Subject Code : MCE 201	**Category :** Program Core III
Subject Name : Antennas and Radiating Systems	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna.
Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Unit 2

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects.
Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Unit 3

Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, planar array, and Design consideration.

Unit 4

Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture.
Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

Unit 5

Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.

Unit 6

Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Course Outcomes:

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

1. Compute the far field distance, radiation pattern and gain of an antenna for given current distribution.
2. Estimate the input impedance, efficiency and ease of match for antennas.
3. Compute the array factor for an array of identical antennas.

4. Design antennas and antenna arrays for various desired radiation pattern characteristics.

Learning Recourses:

1. Constantine A. Balanis, “Antenna Theory Analysis and Design”, John Wiley & Sons, 4th edition, 2016.
2. John D Kraus, Ronald J Marhefka, Ahmad S Khan, “Antennas for All Applications”, Tata McGraw-Hill, 2002.
3. R.C.Johnson and H.Jasik, “Antenna Engineering hand book”, Mc-Graw Hill, 1984.
4. I.J.Bhal and P.Bhartia, “Micro-strip antennas”, Artech house, 1980.

Subject Code : MCE 202	**Category :** Program Core IV
Subject Name : Advanced Digital Signal Processing	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters,IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

Unit 2

Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in subband coding.

Unit 3

Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Unit 4

Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm.

Unit 5

Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

Unit 6

Application of DSP & Multi rate DSP, Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications.

Course Outcomes:

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

1. To understand theory of different filters and algorithms
2. To understand theory of multirate DSP, solve numerical problems and write algorithms
3. To understand theory of prediction and solution of normal equations
4. To know applications of DSP at block level.

Learning Recourses:

1. 1. J.G.Proakis and D.G.Manolakis"Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Academic Press, 1997.
4. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.
5. S.Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.
6. 6. D.G.Manolakis, V.K. Ingle and S.M.Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000

Subject Code : MCE 203	**Category :** Program Elective-III
Subject Name : Satellite Communication	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Unit 2

Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.

Unit 3

Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

Unit 4

Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Unit 5

Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

Unit 6

Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.

Course Outcomes:

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

1. Visualize the architecture of satellite systems as a means of high speed, high range communication system.

2. State various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation and multiple access schemes.
3. Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

Learning Recourses:

1. Timothy Pratt and Others, “Satellite Communications”, Wiley India, 2nd edition, 2010.
2. S. K. Raman, “Fundamentals of Satellite Communication”, Pearson Education India, 2011.
3. Tri T. Ha, “Digital Satellite Communications”, Tata McGraw Hill, 2009.
4. Dennis Roddy, “Satellite Communication”, McGraw Hill, 4th Edition, 2008

Subject Code : MCE 203	**Category :** Program Elective-III
Subject Name : Internet of things	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Smart cities and IOT revolution, Fractal cities, From IT to IOT, M2M and peer networking concepts, Ipv4 and IPV6.

Unit 2

Software Defined Networks SDN, From Cloud to Fog and MIST networking for IOT communications, Principles of Edge/P2P networking, Protocols to support IOT communications, modular design and abstraction, security and privacy in fog.

Unit 3

Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and configuration.

Unit 4

Smart objects as building blocks for IOT, Open source hardware and Embedded systems platforms for IOT, Edge/gateway, IO drivers, C Programming, multithreading concepts.

Unit 5

Operating systems requirement of IOT environment, study of mbed, RIOT, and Contiki operating systems, introductory concepts of big data for IOT applications.

Unit 6

Applications of IOT, Connected cars IOT Transportation, Smart Grid and Healthcare sectors using IOT, Security and legal considerations, IT Act 2000 and scope for IOT legislation.

Course Outcomes:

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

1. Understand what IOT technologies are used for today and what is required in certain scenarios.
2. Understand the types of technologies that are available and in use today and can be utilized to implement IOT solutions.
3. Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications.

Learning Recourses:

1. A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, VPT publisher, 2014.
2. A. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.
3. CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.
4. Samuel Greenguard, “Internet of things”, MIT Press, 2015.

Web Recourses:

1. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things1.html
2. https://developer.mbed.org/handbook/AnalogIn
3. http://www.libelium.com/50_sensor_applications/
4. M2MLabs Mainspring http://www.m2mlabs.com/framework
5. Node-RED http://nodered.org/

Subject Code : MCE 203	**Category :** Program Elective-III
Subject Name : Voice and Data Networks	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

Unit 2

Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit 3

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

Unit 4

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

Unit 5

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

Unit 6

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

Course Outcomes:

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

1. Protocol, algorithms, trade-offs rationale.
2. Routing, transport, DNS resolutions
3. Network extensions and next generation architectures.

Learning Recourses:

1. D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, Prentice Hall, 1992.
2. L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kaufman, 2011.
3. Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach", 1st Edition, Morgan Kaufman, 2004.
4. Walrand, "Communications Network: A First Course", 2nd Edition, McGraw Hill, 2002.
5. Leonard Kleinrock, "Queueing Systems, Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.
6. Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill, 1993.
7. Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill, 1987

Subject Code : MCE 204	**Category :** Program Elective-IV
Subject Name : Markov Chains and Queuing Systems	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Introduction: Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem.

Unit 2

Renewal Processes: Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Poisson process, Walds equation, Blackwell's theorem.

Unit 3

Discrete time Markov chains: definitions and properties, matrix representation, Perron-Frobenius theory.

Unit 4

Continuous time Markov chains: basic definitions, Q-matrix, birth-death processes, quasi birth death processes; Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.

Unit 5

Fundamental queuing results: Little's theorem, invariance of the mean delay, Conservation law.
Markovian queues: Jackson and BCMP networks, numerical Algorithms. M/G/1 & G/M/1 queues and G/G/1 queues.

Unit 6

Advanced queuing models: priority, vacation and retrials in queues.

Course Outcomes:

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

1. Understand Markov Chains and regenerative processes used in modelling a wide variety of systems and phenomena.
2. Model a system as queuing system with some aspect of the queue governed by a random process.
3. Understand telecommunication systems modelling using Markov chains with special emphasis on developing queuing models.

Learning Recourses:

1. Cliffs, "Stochastic Modelling and the Theory Queues", Prentice Hall, 1989.
2. P.Bremaud, "Markov Chains", Springer-Verlag, 1999.
3. E.Seneta, "Non Negative Matrices and Markov Chains", Springer Series in Statistics, Springer, 1981.
4. R.Gallager, "Discrete Stochastic Processes", Kluwer Academic Press, 1996.
5. L.Kleinrock, "Queuing Systems", vols I and II, John Wiley and Sons 1976.

Subject Code : MCE 204	**Category :** Program Elective-IV
Subject Name : MIMO Systems	**Semester** : II
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites:	

Course Outline:

Unit 1

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Unit 2

Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.

Unit 3

The generic MIMO problem, Singular Value Decomposition, Eigenvalues 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 4

Codebooks for MIMO, Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former.

Unit 5

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

Unit 6

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.

Course Outcomes:

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

1. Understand channel modelling and propagation, MIMO Capacity, space-time coding, MIMO receivers, MIMO for multi-carrier systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.
2. Understand cooperative and coordinated multi-cell MIMO, introduction to MIMO in 4G (LTE, LTE-Advanced, WiMAX).
3. Perform Mathematical modelling and analysis of MIMO systems.

Learning Recourses:

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.

Subject Code : MCE 204	**Category :** Program Elective-IV
Subject Name : Programmable Networks - SDN, NFV	**Semester** : II
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites:	

Course Outline:

Unit 1

Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.

Unit 2

Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.

Unit 3

Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.

Unit 4

Control Plane: Overview, Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hardware-based; Programmable Network Hardware.

Unit 5

Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

Unit 6

Data Centre Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centres, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Course Outcomes:

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

1. Understand advanced concepts in Programmable Networks.
2. Understand Software Defined Networking, an emerging Internet architectural framework.
3. Implement the main concepts, architectures, algorithms, protocols and applications in SDN and NFV.

Learning Recourses:

1. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O'Reilly Media, August 2013.
2. Paul Goransson, Chuck Black, Timothy Culver. “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publishers, 2016.
3. Fei Hu, “Network Innovation through Open Flow and SDN: Principles and Design”, CRC Press, 2014.
4. Vivek Tiwari, “SDN and Open Flow for Beginners”, Amazon Digital Services, Inc., ASIN: 2013.
5. Nick Feamster, Jennifer Rexford and Ellen Zegura, “The Road to SDN: An Intellectual History of Programmable Networks” ACM CCR April 2014.
6. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.
7. Open Flow standards, http://www.openflow.org, 2015.

Subject Code : MCE 291	**Category :** Lab-III
Subject Name : Antennas and Radiating Systems Lab	**Semester** : II
L-T-P : **0-0-4**	**Credit: 2**
Pre-Requisites:	

List of Assignments:

1. Simulation of half wave dipole antenna.
2. Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna.
3. Simulation of quarter wave, full wave antenna and comparison of their parameters.
4. Simulation of monopole antenna with and without ground plane.
5. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
6. Simulation of a half wave dipole antenna array.
7. Study the effect of change in distance between elements of array on radiation pattern of dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9. Case study.

Course Outcomes:

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

1. Determine specifications, design, construct and test antenna.
2. Explore and use tools for designing, analysing and testing antennas. These tools include Antenna design and analysis software, network analysers, spectrum analysers, and antenna pattern measurement techniques.

Subject Code : MCE 292	**Category :** Lab-IV
Subject Name : Advanced Digital Signal Processing lab	**Semester** : II
L-T-P : **0-0-4**	**Credit: 2**
Pre-Requisites:	

List of Assignments:

1. Basic Signal Representation
2. Correlation Auto And Cross
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT Of Input Sequence
5. Butterworth Low pass And High pass 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
15. Group Delay Calculation
16. Separation Of T/F
17. Parallel Realization of IIR filter

Course Outcomes:

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

1. Design different digital filters in software
2. Apply various transforms in time and frequency
3. Perform decimation and interpolation