MCKV INSTITUTE OF ENGINEERING

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Approved by AICTE & affiliated to Maulana Abul Kalam Azad University of Technology, West Bengal
243 G.T. Road (N), Liluah, Howrah- 711204, West Bengal, India
Ph: +91 33 26549315/17 Fax +91 33 26549318 Web: www.mckvie.edu.in

Curriculum for Postgraduate Degree (M.Tech.) in Electronics and Communication Engineering (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Second Semester

Course Name:	**Antennas and Radiating Systems**		
Course Code:	PC-MCE201	**Category:**	Professional Core Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	EM Theory & Transmission Lines
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Contents:

Module No.	Description of Topic	Contact Hrs.
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 effective length, Friis Transmission equation, Antenna Temperature.	8
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.	7
3	Linear Arrays: Two element array, N Element array with Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, planar array, and Design consideration.	7
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.	6
5	Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch.	6
6	Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain Reflectors, Introduction to MIMO.	2
Total		36

Course Objectives:	
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.

Course Outcomes:	
1	1. Compute the far field distance, radiation pattern and gain of an antenna for given currentdistribution.
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 Resources:	
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.

Course Name:	**Advanced Digital Signal Processing**		
Course Code:	PC-MCE202	**Category:**	Professional Core Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Signal Processing
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
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.	9
2	Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in subband coding.	6
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.	7
4	Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm.	5
5	Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.	5
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.	4
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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	D.G.Manolakis, V.K. Ingle and S.M.Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

Course Name:	**Satellite Communication**		
Course Code:	PE-MCE201A	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Analog & Digital Communication
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
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.	6
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.	**6**
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.	**6**
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.	6
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.	8
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.	**4**
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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

Course Name:	**Internet of things**		
Course Code:	**PE-MCE201B**	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Advanced Computer Networks
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Smart cities and IOT revolution, Fractal cities, From IT to IOT, M2M and peer networking concepts, Ipv4 and IPV6. Software Defined Networks SDN, From Cloud to Fog and MIST	6
2	networking for IOT communications, Principles of Edge/P2P networking, Protocols to support IOT communications, modular design and abstraction, security and privacy in fog.	6
3	Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and Configuration.	6
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.	6

5	Operating systems requirement of IOT environment, study of mbed, RIOT, and Contiki operating systems, introductory concepts of big data for IOT applications.	6
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.	6
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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.

Course Name:	**Voice and Data Networks**		
Course Code:	PE-MCE201C	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

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

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks	6
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.	6
3	Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid	6
4	ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.	6
5	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.	
6	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.	6
	Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.	6
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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

Course Name:	**Integrable circuits & Design**		
Course Code:	PE-MCE201D	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Circuits & Integrated Design
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand basic knowledge of Integrated circuit devices and Modeling
2	Understand basics of Current Mirrors, Single stage amplifiers.
3	Visualize the concept of MOS Inverters, Sequential and Combinational MOS Logic circuits.
4	Able to analyze the CMOS Timing and I/O systems and noise in integrable circuits.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Integrated circuit devices and modeling: Semiconductors and p-n junction, advanced MOS modeling, bipolar junction transistors MOS devices in weak inversion.	6
2	Basic current mirrors and single stage amplifiers: Simple CMOS current mirror, common source amplifier, source follower, common gate amplifier, source generated current mirrors, high output impedance current mirrors, cascade gain stages, MOS differential pairs, bipolar current mirrors, bipolar gain stages, class AB output stages.	6
3	Switched capacitor amplifiers, switched capacitor integrators. Non linear circuits: Phase locked loop.	6

4	**MOS inverter**: Switching characteristics, static and dynamic behaviors delay. **Combinational MOS logic circuits**: pseudo NMOS, dynamic logic, domino logic, NORA, differential CMOS gates, X-gate and pass transistors. **Sequential MOS logic circuits**: CMOS clocked latches, static and dynamic CMOS latches, D, SR, JK, T and edge triggered SR flip-flop.	6
5	**Digital integrated system building blocks**: Multiplexers and decoders, barrel shifters, counters, digital adders, modified booth multipliers.	6
6	**CMOS timing and I/O considerations**: Delay of CMOS circuits, junction capacitors, interconnect capacitors, delay of CMOS logic gates, input protection circuits, output circuits and driving large capacitors, three state outputs. **Noise in integrable circuits**: Noise in circuits, types of noise, time domain analysis, frequency domain analysis, noise models for circuit elements – resistors, capacitors, diode, BJT and MOSFET.	6
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand basic knowledge of Integrated circuit devices and Modeling
2	Understand basics of Current Mirrors, Single stage amplifiers.
3	Visualize the concept of MOS Inverters, Sequential and Combinational MOS Logic circuits.
4	Able to analyze the CMOS Timing and I/O systems and noise in integrable circuits.

Learning Resources:	
1	Analog integrated circuit design, David Johns and Ken Martin, John Wiley and sons (UK), 2002.
2	Digital integrated circuit design, Ken Martin, Oxford University Press, New York, 2000.
3	Analysis and Design of Analog Circuits, Paul Grey, Paul Hurst, Stephen Lewis and Robert Mayer, John Wiley and Sons (UK), 4th edition.
4	Digital Integrated Circuits - A Design Perspective, *Rabaey, Chandrakasan and Nokolic*, PHI (2nd Edition), 2008.
5	CMOS Digital Integrated Circuits - Analysis and Design, *Sung-Mo Kang & Yusuf Lablebici*, Tata McGraw Hill, (New Delhi), 2003.

Course Name:	**Markov Chains and Queuing**		
Course Code:	PE-MCE202A	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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 modeling using Markov chains with special emphasis on developing queuing models.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction: Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem.	6
2	Renewal Processes: Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Poisson process, Walds equation, Blackwell's theorem.Discrete time Markov chains: definitions and properties, matrix representation, Perron-Frobenius theory.	6
3	Continuous time Markov chains: basic definitions, Q-matrix, birth-death	6
4	processes, quasi birth death processes; Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.	6
5	Fundamental queing results: Little‟s theorem, invariance of the mean delay, Conservation law Marcovian queues: Jackson and BCMP networks, Numerical algorithms, M/G/1 and G/M/1 queues.	6
6	Advanced queuing models: priority, vacation and retrials in queues.	6
Total		**36**

Course Outcomes:	
After completion of the 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 modeling using Markov chains with special emphasis on developing queuing models.

Learning Resources:	
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.

Course Name:	**MIMO Systems**		
Course Code:	PE-MCE202B	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Wireless communication, Antenna system
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multiantenna systems.	3
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. The generic MIMO problem, Singular Value Decomposition,	7
3	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.	7
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.	5
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.	7
6	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.	7
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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.

Course Name:	**Programmable Networks - SDN, NFV**		
Course Code:	PE-MCE202C	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Optical Networks
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
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.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
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.	6
2	Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.	6
3	Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.	6

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.	6
5	Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network	6
6	Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications. 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.	6
Total		**36**

Course Outcomes:	
After completion of the 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 Resources:	
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.

Course Name:	**Microwave Measurement Techniques**		
Course Code:	PE-MCE202D	**Category:**	Professional Elective Courses
Semester:	Second	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Microwave Engineering
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand different techniques of Power, Frequency and Impedance Measurement in Microwave frequency range.
2	Acquire knowledge on Sensors and Detectors used in Microwave Measurement.
3	Visualize the measurement of various parameters using Vector Network Analyzer and Spectrum Analyzers.
4	Implement different measurement circuits of various parameters in microwave frequency.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Radio Frequency & Microwave Measurements-** Introduction Radio Frequency Band, microwave and millimeter wave. **Power Measurement-** High Power Measurement, calorimeter technique, Low power Measurement, bolometer technique, Very Low Power Measurement.	6
2	**Frequency Measurement -** Different Technique to measure frequency, Slotted Line Technique, maxima & minima, wavelength & frequency measurement. **Distortion & Frequency Translation Measurement-** Different types of distortion occurred at microwave frequencies, Procedures for frequency translation.	7
3	**Impedance Measurement-** Measurement of unknown load impedance of a transmission line, Slotted Line Technique to measure unknown impedance.	4
4	**Detectors& Sensors:** Definition of Detectors; Different type of microwave detectors functions and applications, Sensors Definition & working principle, applications.	7

5	**Vector Network Analyzer (VNA):** Concept of vector network analyzer, measurement of Scattering parameters, Basic block diagram of vector network analyzer (VNA), Application of vector network analyzers. **Scalar Network Analyzer (SNA):** Definition of network analyzer,	7
	Difference between SNA&VNA, Basic block diagram Scalar Network Analyzer. **Spectrum Analyzer:** Basic block diagram of a spectrum analyzer,	
6	functions & applications of a spectrum analyzer. **Time Domain Reflectrometer (TDR) :** Introduction to Reflectrometer, Measurement of reflection coefficient using electrometer technique, Basic block diagram of a time domain reflectrometer.	5
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand different techniques of Power, Frequency and Impedance Measurement in Microwave frequency range.
2	Acquire knowledge on Sensors and Detectors used in Microwave Measurement.
3	Visualize the measurement of various parameters using Vector Network Analyzer and Spectrum Analyzers.
4	Implement different measurement circuits of various parameters in microwave frequency.

Learning Resources:	
1	G.H.Bryant- Principles of Microwave Measurements- Peter Peregrinus Ltd.
2	D.M. Pozar- Microwave Engineering, 2nd Ed, John Wiley
3	T.S.Laverghetta- Hand book on Microwave Testing
4	S.F.Adam- Microwave Theory & Application- Prentice Hall, Inc
5	HP Application Notes
6	A.E. Bailey, Ed. Microwave Measurements- Peter Peregrinus Ltd
7	M. Engelson-Moder Spectrum Analyser: Theory & Applications Artech House

Course Name:	Antennas and Radiating Systems Lab		
Course Code:	PC-MCE291	**Category:**	Professional Core Courses
Semester:	Second	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Basic knowledge of Antennas and Radiating Systems theory
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
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.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	Simulation of half wave dipole antenna.	2
2	Simulation of quarter wave, full wave antenna and comparison of their parameters.	2
3	Simulation of monopole antenna with and without ground plane.	4
4	Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.	4
5	Simulation of a half wave dipole antenna array.	4
6	Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.	4
7	Study on Important characteristics of different types of transmission lines.	4
8	Impedance measurement in microwave frequency range applying Smith chart.	4
9	Study on Horn and microstrip antenna – radiation pattern, gain, impedance etc.	4
10	Study of important parameters and practical considerations on different microwave circuit components related to antenna design.	4
Total		**36**

Course Outcomes:	
After completion of the 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.

Learning Resources:	
1	Laboratory Manual

Course Name:	Advanced Digital Signal Processing lab		
Course Code:	PC-MCE292	**Category:**	Professional Core Courses
Semester:	Second	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Digital Signal Processing
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

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

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	Basic Signal Representation using MATLAB	4P
2	Z Transform, Inverse Z Transform using and find frequency response using MATLAB	4P
3	a)Auto Correlation, Cross Correlation and using MATLAB b) Stability analysis of the System	4P
4	Verification of sampling theorem.	4P
5	FFT Of Input Sequence using MATLAB	4P
6	Butterworth Low pass, High pass Filter and Band Pass Filter Design using MATLAB	4P
7	Chebychev Type I and Chebychev Type II Filter design using MATLAB	4P
8	Estimation Of Power Spectral Density (PSD) using MATLAB	4P
9	Implementation of Decimation and Interpolation Process using MATLAB	4P
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design different digital filters in software.
2	Apply various transforms in time and frequency domain.
3	Perform decimation and interpolation.

Learning Resources:	
1	Laboratory Manual

Course Name:	Personality Development through Life Enlightenment Skills		
Course Code:	PW-MCE271A	**Category:**	Project/ Internships/ Sessional
Semester:	Second	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

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

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont‟s) • Verses- 71,73,75,78 (do‟s)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8
Total		**24**

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

Learning Resources:	
1	“Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department),Kolkata
2	Bhartrihari‟s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Name:	Sanskrit for Technical Knowledge		
Course Code:	PW-MCE271B	**Category:**	Project/ Internships/ Sessional
Semester:	Second	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2	Learning of Sanskrit to improve brain functioning
3	Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4	The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	•Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8
Total		**24**

Course Outcomes:	
1	Understanding basic Sanskrit language
2	Ancient Sanskrit literature about science & technology can be understood
3	Being a logical language will help to develop logic in students

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

Course Name:	Constitution of India		
Course Code:	PW-MCE271C	**Category:**	Project/ Internships/ Sessional
Semester:	Second	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2	To address the growth of Indian opinion regarding modern Indian intellectuals" constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3	To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**History of Making of the Indian Constitution:** •History •Drafting Committee, (Composition & Working)	4
2	**Philosophy of the Indian Constitution:** •Preamble •Salient Features	4
3	**Contours of Constitutional Rights & Duties:** • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation	4

4	• Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties. **Organs of Governance:** • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	4
5	**Local Administration:** • District‟s Administration head: Role and Importance,	4
6	• Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. • Pachayati raj: Introduction, PRI: Zila Pachayat. • Elected officials and their roles, CEO Zila Pachayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy **Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.	4
Total		**24**

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

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

Course Name:	Disaster Management		
Course Code:	PW-MCE271D	**Category:**	Project/ Internships/ Sessional
Semester:	Second	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination	Semester Examination:	Continuous	Attendance:
Scheme:		Assessment:	

Course Objectives:	
1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4	critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types	4

	And Magnitude.	
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People‟s Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India	4
Total		**24**

Course Outcomes:	
1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

4	critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Learning Resources:	
1	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New Royal book Company.
2	Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3	Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep & Deep Publication Pvt. Ltd., New Delhi.