 2nd Edition, McGraw Hill,1990. |
| 5. | B.N.Agarwal, Design of Geosynchronous Spacecraft, Prentice Hall, 1993. |
| 6. | Brian Ackroyd, ―World Satellite Communication and Earth Station Design, BSP Professional Books, 1990. |

| AL18012 | WIRELESS SENSOR NETWORKS | L | T | P | C |
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**OBJECTIVES**:

- To enable the student to understand the role of sensors and the networking of sensed data for different applications.
- To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario.
- To enable the student to understand the challenges in synchronization and localization of sensor nodes, topology management for effective and sustained communication, data management and security aspects.

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| **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- case study, Enabling Technologies for Wireless Sensor Networks.

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| **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, Gateway Concepts. Physical Layer and Transceiver Design Considerations

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| **UNIT III** | **MAC AND ROUTING** | **9** |

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, 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.

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| **UNIT IV** | **INFRASTRUCTURE ESTABLISHMENT** | **9** |

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

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| **UNIT V** | **DATA MANAGEMENT and SECURITY** | **9** |

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

**TOTAL : 45 PERIODS**

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

- The student would be able to appreciate the need for designing energy efficient sensor nodes and protocols for prolonging network lifetime.
- The student would be able to demonstrate an understanding of the different implementation challenges and the solution approaches.

**REFERENCES:**


1. Ian F. Akyildiz, Mehmet Can Vuran, ― Wireless Sensor Networks, John Wiley, 2010
2. Yingshu Li, My T. Thai,Weili Wu, ― Wireless Sensor Networks and Applications,Springer 2008

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| 3. | Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005. |
| 4. | Feng Zhao & Leonidas J. Guibas, ―Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007. |
| 5. | Kazem Sohraby, Daniel Minoli, & Taieb Znati, ―Wireless Sensor Networks-s |
| 6. | Anna Hac, ―Wireless Sensor Network Designs, John Wiley, 2003. |
| 7. | Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge Press,2005. |
| 8. | Mohammad Ilyas And Imad Mahgaob,Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems, CRC Press,2005. |
| 9. | Wayne Tomasi, ―Introduction To Data Communication And Networking, Pearson Education, 2007 |

| CU18011 | ADVANCED MICROWAVE COMMUNICATION | L | T | P | C |
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**OBJECTIVES**:

- To enable the student to understand the basic principles of microwave amplifiers and oscillators, passive component characteristics, resonators and filters, antennas and microwave radio link characterization.

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| **UNIT I** | **MICROWAVE AMPLIFIERS AND OSCILLATORS** | **10** |

Klystron Amplifier – Reflex Klystron Amplifier –Travelling wave tube Amplifier – Magnetron Oscillator and Modulator-Varactor diode – Solid State Broad band Amplifiers – diode detector and mixer-- YIG tuned Oscillators– Comb generators. GUNN, Tunnel IMPATT diode oscillators.

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| **UNIT II** | **MICROWAVE PASSIVE COMPONENTS** | **8** |

Scattering parameters-S-Matrix – Attenuator –Phase shifters – T Junctions – Hybrid T Junctions – Directional couplers – Isolater, Properties of ferrite devices – YIG devices—Step recovery Diodes – Gyrator – Circulator – Scattering parameter measurement.

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| **UNIT III** | **MICROWAVE RESONATORS AND FILTERS** | **9** |

Review of resonant circuits – principle of Microwave resonators – field analysis of cavity resonators – Characteristics of filters –YIG tuned filters – Filter and resonant applications – SRD Frequency multipliers and frequency Discriminators.

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| **UNIT IV** | **MICROWAVE ANTENNAS** | **8** |

Characteristics of Microwave Antennas – Half Wave Dipole –Array – Horn –Paraboloidal Reflector – feeds – Lens and slot Antennas – Leaky and surface wave Antennas – Broad band Antennas – Micro strip Antennas – Antenna measurements.

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| **UNIT V** | **MICROWAVE RADIO SYSTEM** | **10** |

Satellite Packet Communications , Intelsat series, INSAT series, VSAT Systems: Network architectures , access control protocols, earth station engineering, antennas , link margins, system design procedure , mobile satellite services, Satellite Phones, INMARSAT, Remote Sensing, Satellite and Cable Television, DBS (DTH).

**TOTAL : 45 PERIODS**

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

- The student would be able to design a microwave system taking into account the path losses and fading channel characteristics,
- The student will able to carry out measurements and interpret results obtained from Microwave system

**REFERENCES:**


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|---|---|
| 1. | Roddy.D., ―Microwave Technology, Reston Publications.1986. |
| 2. | Chatterjee R. ―Microwave Engineering ―East West Press. 1988. |
| 3. | Rizzi.P. Microwave Engineering Passive circuits. Prentice Hall.1987 |
| 4. | Tomasi.W ―Advanced Electronic communication systems ―Prentice Hall.1987. |
| 5. | Clock.P.N. ―Microwave Principles and Systems, Prentice Hall.1986. |
| 6. | Combes, Graffewil and Sauterean ―Microwave Components, Devices and Active Circuits. |

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| | John wiley.1987. |
| 7. | Annapurana Das.Sisir.K.Das,‖Microwave Engineering‖ Tata Mc Graw Hill, 2000. |

| CU18012 | ADVANCED WIRELESS COMMUNICATION TECHNIQUES | L | T | P | C |
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**OBJECTIVES**:

- To enable the student to understand the evolving paradigm of cooperative and green wireless communication concepts and the challenges and trade-offs involved in such networks.
- To enable the student to understand the different power saving strategies and energy efficient signal, system and network design.
- To expose the student to the energy saving techniques adopted in existing wireless components, protocols and networks and the evolution of green future wireless communication technologies.

| UNIT I | COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS | 9 |
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Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

| UNIT II | COOPERATIVE TECHNIQUES | 9 |
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Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

| UNIT III | RELAY-BASED COOPERATIVE CELLULAR NETWORKS | 9 |
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Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

| UNIT IV | GREEN RADIO NETWORKS | 9 |
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Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations, Power-management for base stations in smart grid environment, Cooperative multicell processing techniques for energy-efficient cellular wireless communications.

| UNIT V | ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS | 9 |
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Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks; Energy performance in TDD-CDMA multihop cellular networks ; Resource allocation for green communication in relay-based cellular networks ; Green Radio Test-Beds and Standardization Activities.

**TOTAL : 45 PERIODS**

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

- The student would be able to appreciate the necessity and the design aspects of cooperative and green wireless communication.
- The student would be able to evolve new techniques and demonstrate their feasibility

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| using mathematical validations and simulation tools.<br>• The student would be able to demonstrate the impact of the green engineering solutions in a global, economic, environmental and societal context. | |
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| **REFERENCES:** | |
| 1. | Ekram Hossain, Dong In Kim, Vijay K. Bhargava , ―Cooperative Cellular Wireless Networks, Cambridge University Press, 2011. |
| 2. | Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), ―Green RadioCommunication Networks, Cambridge University Press, 2012. |
| 3. | F. Richard Yu, Yu, Zhang and Victor C. M. Leung ―Green Communications and Networking,CRC press, 2012. |
| 4. | Mazin Al Noor, ―Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access, GRIN Verlag, 2012. |
| 5. | Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, ―Handbook of Green Information and Communication Systems‖, Academic Press, 2012. |
| 6. | Ramjee Prasad and Shingo Ohmori, Dina Simunic, ―Towards Green ICT, River Publishers, 2010. |
| 7. | Jinsong Wu, Sundeep Rangan and Honggang Zhang, ―Green Communications: Theoretical Fundamentals, Algorithms and Applications, CRC Press, 2012. |

| CU18013 | COGNITIVE RADIO NETWORKS | L | T | P | C |
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**OBJECTIVES**:

- To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To enable the student to understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
- To expose the student to the evolving next generation wireless networks and their associated challenges.

| UNIT I | SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE | 9 |
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Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

| UNIT II | COGNITIVE RADIOS AND ITS ARCHITECTURE | 9 |
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Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio– functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architechture.

| UNIT III | SPECTRUM SENSING AND IDENTIFICATION | 9 |
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Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector,Matched Filter ,Cooperative Sensing , Definition and Implications of Spectrum Opportunity, Spectrum Opportunity Detection , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

| UNIT IV | USER COOPERATIVE COMMUNICATIONS | 9 |
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User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel , User Cooperation in Wireless Networks: Two-User Cooperative Network, Cooperative Wireless Network , Multihop Relay Channel

| UNIT V | INFORMATION THEORETICAL LIMITS ON CR NETWORKS | 9 |
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Types of Cognitive Behavior, Interference-Avoiding Behavior: Spectrum Interweave, Interference-Controlled Behavior: Spectrum Underlay, Underlay in Small Networks: Achievable Rates, Underlay in Large Networks: Scaling Laws, Interference-Mitigating Behavior: Spectrum Overlay, Opportunistic Interference Cancellation, Asymmetrically Cooperating Cognitive Radio Channels.

**TOTAL : 45 PERIODS**

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

- The student would be able to appreciate the motivation and the necessity for cognitive radio communication strategies.

- The student would be able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
- The student would be able to demonstrate the impact of the evolved solutions in future wireless network design.

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**REFERENCES:**


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| 1. | Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, ― Cognitive Radio Communications And Networks - Principles And Practice, Elsevier Inc. , 2010. |
| 2. | Kwang-Cheng Chen and Ramjee Prasad, Cognitive Radio Networks , John Wiley & Sons, Ltd, 2009. |
| 3. | Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, ―Cognitive Radio Networks - From Theory to Practice, Springer Series: Analog Circuits and Signal Processing, 2009. |
| 4. | J. Mitola, ― Cognitive Radio: An Integrated Agent Architecture for software defined radio, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000. |
| 5. | Simon Haykin, ―Cognitive Radio: Brain –empowered wireless communications, IEEE Journal on selected areas in communications, Feb 2005. |
| 6. | Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, ― Next generation/ /dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks, May 2006. |

| CU18014 | COMMUNICATION NETWORK DESIGN | L | T | P | C |
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**OBJECTIVES**:

- To expose the student to the functional elements and evolution of networking, the multiplexing, switching and routing related issues and some case studies of wired and wireless network design process.
- To enable the student to analyse the various aspects of a protocol and implement it using a network simulation tool.

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

Importance of Quantitative Modeling in Engineering of Telecommunication networks, The Functional Elements of Networking, Evolution of Networking in the Wired and Wireless Domain.

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| **UNIT II** | **MULTIPLEXING** | **9** |

Performance Measures and Engineering Issues Network performance and source characterization, Circuit multiplexed Networks, packet Multiplexing over wireless networks, Events and processes in packet multiplexer models, Deterministic traffic Models and network calculus, stochastic traffic models, LRD traffic, Link Scheduling and network capacity in wireless networks.

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| **UNIT III** | **SWITCHING** | **9** |

Performance Measures of packet switches and circuit switches, queuing in packet switches, delay Analysis in Output Queued Switch, Input Queued Switch and CIOQ Switch with Parallelism, Blocking in Switching Networks, Closed Networks.

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| **UNIT IV** | **ROUTING** | **9** |

Algorithms for Shortest Path Routing - Dijkstra‘s Algorithm, Bellman Ford Algorithm, Generalized Dijkstra‘s Algorithm, Optimal Routing, Routing Protocols-Distance Vector, Link State and Exterior gateway protocols, Formulations of the Routing Problem-minimum interference Routing, MPLS, QoS Routing, Non additive and Additive metrics

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| **UNIT V** | **CASE STUDIES** | **9** |

Design of a wireless network and a wired network, prototype implementation to be simulated in a network simulator.

**TOTAL : 45 PERIODS**

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

- Given the specifications of an application, the student would be able to break up the communication network design problem into a number of sub-problems, identify suitable protocol solutions,
- The student will able to implement the communication network design using any simulator tool and carry out performance characterization.

**REFERENCES:**


1. Anurag Kumar, D. Manjunath and Joy ―Communication Networking, Morgan Kaufan Publishers,2005.
2. A.Lean Garica and Indra Widjaja,Communications Networks, Tata Mc Graw Hill,2004.

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| 3. | Thomas G.Robertazzi, ―Computer Networks and Systems, Third Edition, Springer,2006. |
| 4. | Keshav.S., ―An Engineering Approach to Computer Networking, Addison – Wesley, 1999. |

| CU18015 | MOBILE AD HOC NETWORKS | L | T | P | C |
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**OBJECTIVES**:

- To introduce the characteristic features of adhoc wireless networks and their applications to the students.
- To enable the student to understand the functioning of different access and routing protocols that can be used for adhoc networks.
- To enable the student to understand the need for security and the challenges and also the role of crosslayer design in enhancing the network performance.

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

Introduction to Ad Hoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - entity and group models.

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| **UNIT II** | **MEDIUM ACCESS PROTOCOLS** | **9** |

MAC Protocols: design issues, goals and classification. Contention based protocols, reservation based protocols, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

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| **UNIT III** | **NETWORK PROTOCOLS** | **9** |

Addressing issues in ad hoc network, Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Power/ Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

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| **UNIT IV** | **END -TO - END DELIVERY AND SECURITY** | **9** |

Transport layer: Issues in designing- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols.

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| **UNIT V** | **CROSS LAYER DESIGN AND INTEGRATION** | **9** |

Design of a wireless network and a wired network, prototype implementation to be simulated in a network simulator.

**TOTAL : 45 PERIODS**

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

- The student would be able to demonstrate an understanding of the trade-offs involved in the design of adhoc networks
- The student would be able to design and implement protocols suitable to adhoc communication scenario using design tools and characterize them.
- The student is exposed to the advances in adhoc network design concepts.

**REFERENCES:**


1. C.Siva Ram Murthy and B.S.Manoj, ―Ad hoc Wireless Networks Architectures and protocols,2nd edition, Pearson Education. 2007
2. Charles E. Perkins, ―Ad hoc Networking, Addison – Wesley, 2000
3. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, ―Mobile adhoc networking, Wiley-IEEE press, 2004.

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| 4. | Mohammad Ilyas, ―The handbook of adhoc wireless networks, CRC press, 2002. |
| 5. | T. Camp, J. Boleng, and V. Davies ―A Survey of Mobility Models for Ad Hoc Network Research,Wireless Communication and Mobile Comp., Special Issue on Mobile Ad Hoc Networking Research, Trends and Applications, vol. 2, no. 5, 2002, pp. 483–502. |
| 6. | Fekri M. Abduljalil and Shrikant K. Bodhe , ―A survey of integrating IP mobility protocols and Mobile Ad hoc networks, IEEE communication Survey and tutorials, v 9.no.1 2007. |
| 7. | Erdal Çayırcı and Chunming Rong c, ― Security in Wireless Ad Hoc and Sensor Networks 2009, John Wiley & Sons, Ltd. ISBN: 978-0-470-02748-6 |

| CU18016 | MIMO SYSTEMS | L | T | P | C |
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**OBJECTIVES**:

- To introduce the concept of MIMO sytems
- To inculcate the knowledge of beamforming in MIMO systems
- To provide knowledge channel estimation techniques for an MIMO system

**UNIT I** **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

**UNIT II** **9**

The generic MIMO problem, Singular Value Decomposition, Eigen values and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion 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 precoding and combining, Channel state information.

**UNIT III** **9**

Codebooks for MIMO, Beamforming, Beamforming principles, Increased spectrum efficiency, Interference cancellation, Switched beamformer, Adaptive beamformer, Narrowband beamformer, Wideband beamformer

**UNIT IV** **9**

Case study: MIMO in LTE, Codewords to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beamforming 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, MIMO channel models

**UNIT V** **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.

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**TOTAL : 45 PERIODS**

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

- Understand channel modeling and propagation, MIMO Capacity, space-time coding,

MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.

- Understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE, LTE-Advanced, WiMAX).
- Perform Mathematical modelling and analysis of MIMO systems.

**REFERENCES:**


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|---|---|
| 1. | Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications : From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010. |
| 2. | Mohinder Janakiraman, “Space - Time Codes and MIMO Systems”, Artech House Publishers, 2004. |

| CU18017 | SPEECH PROCESSING AND SYNTHESIS FOR COMMUNICATION SYSTEM | L | T | P | C |
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**OBJECTIVES**:

- To introduce speech production and related parameters of speech.
- To illustrate the concepts of speech signal representations and coding.
- To understand different speech modeling procedures such Markov and their implementation issues.
- To gain knowledge about text analysis and speech synthesis. .

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| **UNIT I** | **FUNDAMENTALS OF SPEECH PROCESSING** | **9** |

Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

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| **UNIT II** | **SPEECH SIGNAL REPRESENTATIONS AND CODING** | **9** |

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vocoders.

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| **UNIT III** | **SPEECH RECOGNITION** | **9** |

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

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| **UNIT IV** | **TEXT ANALYSIS** | **9** |

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation

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| **UNIT V** | **SPEECH SYNTHESIS** | **9** |

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

**TOTAL : 45 PERIODS**

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

- Model speech production system and describe the fundamentals of speech.
- Extract and compare different speech parameters.
- Choose an appropriate statistical speech model for a given application.
- Design a speech recognition system.
- Use different text analysis and speech synthesis techniques.

**REFERENCES:**


1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006

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|---|---|
| 2. | Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999 |
| 3. | Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002 |
| 4. | Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997. |
| 5. | Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003. |
| 6. | Steven W. Smith, “The Scientist and Engineers Guide to Digital Signal Processing”, California Technical Publishing, 1997 |
| 7. | Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004. |

| AL18019 | ADVANCED DIGITAL IMAGE PROCESSING | L | T | P | C |
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**OBJECTIVES**:

- To understand the image fundamentals.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

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| **UNIT I** | **FUNDAMENTALS OF DIGITAL IMAGE PROCESSING** | **9** |

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT,SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing.

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| **UNIT II** | **SEGMENTATION** | **9** |

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

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| **UNIT III** | **FEATURE EXTRACTION** | **9** |

First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

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| **UNIT IV** | **REGISTRATION AND IMAGE FUSION** | **9** |

Registration - Preprocessing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, wavelet based fusion -region based fusion.

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| **UNIT V** | **3D IMAGE VISUALIZATION** | **9** |

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

**TOTAL : 45 PERIODS**

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

- Explain the fundamentals digital image processing.
- Describe image various segmentation and feature extraction techniques for image analysis.
- Discuss the concepts of image registration and fusion.
- Explain 3D image visualization.

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|---|---|
| • Use different text analysis and speech synthesis techniques. | |
| **REFERENCES:** | |
| 1. | Ardeshir Goshtasby, " 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications",John Wiley and Sons,2005. |
| 2. | Anil K. Jain, Fundamentals of Digital Image Processing', Pearson Education, Inc., 2002 |
| 3. | C.Russ, "The Image Processing Handbook", CRC Press,2007 |
| 4. | Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press,2008. |
| 5. | Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson,Education, Inc.,Second Edition, 2004. |
| 6. | Rick S.Blum, Zheng Liu, "Multisensor image fusion and its Applications", Taylor& Francis,2006. |

| CU18018 | ULTRAWIDE BAND COMMUNICATION | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES**:

- To introduce UWB communication system with various technologies
- To provide in-depth knowledge on signal processing over UWB system
- To familiarize with the UWB antenna, UWB applications and regulations

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| **UNIT I** | **INTRODUCTION TO UWB** | **9** |

History, Definition, FCC Mask, UWB features, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

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| **UNIT II** | **UWB TECHNOLOGIESAND CHANNEL MODELS** | **9** |

Impulse Radio, Pulsed Multiband, Multiband OFDM, features: Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization Ultra Wide Band Wireless Channels Channel model: Impulse Response Modeling of UWB Wireless Channels, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling.

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| **UNIT III** | **UWB SIGNAL PROCESSING** | **9** |

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error, Locationing with OFDM.

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| **UNIT IV** | **UWB ANTENNAS** | **9** |

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

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| **UNIT V** | **UWB APPLICATIONS AND REGULATIONS** | **9** |

Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications UWB Regulation and standards in various countries, UWB

**TOTAL : 45 PERIODS**

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

**REFERENCES:**


1. Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications"1st Edition, Springer Science &Business Media B.V. 2009.
2. Thomas Kaiser, Feng Zheng "Ultra Wideband Systems with MIMO", 1st Edition, John Wiley & Sons Ltd, New York, 2010.
3. W. Pam Siriwongpairat and K.J.Ray Liu, "Ultra-Wideband Communications Systems:Multiband OFDM approach" John Wiley and IEEE press, New York 2008.

| CU18311 & CU18411 | PROJECT WORK PHASE I & II | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 12 | 6 |
| | | 0 | 0 | 30 | 15 |

**OBJECTIVES**:

- To make the student to take up an research issue related to communication system and provide an optimal solution for the same.
- To make the student to prepare a detailed report on the research issue they came across.

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domain

The student should complete the following:

- Literature survey Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them. It may be based on:

- Experimental verification / Proof of concept.
- Design, fabrication, testing of Communication System.
- The viva-voce examination will be based on the above report and work.

**Guidelines for Dissertation Phase – I and II**

- Dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.
    - The dissertation may be carried out preferably in-house i.e. department's laboratories and

centers OR in industry allotted through department's T & P coordinator.

- After multiple interactions with guide and based on comprehensive literature survey, the

student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computing and Processing (Hardware and Software), Circuits-Devices and Systems, Communication-Networking and Security, Robotics and Control Systems,Signal Processing and Analysis and any other related domain. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.

Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

- Phase – I deliverables: A document report comprising of summary of literature survey,

detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.

- Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the Phase-I work.
    - During phase – II, student is expected to exert on design, development and testing of the

proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences

OR IP/Patents.

- Phase – II deliverables: A dissertation report as per the specified format, developed system in

the form of hardware and/or software, A record of continuous progress.

- Phase – II evaluation: Guide along with appointed external examiner shall

assess theprogress/performance of the student based on report, presentation and Q & A.
In case ofun satisfactory performance, committee may recommend for extension or repeating
the work

**TOTAL : 12 + 30 = 42**