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

Part III: Detailed Curriculum

First Semester

Course Name:	**Advanced Communication Networks**		
Course Code:	**PC-MCE101**	**Category:**	Professional Core Courses
Semester:	First	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Network
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand advanced concepts in Communication Networking.
2	Design and develop protocols for Communication Networks
3	Understand the mechanisms in Quality of Service in networking
4	Optimise the Network Design.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Overview of Internet-Concepts, challenges and history. Overview of ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.	**6**
2	Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.; Characterization of Traffic by Linearly Bounded Arrival	**6**
3	Processes (LBAP). Leaky bucket algorithm and its properties. 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 for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management	**6**

4	IP address lookup-challenges. Packet classification algorithms and Flow Identification Grid of Tries, Cross producing and controlled prefix expansion algorithms.	6
5	Admission control in Internet. Concept of Effective bandwidth. Measurement Based admission control. Differentiated Services in Internet (DiffServ). Diff Serv architecture and framework.	6
6	IPV4, IPV6, IP tunnelling, IPswitching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.	6
Total		**36**

Course Outcomes:	
1	Understand advanced concepts in Communication Networking.
2	Design and develop protocols for Communication Networks
3	Understand the mechanisms in Quality of Service in networking
4	Optimize the Network Design

Learning Resources:	
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	Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An AnalyticalApproach" , Morgan Kaufman Publishers, 2004.
4	George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005
5	Zhang Wang, "Internet QoS", Morgan Kaufman, 2001.

Course Name:	**Wireless and Mobile Communication**		
Course Code:	**PC-MCE102**	**Category:**	Professional Core Courses
Semester:	First	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Communication
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Design appropriate mobile communication systems
2	Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
3	Distinguish various multiple-access techniques for mobile communications e.g. DMA, TDMA, CDMA, and their advantages and disadvantages.
4	Analyze path loss and interference for wireless telephony and their influences on a mobile communication system‟s performance
5	Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology
6	Understanding upcoming technologies like 3G, 4G etc

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel Interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical	7
2	Channels, Data Encryption in GSM, Mobility Management, Call Flows in Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations)	5
3	Mobile Radio Propagation:Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading	8
4	Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving..	4

5	Code Division Multiple Access:Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.	7
6	Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.	5
Total		**36**

Course Outcomes:	
1	Design appropriate mobile communication systems
2	Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
3	Distinguish various multiple-access techniques for mobile communications e.g. DMA, TDMA, CDMA, and their advantages and disadvantages.
4	Analyze path loss and interference for wireless telephony and their influences on a mobile communication system‟s performance
5	Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology
6	Understanding upcoming technologies like 3G, 4G etc

Learning Resources:	
1	V.K.Garg, J.E.Wilkes, “Principle and Application of GSM”, Pearson Education, 5th edition, 2008
2	V.K.Garg, “IS-95 CDMA & CDMA 2000”, Pearson Education, 4th edition, 2009.
3	T.S.Rappaport, “Wireless Communications Principles and Practice”, 2nd edition, PHI,2002.
4	William C.Y.Lee, “Mobile Cellular Telecommunications Analog and Digital Systems”, 2nd edition, TMH, 1995
5	Asha Mehrotra, “A GSM system Engineering” Artech House Publishers Bosten, London,1997.

Course Name:	**Wireless Sensor Networks**		
Course Code:	**PE-MCE101A**	**Category:**	Professional Elective Courses
Semester:	First	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Networks
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Design wireless sensor network system for different applications under consideration
2	Understand the hardware details of different types of sensors and select right type of sensor for various applications.
3	Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
4	Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
5	Handle special issues related to sensors like energy conservation and security challenges

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.	6
2	Hardware: Examples like mica2, mica Z, telos B, cricket, Imote2, t mote, b t node, and Sun SPOT, Software (Operating Systems): tiny OS, MANTIS, Contiki, and Ret OS	5
3	Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)	6
4	Overview of sensor network protocols (details of atleast 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node. discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.	6
5	Data dissemination and processing; differences compared with other database management systems, data storage; query processing.	6
6	Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network	7
Total		**36 L**

Course Outcomes:	
1	Design wireless sensor network system for different applications under consideration
2	Understand the hardware details of different types of sensors and select right type of sensor for various applications.
3	Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
4	Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
5	Handle special issues related to sensors like energy conservation and security challenges

Learning Resources:	
1	H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012
2	C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks", Springer Verlag, 1st Indian reprint, 2010.
3	F. Zhao and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann, 1st Indian reprint, 2013.
4	YingshuLi, MyT. Thai, Weili Wu, "Wireless sensor Network and Applications", Springer series on signals and communication technology, 2008.

Course Name:	**Optical Networks**		
Course Code:	**PE-MCE101B**	**Category:**	Professional Elective Courses
Semester:	First	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Optical Communication
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Contribute in the areas of optical network and WDM network design.
2	Implement simple optical network and understand further technology developments for future enhanced network

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	SONET/SDH: optical transport network, IP, routing and forwarding, multiprotocol label switching.	6
2	WDM network elements: optical line terminals and amplifiers, optical add/drop multiplexers, OADM architectures, reconfigurable OADM, optical cross connects.	6
3	Control and management: network management functions, optical layer services and interfacing, performance and fault management, configuration management, optical safety.	6
4	Network Survivability: protection in SONET/SDH & client layer, optical layer protection schemes	6
5	WD M network design: LTD and RWA problems, dimensioning wavelength routing networks, statistical dimensioning models	6
6	Access networks: Optical time division multiplexing, synchronization, header processing, buffering, burst switching, test beds, Introduction to PON, GPON, AON.	6
Total		**36**

Course Outcomes:	
1	Contribute in the areas of optical network and WDM network design.
2	Implement simple optical network and understand further technology developments for future enhanced network

Learning Resources:	
1	Rajiv Ramaswami, Sivarajan, Sasaki, "Optical Networks: A Practical Perspective", MK, Elsevier, 3 rd edition, 2010
2	C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001.

Course Name:	**Statistical Information Processing**		
Course Code:	**PE-MCE101C**	**Category:**	Professional Elective Courses
Semester:	First	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics & random Signal Theory
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering and statistical operations
2	Demonstrate mathematical modelling and problem solving using such models.
3	Comparatively evolve key results developed in this course for applications to signal processing, communications systems.
4	Develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables. Random process: Expectations, Moments,	6
2	Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and auto covariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.	6
3	Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model& its applications ,Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm. Statistical Decision Theory: Bayes‟ Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Mini max Criterion, Neyman- Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes" Estimation Minimum Mean- Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate , Multiple Parameter Estimation Best Linear Unbiased Estimator ,Least-Square Estimation Recursive Least-Square Estimator.	6
4	Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p)spectral estimation and detection of Harmonic signals Information Theory and Source Coding: Introduction, Uncertainty,	6

5	Information and Entropy, Source coding theorem, Huffman, Shanon-Fano , Arithmetic adaptive coding , RLE ,LZW Data compaction, , LZ-77, LZ-78. Discrete Memory less channels, Mutual in formation, channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.	6
6	Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements , Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes,& Decoder, Reed- Solomon codes & Decoder, implementation of Reed Solomon encoders and decoders.	6
Total		**36**

Course Outcomes:	
1	Characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering and statistical operations
2	Demonstrate mathematical modelling and problem solving using such models.
3	Comparatively evolve key results developed in this course for applications to signal processing, communications systems.
4	Develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.

Learning Resources:	
1	Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes",4th Edition, McGraw-Hill, 2002
2	D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.
3	Mourad Barkat , "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.
4	R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.
5	F. J. MacWilliams and N. J. A. Sloane, "The Theory of Error-Correcting Codes", New York, North-Holland, 1977.
6	Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.

Course Name:	**Cognitive Radio**		
Course Code:	**PE-MCE102A**	**Category:**	Professional Elective Courses
Semester:	First	**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	Understand the fundamental concepts of cognitive radio networks
2	Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3	Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4	Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.	6
2	Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).	6
3	Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.	6
4	Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.	6
5	Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).	6
6	Research Challenges in Cognitive Radio: Network layer and transport layer issues, crosslayer design for cognitive radio networks.	6
Total		**36**

Course Outcomes:	
1	Understand the fundamental concepts of cognitive radio networks.
2	Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3	Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4	Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.

Learning Resources:	
1	Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2	Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3	Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4	Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5	Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6	Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Course Name:	**RF and Microwave Circuit Design**		
Course Code:	**PE-MCE102B**	**Category:**	Professional Elective Courses
Semester:	First	**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 Objectives:	
1	Understand the behaviour of RF passive components and model active components.
2	Perform transmission line analysis.
3	Demonstrate use of Smith Chart for high frequency circuit design.
4	Justify the choice/selection of components from the design aspects.
5	Contribute in the areas of RF circuit design.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Transmission Line Theory:Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.	6
2	Microwave Network Analysis:Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.	6
3	Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.	7
4	Nonlinearity And Time Variance : Inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.	4
5	Microwave Semiconductor Devices And Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.	8
6	Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, Mixer Design.	5
Total		**36**

Course Outcomes:	
1	Understand the behaviour of RF passive components and model active components.
2	Perform transmission line analysis.
3	Demonstrate use of Smith Chart for high frequency circuit design.
4	Justify the choice/selection of components from the design aspects.

Learning Resources:	
1	D.M.Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.
2	S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.
3	Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", AuthorHouse, 2009..
4	R.E. Collin, Foundations of Microwave Engineering. McGraw Hill.
5	G.D. Vendelin, A.M. Pavoi, U. L. Rohde, "Microwave Circuit Design Using Linear And Non Linear Techniques", John Wiley 1990.

Course Name:	**DSP Architecture**		
Course Code:	**PE-MCE102C**	**Category:**	Professional Elective Courses
Semester:	First	**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	Identify and formalize architectural level characterization of P-DSP hardware.
2	Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment.
3	Deployment of DSP hardware for Control, Audio and Video Signal processing applications.
4	Understanding of major areas and challenges in DSP based embedded systems.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking	6
2	Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 – Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.	6
3	VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.	6

4	Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).	6
5	FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.	6
6	High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.	6
Total		**36**

Course Outcomes:	
1	Identify and formalize architectural level characterization of P-DSP hardware.
2	Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment.
3	Deployment of DSP hardware for Control, Audio and Video Signal processing applications.
4	Understanding of major areas and challenges in DSP based embedded systems.

Learning Resources:	
1	M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.
2	Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011.
3	Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, Jeff McDonald,"Parallel Programming in OpenMP", 1st Edition, Morgan Kaufman,2000.
4	Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.
5	Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.
6	E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands,2007.

Course Name:	**Research Methodology and IPR**		
Course Code:	**MC-MCE171**	**Category:**	Mandatory Courses
Semester:	First	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand research problem formulation.
2	Analyze research related information.
3	Follow research ethics.
4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6	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.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	4L
2	Effective literature studies approaches, analysis Plagiarism, Research ethics,	3L
3	Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	4L
4	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property.	3L 3L
5	Procedure for grants of patents, Patenting under PCT.Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	3L
6	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	4L
Total		**24**

Course Outcomes:	
1	Understand research problem formulation.
2	Analyze research related information.
3	Follow research ethics.
4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6	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.

Learning Resources:	
1	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
2	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3	Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners".
4	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5	Niebel , "Product Design", McGraw Hill, 1974.
6	Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
7	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Name:	**Advanced Communication Networks Laboratory**		
Course Code:	**PC- MCE191**	**Category:**	Professional Core Courses
Semester:	First	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Computer Network
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

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

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1.	Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP,RARP) and Network Configuration Files.	3
2.	Linux Network Configuration. a.Configuring NIC"s IP Address. b. Determining IP Address and MAC Address using if-config command. c.Changing IP Address using if-config. d. Static IP Address and Configuration by Editing. e.Determining IP Address using DHCP. f. Configuring Hostname in /etc/hosts file.	3
3.	Design TCP iterative Client and Server application to reverse the given input sentence.	3
4.	Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call "select".	3
5.	Design UDP Client Server to transfer a file. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP	3
6.	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. 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.	6
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.	6
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.	3
9.	Signaling and QoS of labeled paths using RSVP in MPLS.	3
10.	Find shortest paths through provider network for RSVP and BGP.	3
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify the different types of network devices and their functions within a network.
2	Understand and build the skills of sub-netting and routing mechanisms.
3	Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Learning Resources:	
1	Laboratory Manual

Course Name:	**Wireless and Mobile Communication Laboratory**		
Course Code:	**PC-MCE192**	**Category:**	Professional Core Courses
Semester:	First	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Analog an Digital Communication
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	Understanding Cellular concepts, GSM and CDMA networks.
2	To study GSM handset by experimentation and fault insertion techniques.
3	Understating of 3G communication system by means of various AT commands usage in GSM.
4	Understanding CDMA concept using DSSS kit.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1.	Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi path environment, Coverage and Capacity issues using communication software.	6
2.	Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release,Security and Power Control, Handoff Process and types, Rake Receiver etc.	6
3.	Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).	6

4.	To study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.	6
5.	To study various GSM AT Commands their use and developing new application using it. Understating of 3G Communication System with features like; transmission of voice and videocalls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.	6
6.	Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.	6
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understanding Cellular concepts, GSM and CDMA networks.
2	To study GSM handset by experimentation and fault insertion techniques.
3	Understating of 3G communication system by means of various AT commands usage in GSM.
4	Understanding CDMA concept using DSSS kit.

Learning Resources:	
1	Laboratory Manual

Course Name:	**English for Research Paper Writing**		
Course Code:	**PW-MCE171A**	**Category:**	Project/ Internships/ Sessional
Semester:	First	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Understand that how to improve your writing skills and level of readability
2	Learn about what to write in each section.
3	Understand the skills needed when writing a Title.
4	Ensure the good quality of paper at very first-time submission.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check .	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion,	4
	skills are needed when writing the Conclusions.	
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4
Total		**24**

Course Outcomes:	
1	Understand that how to improve your writing skills and level of readability
2	Learn about what to write in each section.
3	Understand the skills needed when writing a Title.
4	Ensure the good quality of paper at very first-time submission.

Learning Resources:	
1	Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3	Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman‟s book .
4	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course Name:	**Pedagogy Studies**		
Course Code:	**PW-MCE171B**	**Category:**	Project/ Internships/ Sessional
Semester:	First	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2	Identify critical evidence gaps to guide the development.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction and Methodology:** • Aims and rationale, Policy background, Conceptual framework and terminology • Theories of learning, Curriculum, Teacher education. • Conceptual framework, Research questions. • Overview of methodology and Searching.	3
2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	6
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change.	6

4	• Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers" attitudes and beliefs and Pedagogic strategies. • Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	6
5	• **Research gaps and future directions** • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact.	3
Total		**24**

Course Outcomes:	
1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Learning Resources:	
1	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
5	Chavan M (2003) Read India: A mass scale, rapid, „learning to read" campaign.

Course Name:	**Value Education**		
Course Code:	**PW-MCE171C**	**Category:**	Project/ Internships/ Sessional
Semester:	First	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Values and Ethics
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Understand value of education and self- development.
2	Imbibe good values in students.
3	Let the should know about the importance of character.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	8

4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively	6
Total		**24**

Course Outcomes:	
1	Knowledge of self-development.
2	Learn the importance of Human values.
3	Developing the overall personality.

Learning Resources:	
1	Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course Name:	**Stress Management by Yoga**		
Course Code:	**PW-MCE171D**	**Category:**	Project/ Internships/ Sessional
Semester:	First	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Project/ Internships/ Sessional
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To achieve overall health of body and mind.
2	To overcome stress.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	• Definitions of Eight parts of yog. (Ashtanga)	8

2	• Yam and Niyam. Do`s and Don"t"s in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	8
Total		**24**

Course Outcomes:	
1	Develop healthy mind in a healthy body thus improving social health also.
2	Improve efficiency.

Learning Resources:	
1	„Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur .
2	"Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.