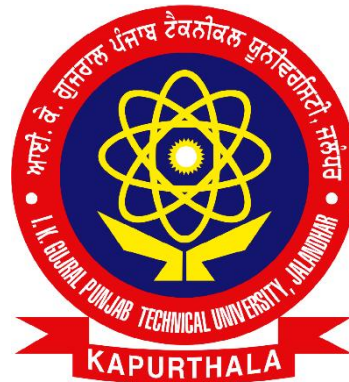


M. Tech ECE
(Wireless Communication)



IK Gujral Punjab Technical University
Jalandhar-Kapurthala Highway, Kapurthala-144603 (PB)

IK Gujral Punjab Technical University, Kapurthala

Study Scheme and Syllabus M.Tech. ECE (Wireless Communication) 2018

PROGRAMME OUTCOMES

At the end of the programme, the post graduate students of M.Tech (Electronics and Communication Engineering) will be able to:

1. Understand the key concepts, terminologies in the field of Electronics and Communication Engineering. Survey the available literature to discover a list of problems occurring in society in the field of Electronics and Communication.
2. Develop ability to critically analyse the problem, formulate the innovative framework to find the solution for it.
3. Review the literature, write survey and research articles.
4. Analyse and evaluate the gaps in the existing literature and gather new insights into it.
5. Find alternative solution to the problem which is economically feasible, socially acceptable and environment-friendly.
6. Develop the research design, conduct experiments, gather results- analyse and interpret them through technical knowledge to come to a valid conclusion.
7. Learn coding skills for modelling and error debugging and handling. Use latest engineering methods and software tools for problem solving.
8. Perform in multidisciplinary environments in a team to achieve goals.
9. Know the importance of limited resources and utilise them efficiently while maintaining the reserve for the future generation.
10. Communicate effectively with peers and higher authorities both orally and in-writing in academic as well as industrial environment.
11. Familiar with ongoing research areas, technologies, electronic products and gadgets.
12. Engage in life-long learning as a means of enhancing knowledge and skills for continuous professional advancement.

M.Tech. ECE (Wireless Communication) 2018 Study Scheme

Semester-1

Course Code	Course Name	L	T	P	Int	Ext	Total	Credits
MTWC-101-18	Wireless Communication	3	0	0	40	60	100	3
MTWC-102-18	Information Theory & Coding	3	0	0	40	60	100	3
MTWC-PE1X-18	Elective I	3	0	0	40	60	100	3
MTWC-PE2Y-18	Elective II	3	0	0	40	60	100	3
MTWC-111-18	Wireless Communication Lab	0	0	4	60	40	100	2
MTWC-112-18	Information Theory & Coding Lab	0	0	4	60	40	100	2
MTRM-101-18*	Research Methodology & IPR	2	0	0	40	60	100	2
MTAXX-18	Audit Course I	2	0	0	S/US**	S/US**	100	Non-credit
	Total	14	0	8	320	380	800	18

Semester-2

Course Code	Course Name	L	T	P	Int	Ext	Total	Credits
MTWC-103-18	Advanced Wireless Communication	3	0	0	40	60	100	3
MTWC-104-18	Soft Computing Techniques	3	0	0	40	60	100	3
MTWC-105-18	Simulation of Wireless Communication Systems	3	0	0	40	60	100	3
MTWC-PE3X-18	Elective III	3	0	0	40	60	100	3
MTWC-PE4Y-18	Elective IV	3	0	0	40	60	100	3
MTWC-113-18	Wireless Communication Simulation Lab	0	0	4	60	40	100	2
MTWC-MP1-18	Mini Project	0	0	4	60	40	100	2
MTAXX-18	Audit Course II	2	0	0	S/US**	S/US**	100	Non-credit
	Total	17	0	8	320	380	800	19

Semester-3

Course Code	Course Name	L	T	P	Int	Ext	Total	Credits
MTWC-PE5X-18	Elective V	3	0	0	40	60	100	3
MTOE-301X-18*	Open Elective	3	0	0	40	60	100	3
MTWC-DS1-18	Dissertation Phase I	0	0	20	60	40	100	10
	Total	6	0	20	140	160	300	16

Semester-4

Course Code	Course Name	L	T	P	Int	Ext	Total	Credits
MTWC-DS2-18	Dissertation Phase II	6	0	20	60	40	100	16
	Total	6	0	20	60	40	100	16
					840	960	2000	69

* These courses are common to all M.Tech. Courses.

**S/US - Satisfactory/Unsatisfactory

IK Gujral Punjab Technical University, Kapurthala

Study Scheme 2018 M.Tech. ECE (Wireless Communication)-Program Electives

Program Elective I	
MTWC-PE1A-18	Wireless Sensor Networks
MTWC-PE1B-18	RF MEMS for Wireless Communication
MTWC-PE1C-18	Advanced Digital Signal processing
MTWC-PE1D-18	Audio & Video Signal Processing
Program Elective II	
MTWC-PE2A-18	Advanced Communication Systems
MTWC-PE2B-18	Detection & Estimation Theory
MTWC-PE2C-18	Mobile Adhoc Networks
MTWC-PE2D-18	Optical Network and Photonic Switching
Program Elective III	
MTWC-PE3A-18	Smart Antennas
MTWC-PE3B-18	Wireless Network Planning, Optimization and Mngement
MTWC-PE3C-18	Microwave and RF Design
MTWC-PE3D-18	Multimedia Communication and Technology
Program Elective IV	
MTWC-PE4A-18	Cryptography and Wireless Security
MTWC-PE4B-18	Software Defined Radio & Cognitive Radio
MTWC-PE4C-18	Wireless & Optical Communication Networks
MTWC-PE4D-18	MIMO Systems
Program Elective V	
MTWC-PE5A-18	Millimeter Wave Communication and Technology
MTWC-PE5B-18	Space Time Wireless Communication
MTWC-PE5C-18	Advance Techniques for Wireless Reception
MTWC-PE5D-18	Emerging Technologies in Wireless Communication
MTWC-PE5E-18	Microstrip Antennas

IK Gujral Punjab Technical University, Kapurthala

Study Scheme 2018 M.Tech. ECE (Wireless Communication)

Audit Courses I and II & Open Electives

List of Audit Courses	
MTA101-18	English for Research Paper Writing
MTA102-18	Disaster Management
MTA103-18	Sanskrit for Technical Knowledge
MTA104-18	Value Education
MTA105-18	Constitution of India
MTA106-18	Pedagogy Studies
MTA107-18	Stress Management by Yoga
MTA108-18	Personality Development through Life Enlightenment Skills
Open Electives	
MTOE- 301A-18	Business Analytics
MTOE- 301B-18	Industrial Safety
MTOE- 301C-18	Operations Research
MTOE- 301D-18	Cost Management of Engineering Projects
MTOE- 301E-18	Composite Materials
MTOE- 301F-18	Waste to Energy

First Semester

MTWC-101-18	Credits	L	T	P	Internal	External
WIRELESS COMMUNICATION	3	3	0	0	40	60

Course Objective

To enable students understand the various aspects of wireless communication, factors affecting the communication link and physical models.

Course Outcomes

After the completion of the course, the student will be able to:

1. Implement physical models of wireless channels.
2. Gain knowledge of key concepts of wireless communication.
3. Measure capacity of AWGN channel, LTI Gaussian channels and various fading channels.
4. Study uplink and downlink model of AWGN channel, fading channels and multiuser diversity.

Unit I Physical modelling for wireless channels: Free space, fixed transmit and receive antennas, Free space, moving antenna, Reflecting wall, fixed antenna, Reflecting wall, moving antenna, Reflection from a ground plane, Power decay with distance and shadowing, Moving antenna, multiple reflectors

Unit II Input /output model of the wireless channel: The wireless channel as a linear time-varying system, Baseband equivalent model, discrete-time baseband model, Additive white noise

Unit III Time and frequency coherence: Doppler spread and coherence time, delay spread and coherence bandwidth

Unit IV AWGN channel capacity: Repetition coding, Packing spheres, Capacity-achieving AWGN channel codes, Reliable rate of communication and capacity, Resources of the AWGN channel-Continuous-time AWGN channel, Power and bandwidth, Bandwidth reuse in cellular systems

Unit V Linear time-invariant Gaussian channels: Single input multiple output (SIMO) channel, Multiple input single output (MISO) channel, Frequency-selective channel

Unit VI Capacity of fading channels: Slow fading channel, Receive diversity, Transmit diversity, Transmit and receive diversity, Time and frequency diversity, Outage for parallel channels, Fast fading channel, Transmitter side information, Frequency-selective fading channels

Unit VII Uplink and Downlink AWGN channel: Capacity via successive interference cancellation, Comparison with conventional CDMA, Comparison with orthogonal multiple access, General K-user uplink capacity, Symmetric case: two capacity achieving schemes, General case: superposition coding achieves capacity

Unit VIII Uplink and Downlink fading channel: Slow fading channel, Fast fading channel, Full channel side information, Channel side information at receiver only, Full channel side information, Frequency selective fading channels

Unit IX Multiuser diversity: Multiuser diversity gain, Multiuser versus classical diversity, Fair scheduling and multiuser diversity, Channel prediction and feedback, Opportunistic beam forming using dumb antennas, Multiuser diversity in multicell systems

Unit X Physical Modeling of MIMO channels: Line-of-sight SIMO channel, Line-of-sight MISO channel, Antenna arrays with only a line-of-sight path, Geographically separated antennas, Line-of-sight plus one reflected path, MIMO multipath channel, Angular domain representation of signals, Angular domain representation of MIMO channels, Statistical modeling in the angular domain, Degrees of freedom and diversity, Dependency on antenna spacing.

Recommended Books

- Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
- David Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge

MTWC-102-18	Credits	L	T	P	Internal	External
INFORMATION THEORY & CODING	3	3	0	0	40	60

Course Objective

To enable students to understand information signals, coding and compression techniques and error detection and correction handling.

Course Outcomes

After the completion of the course, the student will be able to:

1. Understand the fundamentals of information theory
2. Encode text, audio, speech, image and video signals through various coding and compression techniques.
3. Detect and correct errors in the received signals through error detecting and correcting codes

Unit I Information Theory: Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit.

Unit II Source Coding: Text, Audio And Speech: Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MPEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

Unit III Source Coding: Image and Video: Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard

Unit IV Error Control Coding: Block Codes: Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes – Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder - CRC

Unit V Error Control Coding: Convolutional Codes: Convolutional codes – code tree, trellis, state diagram - Encoding – Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding

Recommended Books

- R Bose, Information Theory, Coding and Crptography, TMH 2007
- Fred Halsall, Multidedia Communications: Applications, Networks, Protocols and Standards, Perason Education Asia, 2002
- K Sayood, Introduction to Data Compression, 3rd Edition, Elsevier 2006
- S Gravano, Introduction to Error Control Codes, Oxford University Press 2007
- Amitabha Bhattacharya, Digital Communication, TMH 2006

PROGRAM ELECTIVES - I

MTWC-PE1-18	Credits	L	T	P	Internal	External
WIRELESS SENSOR NETWORKS	3	3	0	0	40	60

Course Objective

To enable students familiarize with sensor networks, its constraints and protocols.

Course Outcomes

After the completion of the course, the student will be able to:

1. Gain insights of Wireless Sensor Network(WSN) background, its challenges, constraints along with its advantages and applications.
2. Know the architecture of WSN and its sub-systems.
3. Explain node structure along with the technologies used in WSN.
4. Study various Wireless Propagation Models and discuss the various MAC protocols, communication protocols and routing protocols.

Unit I Introduction: Introduction to Wireless sensor networks, Definitions and background, Challenges and constraints, Single-sink single-hop WSN, Single-sink multi-hop WSN, Multi-sink multi-hop WSN, Advantages of sensor networks.

Unit II Applications of WSNs: Positioning and animals tracking, Entertainment, Logistics, Transportation, Industrial Control and Monitoring, Home Automation and Consumer Electronics, Security and Military Sensing, Asset Tracking and Supply Chain Management, Intelligent Agriculture and Environmental monitoring, Health Monitoring.

Unit III Node Structure: The Sensing Subsystem, Analog-to-Digital Converter, The Processor Subsystem, Architectural Overview, Microcontroller, Digital Signal Processor, Application-specific Integrated Circuit, Field Programmable Gate Array, Comparison Communication Interfaces, Serial Peripheral Interface, Inter-Integrated Circuit, Prototypes, The IMote Node Architecture, The XYZ Node Architecture, The Hogthrob Node Architecture

Unit IV Technologies for WSNs: ZigBee technology, Ultrawide bandwidth technology, Bluetooth technology, Comparison among technologies

Unit V

Physical Layer: Introduction, Wireless Propagation Models: The Free Space Propagation Model, The Two-Ray Ground Model, The Log-Distance Path Model, Energy Dissipation Model, Error Models: The Independent Error Model, The Two-State Markov Error Model, Sensing Models: The Binary Sensing Model, The Probabilistic Sensing Model

Unit VI Communication Protocols for WSNs: MAC protocols: Scheduled protocols, LEACH protocol, Guo protocol, TRAMA protocol, Contention-based protocols, Zhong protocol, DMAC protocol, PAMAS protocol, SMAC protocol.

Unit VII Routing Protocols: Issues in designing routing protocols, Classification of routing protocols, Flat routing, Flooding and gossiping, SPIN protocol, Directed diffusion protocol, Rumour routing, Gradient-based routing, Hierarchical routing, LEACH protocol, PEGASIS protocol, TEEN protocol, MECN protocol, SPAN protocol, Location-based routing protocols, GAF protocol, GEAR protocol, GeRaF protocol, Rugin protocol.

Recommended Books

- Kazem Sohraby, Daniel Minoli, TaiebZnati, Wireless Sensor Networks: Technology, Protocols, and Applications, Wiley Inter Science
- Edgar H. Callaway, Wireless Sensor Networks: Architectures and Protocols, Jr. AuerbachPublications, CRC Press
- C. S Raghavendra, Krishna M, Sivalingam, TaiebZnati, Wireless Sensor Networks, Springer
- Bhaskar Krismachari, Networking Wireless Sensors, Cambridge University Press
- Victor Lesser, Charles L. Ortiz, Milind Tambe, Distributed Sensor Networks: A MultiagentPerspective, Kluwer Publications

- Feng Zhao, Leonidas Guibas, Wireless Sensor Networks: An Information Processing Approach, Morgan Kaufmann Series in Networking 2004
- Walteneagus Dargie, Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory And Practice, John Wiley & Sons, August 2010

MTWC-PE1B-18	Credits	L	T	P	Internal	External
RF MEMS FOR WIRELESS COMMUNICATION SYSTEM	3	3	0	0	40	60

Course Objective

To familiarize students with circuits and circuit elements used in radio frequency MEMS wireless communication system.

Course Outcomes

After the completion of the course, the student will be able to:

1. Understand the key concepts in RF based MEMS wireless communication system
2. Design RF based circuits through modelling
3. Understand the usage of RF based circuit elements to reconfigure the circuit design
4. Study various oscillators and filters

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

Unit II Enabled Circuit Elements: RF/Microwave substrate properties, Micro machined – enhanced

elements – capacitors, inductors, varactors, MEM switches – shunt MEM switch, low voltage hinged MEM switch approaches, push-pull series switch, folded – beam – springs suspension series switch.

Unit III Resonators & Enabled Circuits: transmission line planar resonators, cavity resonators, micromechanical resonators, film bulk acoustic wave resonators, MEMS modeling – mechanical modeling, electromagnetic modeling. Enabled circuits – reconfigurable circuits – the resonant MEMS switch, Capacitors, inductors, tunable CPW resonator, MEMS microswitch arrays.

Unit IV Reconfigurable Circuits: Double – stud tuner, Nth – stub tuner, filters, resonator tuning system, massively parallel switchable RF front ends, true time-delay digital phase shifters, Reconfigurable antennas – tunable dipole antennas, tunable microstrip patch-array antenna. Phase shifters fundamentals, X-Band RF MEMS Phase shifter for phased array applications, Ka-Band RF MEMS Phase shifter for radar systems applications.

Unit V Filters & Oscillators: Film bulk acoustic wave filters – FBAR filter fundamentals, FBAR filter for PCS applications, RF MEMS filters – A Ka-Band millimeter-wave Micromachined tunable filter, A High-Q8-MHz MEM Resonator filter, RF MEMS Oscillators – fundamentals, A 14-GHzMEM Oscillator, A Ka-Band Micromachined cavity oscillator, A 2.4 GHz MEMS based voltage controlled oscillator.

Recommended Books

- Hector J. De Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech House,2002
- Vijay K. Varadan, K. J. Vinoy, K. A. Jose., RF MEMS and their Applications, John Wiley and sons, Ltd., 2002
- Gabriel M. Rebeiz, RF MEMS Theory, Design & Technology, Wiley Interscience, 2002

MTWC-PE1C-18	Credits	L	T	P	Internal	External
ADVANCED DIGITAL SIGNAL PROCESSING	3	3	0	0	40	60

Course Objective

To understand the importance and usage of different signals, digital systems and processors.

Course Outcomes

After the completion of the course, the student will be able to:

1. Apply digital transform techniques on signals
2. Design digital FIR and IIR filters
3. Predict and estimate errors in digital signal processing systems
4. Handle multirate DSP and use adaptive filters

Unit I Review: Fourier Transforms, Z-Transforms, Discrete Fourier Transform, Fast Fourier Transform, Convolution and Correlation.

Unit II Design of digital filters: Introduction to filter design, types of digital filters, choosing between, FIR and IIR filters, filter design steps, effect of finite register length in filter design, realization of IIR digital filters and FIR digital filter, design of IIR filters from continuous time filters, design of FIR filters by windowing.

Unit III Digital signal processors: General and special purpose digital signal processors, computer architecture for signal processing, selecting digital signal processors, architecture and programming of ADSP 2181 processor.

Unit IV Spectrum estimation: non-parametric methods correlation method, co-variance estimator, performance analysis of estimators, consistent estimators, AR, MA, ARMA signal modeling parameter estimation using Yule-walker method.

Unit V Linear estimation and prediction: Maximum likelihood criterion efficiency of estimator, least mean squared error criterion, recursive estimators, and linear predictions.

Unit VI Multirate digital signal processing: Mathematical description of change of sampling rate, interpolation and decimation, continuous time model, direct digital domain approach, interpolation and decimation by an integer factor, single and multistage realization, applications of sub band coding.

Unit VII Adaptive Filters: Applications of Adaptive Filters, Adaptive Direct Form FIR Filters: The LMS Algorithm, Adaptive Lattice Ladder Filters, Recursive Least Squares Lattice Ladder Algorithms.

Recommended Books

- Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, New York, 1996
- Emmanuel C. Ifeachor Barrie W. Jervis, Digital Signal Processing, Pearson Education, Asia
- Proakis Manolakis, Digital Signal Processing principles, algorithms, and applications, Prentice Hall India
- ADSP 2181 manuals
- Keshab K. Parhi, VLSI DSP Systems; Design & implementation, Wiley Inter Science Publishers
- Moonen, Ian k. Proudler, Algorithms for statistic

MTWC-PE1D-18	Credits	L	T	P	Internal	External
AUDIO AND VIDEO SIGNAL PROCESSING	3	3	0	0	40	60

Course Objective

To inculcate in students the knowledge of audio and video signal generation, transmission, processing and reception.

Course Outcomes

After the completion of the course, the student will be able to:

1. Learn the audio and video signal processing systems.

2. Code and decode the image, audio and video signals.
3. Modulate and demodulate digital signal processing systems.

Unit I: Limitation of natural reverberation by electronic devices, circuit solutions of Schroeder reverberators based on DSP. Systems of audio signal processing for home theatres 3D sound, DolbyProLogic, Dolby Digital, DTS, THX, coding and decoding of audio signals.

Unit II: Systems of synthesis of natural and unnatural sounds, sound paradoxes. Properties, algorithms of computation, application of wavelet transform and wavelet systems to separate noise and undesirable components of audio signals and video signals. Methods and algorithms of preprocessing and postprocessing of images in spatial and frequency domain with application of discrete orthogonal 2D transformations.

Unit III: Modern methods of digital coding of images and video sequences entropic, predictive, transform, hybrid, hierarchical, sub band, wavelet. Intra frame and predictive interframe source coding of video sequences with movement estimation. Nonlinear and invariant transforms in applications of image processing and coding and movement estimation in video sequences.

Unit IV: International standardized codecs in systems DVB T,C,S and DVB H for mobile communication systems 3G and 4G. Methods of channel coding and decoding of digital video signals, digital modulations and demodulations in systems DVB T,C,S,H.

Recommended Books

- Branderburg K., Kahrs M., Applications of Digital Signal Processing to Audio and Acoustics, New York, Kluwer Academic Publishers, 2002
- Russ, M., Sound Synthesis and Sampling, Amsterdam, Focal Press, 2004
- Vaseghi S., Multimedia Signal Processing - Theory and Applications in Speech, Music and Communications, Chichester, England, John Wiley & Sons, 2007
- Zözler U., Digital Audio Signal Processing, Chichester, England, John Wiley & Sons, 2008
- Park T., Introduction to Digital Signal Processing Computer Musically Speaking, New Jersey, World Scientific Publishing Co., 2010.

PROGRAM ELECTIVES - II

MTWC-PE2A-18	Credits	L	T	P	Internal	External
ADVANCED COMMUNICATION SYSTEM	3	3	0	0	40	60

Course Objective

To familiarize with the working of advanced communication systems.

Course Outcomes

After the completion of the course, the student will be able to:

1. Differentiate between analog and digital communication systems.
2. Transmit data through various digital modulation techniques.
3. Understand optical and satellite communication systems.
4. Recognize mobile communication systems, access techniques and transmission protocols.

UNIT-I Introduction: Conceptualized model of Digital Communication System (Description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt Orthogonalization procedure. Geometric Interpretation of Signals, Response of Bank of Correlators to Noisy Input, M-ary orthogonal signals, Complex Signal space and Orthogonality, Energy of the Sum of Orthogonal Signals

UNIT-II Band-limited channels: Pulse shaping for channels with ISI: Nyquist's First Criterion for Zero ISI, Partial response signaling (Duobinary and modified Duobinary pulses), detection of Duobinary Signaling, Maximum likelihood estimation technique.

UNIT-III Performance Analysis of Digital Communication Systems: Optimum Linear Detector for Binary Polar Signaling-Binary Threshold detection, Optimum Receiver Matched Filter, General Binary Signaling, Performance analysis of General Binary systems, Coherent Receivers for Digital Carrier Modulations, Signal Space Analysis of Optimum Detection, Vector Decomposition of White Noise Random Processes, Optimum Receiver for White Gaussian Noise Channels, Generalized Expression for Error Probability of Optimum Receivers.

UNIT-IV 4G Technology /OFDM: Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, BER performance over AWGN and Rayleigh fading, OFDM Issues like PAPR, Frequency and Timing Offset.

Recommended Books:

1. G. Proakis and M. Salehi, 'Fundamentals of Communication Systems', Pearson Education, 2005.
2. S. Haykins, 'Communication Systems', 5th Edn., John Wiley, 2008.
3. B.P.Lathi and Zhi Ding, 'Modern Digital and Analog Communication Systems, International Fourth Edition, Oxford University Press 2010.
4. S.Haykin, 'Digital Communication' Wiley-India, 2010

MTWC-PE2B-18	Credits	L	T	P	Internal	External
DETECTION AND ESTIMATION THEORY	3	3	0	0	40	60

Course Objective

To understand the different detection and estimation techniques for different signals.

Course Outcomes

After the completion of the course, the student will be able to:

1. Know the background of the signals, variables and processes.

2. Test the data through statistical tools.
3. Learn the ways to detect non-parametric, random and deterministic signals.
4. Familiarize with the estimation of signal parameters

Unit I Background: Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain.

Unit II Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

Unit III Detection of Deterministic Signals: Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

Unit IV Detection of Random Signals: Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Unit V Nonparametric Detection: Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

Unit VI Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum variance unbiased estimation, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

Unit VII Signal Estimation in Discrete-Time: Linear Bayesian estimation, Wiener filtering, dynamical signal model, discrete Kalman filtering.

Recommended Books

- H. L. Van Trees, Detection, Estimation and Modulation Theory: Part I, II, and III, John Wiley, NY, 1968

- H. V. Poor, An Introduction to Signal Detection and Estimation, Springer, 2nd Edition, 1998
- S. M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall PTR, 1993

MTWC-PE2C-18	Credits	L	T	P	Internal	External
MOBILE ADHOC NETWORKS	3	3	0	0	40	60

Course Objective

To understand the working and protocol stack in mobile adhoc network.

Course Outcomes

After the completion of the course, the student will be able to:

1. Know the features, applications, models and characteristics of adhoc networks.
2. Learn the protocols followed in MAC layer, Network layer, Transport layer, Security layer and Cross layer design.
3. Learn how to integrate adhoc networks with mobile-IP networks.

Unit I Introduction: Introduction to adhoc networks–definition, characteristics features, applications, Characteristics of Wireless channel, Adhoc Mobility Models:- Indoor and outdoor models.

Unit II Medium Access Protocols MAC Protocols: design issues, goals and classification. Contentionbased protocols-with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

Unit III Network Protocols: Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

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

Unit V Cross Layer Design and Integration of Adhoc for 4G: Cross layer Design: Need for crosslayer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective. Intergration of adhoc with Mobile IP networks.

Recommended Books

- C. Siva Ram Murthy, B. S. Manoj, Ad hoc Wireless Networks Architectures and protocols, 2nd Edition, Pearson Education, 2007
- Charles E. Perkins, Ad hoc Networking, Addison, Wesley, 2000
- Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic, Mobile Adhoc Networking, Wiley-IEEE Press, 2004
- Mohammad Ilyas, The handbook of Adhoc Wireless Networks, CRC press, 2002

MTWC-PE2D-18	Credits	L	T	P	Internal	External
OPTICAL NETWORK AND PHOTONIC SWITCHING	3	3	0	0	40	60

Course Objective

To understand the communication process in optical networks and switching process.

Course Outcomes

After the completion of the course, the student will be able to:

1. Know the optical transmission and reception.
2. Apply the compensation techniques to the lost data/signals.
3. Learn the architecture and protocols of passive optical networks.
4. Learn the process of wire line techniques.

UNIT I Ray Theory Analysis & Transmission Characteristics: Fibre Optic Guides, Light wavegeneration systems, systems components, optical fibers, SI, GI fibre, modes, Dispersion in fibers limitations due to dispersions, fibre loss, non liner effects.

UNIT II Optical Transmitters & Receivers: Optical Transmitters and Fibres, Basic concept, spectraldistribution, semiconductor lasers, gain coefficients, modes. Transmitter design, Receive PIN and APD diodes,SNR. Switches, Coherent, homodyne and Hetro dyne keying formats, BER in synchronous and Asynchronous.

UNIT III Compensation Techniques: Amplifiers, Basic concepts, Semiconductor laser amplifiers Ramanand Brillouin-fibre amplifiers, Erbium doped-fibre and amplifiers, pumping phenomenon Dispersion Compensation Limitations, post and pre-compensation techniques, equalizing filters, SONET/SDH.

UNIT IV Passive Optical Networks: Architectures And Protocols: PON Architectures, Network Dimensioning and operation, Power Budget, FTTx , Broadband PON: architecture, protocol and Service, Bandwidth allocation. Gigabit-Capable PON. Burst switching, Ethernet PON Architecture, 10GEPON PMD Architecture.

UNIT V Wire Line Techniques: Wire line Narrowband, XDSL, Wire line broad band, Very High Bit Rate Digital Subscriber Line (VDSL), Cable MODEM Home Networks, & VDSL Transmission Protocols. DOCSIS-Standards.

Recommended Books

- G. Keiser, Optical Communications Essentials, 1st Reprint, Tata McGraw Hill, 2008
- G. Keiser, Optical Fibre Communication System, McGraw Hill, New York, 2000
- J. M. Pitts & J. A. Schormans, Introduction to IP and ATM Design and Performance, 2nd Edition, Wiley, 2000
- G. P. Agarwal, Fibre Optic Communication System, 2nd Edition, John Wiley & b sons, New York 1997
- Franz, Jain, Optical Communication System, Narosa Publications, New Delhi, 1995
- Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, Broadband Optical Access Networks, John Wiley and Sons, New Jersey, 2011

MTWC-111-18	Credits	L	T	P	Internal	External
WIRELESS COMMUNICATION LAB	2	0	0	4	40	60

Course Objective

This Laboratory will help the PG students to understand and design/Investigate Wireless channels, Fading environment and analyze their behavior.

Course Outcomes

1. To design Path-Loss models
2. To realize fading environments in wireless channels
3. To realize general modulation techniques

List of Experiments

1. Design Free-Space Propagation-Path Loss model to determine the free space loss and power received.
2. Realization of WLAN Multipath Channel to plot BER-SNR and Bit Rate -SNR graph for the fading environments of
(i) No Fading (ii) Flat Fading
3. Realization of WLAN Multipath Channel to plot BER-SNR and Bit Rate -SNR graph for Dispersive Fading environment.
4. Implement Amplitude Modulation Techniques
5. Realize Frequency Modulation and Pulse Modulation.
6. Study the behavior of different filters.
7. Simulate MIMO channel and estimate BER and SNR .

MTWC-112-18	Credits	L	T	P	Internal	External
INFORMATION THEORY & CODING LAB	2	0	0	4	40	60

Course Objective

This Laboratory will help the PG students to understand and learn to implement programs for Information Theory and Coding.

Course Outcomes

1. To understand the programming of Entropies and Mutual Information
2. To learn and practice programming for generation and evaluation of various codes
3. To develop MATLAB codes for Block codes, Cyclic codes and Convolutional codes.

List of Experiments

1. Write a program for determination of various entropies and mutual information of a given channel.
2. Write a program for generation and evaluation of variable length source coding using C/MATLAB
 - a) Shannon – Fano coding and decoding
 - b) Huffman Coding and decoding
 - c) Lempel Ziv Coding and decoding
3. Write a Program for coding & decoding of Linear block codes.
4. Write a Program for coding & decoding of Cyclic codes.

5. Write a program for coding and decoding of convolutional codes.
 6. Write a program for coding and decoding of BCH and RS codes.
 7. Write a simulation program to implement source coding and channel coding for transmitting a text file.
- More programs can be added as per the syllabus.

MTRM-101-18	Credits	L	T	P	Internal	External
RESEARCH METHODOLOGY & IPR	2	2	0	0	40	60

Course Objective

To enable student to acquire knowledge of research process: gather data, implement the proposed work and collect the results and publish them.

Course Outcomes

After the completion of the course, students will be able to

1. Understand research, research process, define and redefine research problem through literature survey.
2. Know the primary and secondary sources of data collection and select sample size based on the requirement.
3. Utilize the resources efficiently.
4. Critically analyze the data through various statistical measures, perform experiment, gather data and reach to a conclusion based on some hypothesis.
5. Know the intellectual property rights.
6. Write up the report and research article.

Unit I Overview of Research: Meaning of Research, Objectives of research, Types of research, Research approaches, Significance of research, Criteria of good research. Defining the research problem: research problem, Necessity of defining the problem, Technique involve in defining a problem.

Unit II Research Design: Need for research design, Features of a good design, Basic principles of Experimental design Data Collection: Methods of Data Collection; Primary data and Secondary Data.

Unit III Data preparation: Data preparation process, designing questionnaires and schedules. Descriptive statistics: Measures of central tendency, Mean, Median, Mode etc. Sampling and non-sampling errors, Testing of Hypotheses: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests.

Unit IV Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), Patents, Patent Law, Copyright, Trademarks, Geographical Indications, Industrial Design, Unfair Competition, Protection of IPR, Basic steps to write a research paper/ report writing, Introduction to Latex report writing, Introduction to Plagiarism.

Suggested Readings/ Books:

- Krishnaswami K. N., Sivakumar A. I., Mathirajan M., *Management Research Methodology*, Pearson Education, New Delhi
- Kothari C. R., *Research Methodology Methods and Techniques*, 2nd Edition, New Age International Publishers
- Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd ,2007.
- Niebel, *Product Design*, McGraw Hill.
- Asimov, *Introduction to Design*, Prentice Hall.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*.
- T. Ramappa, *Intellectual Property Rights Under WT*, S. Chand
- J.F.Kaiser, "Richard Hamming-You and Your Research", Transcription of Bell Communications Research Colloquium Seminar, 1986.

MTA101-18 Audit Courses -I

MTA101-18	Credits	L	T	P	Internal	External
Audit Course 1 English for research paper writing	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to develop skills in effective English writing to communicate the research work

Course Outcomes

At the end of this course Students will be able to:

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

Unit 1

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit 2

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit 3

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 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.

Unit 5

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Unit 6

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Recommended Books :

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.

MTA102-18	Credits	L	T	P	Internal	External
Audit Course 1 Disaster Management	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to develop skills in helping society during natural disasters and how to manage.

Course Outcomes

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

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

Unit 1

Introduction: Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Unit 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.

Unit 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.

Unit 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.

Unit 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.

Unit 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.

Recommended Books :

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company.
2. Sahni, PardeepEt.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.

MTA103-18	Credits	L	T	P	Internal	External
Audit Course 1 Sanskrit For Technical Knowledge	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to develop

1. 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 Outcomes

At the end of this course students will be able to

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

Unit 1

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

Unit 2

Order, Introduction of roots, Technical information about Sanskrit Literature.

Unit 3

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Recommended Books :

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

MTA104-18	Credits	L	T	P	Internal	External
Audit Course 1 Value Education	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to develop

1. Value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Course Outcomes

At the end of this course students will be able to

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

Unit 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.

Unit 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.

Unit 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.

Unit 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.

Recommended Books :

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Second Semester

MTWC-103-18	Credits	L	T	P	Internal	External
ADVANCED WIRELESS COMMUNICATION	3	3	0	0	40	60

Course Objective

To learn the fundamentals and advanced concepts in wireless communication.

Course Outcomes

After the completion of the course, the student will be able to:

1. Review the fundamentals of wireless communication.
2. Compare the performance of different digital modulation techniques over wireless channels.
3. Design OFDM system and data transmission through multicarrier modulation.
4. Describe OFDMA system, its operation and applications.

Unit I Review of Fundamentals of Wireless Communication: Multipath fading, multipath channel models, and capacity of wireless channels.

Unit II Performances of Digital Modulation over Wireless Channels: AWGN channels signal to noise power ratio and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM- their comparison.

Unit III Multicarrier Modulation: Data transmission using multiple carriers, multicarrier modulation with overlapping sub channels, mitigation of subcarrier fading, discrete implementation of multicarrier modulation, challenges in multicarrier systems.

Unit IV Introduction to Wireless OFDM: OFDM principles, system model, generation of sub carrier using IFFT, guard time, cyclic extension, windowing, OFDM parameters, OFDM signal processing, coherent and differential detection

Unit V OFDMA: frequency hopping in OFDMA, difference between OFDMA and MC-CDMA, OFDMA system description-channel coding, frequency synchronization, initial modulation timing and frequency offset synchronization accuracy, random frequency hopping operation, applications of OFDMA.

Recommended Books

- Goldsmith, Wireless Communications, Cambridge Univ. Press, 2005
- R. Vanne, R. Prasad, OFDM for Wireless Multimedia Communication, Artech House, 2000
- M. Engels, Wireless OFDM systems, Klumer Academic Publishers, 2002

MTWC-104-18	Credits	L	T	P	Internal	External
SOFT COMPUTING TECHNIQUES	3	3	0	0	40	60

Course Objective

To enable the students utilize the soft computing techniques to optimize the systems.

Course Outcomes

After the completion of the course, the student will be able to:

1. Study basic concept of soft computing and differentiate between supervised, unsupervised and reinforced learning methods.
2. Learn various artificial neural network techniques, fuzzy sets, fuzzification and defuzzification.
3. Optimize solutions using Genetic Algorithm.

4. Use hybrid soft computing techniques.

Unit I Artificial Neural Network: Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model, Properties of neural network, Typical architectures: single layer, multilayer, competitive layer; Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent N.N; Application of N.N; Neuron. Pattern Recognition: Pattern Classification, Pattern Association, Clustering, Simple Clustering algorithm, k-means & k-medoid based algorithm. Models Of Neural Network: Architecture, Algorithm & Application of McCulloch-Pitts, Hebb Net, Perceptron (with limitations & Perceptron learning rule Convergence theorem), Back propagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet , Kohonen Self Organizing Maps, ART1, ART2.

Unit II Fuzzy Sets & Logic: Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic— Laws of propositional logic, Inference; Predicate logic—Interpretations, Inference; Fuzzy logic— Quantifiers, Inference; Fuzzy Rule based system; Defuzzification methods; FAM

Unit III Genetic Algorithm: Basic concept; role of GA in optimization, Fitness function, Selection of initial population, Cross over (different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation; Genetic Programming; Schema theorem; Multi objective & Multimodal optimization in GA; Application—Travelling Salesman Problem

Unit IV Hybrid soft computing Techniques: GA based BPNN (Weight determination, Application); Neuro Fuzzy Systems—Fuzzy BPNN—fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled G. A.

Recommended Books

- S. N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Wiley India
- Simon Haykin, Neural Networks- A Comprehensive foundation, 2nd Edition Pearson

- T. S. Rajasekaran, G. A. Vijaylakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms–Synthesis & applications, PHI
- Sanchez, Takanori, Zadeh, Genetic Algorithm & fuzzy Logic Systems, World Scientific
- Goldberg David E., Genetic Algorithm, Pearson
- Zimmermann H. J., Fuzzy Set Theory & Its Applications, Allied Publishers

MTWC-105-18	Credits	L	T	P	Internal	External
SIMULATION OF WIRELESS COMM. SYSTEMS	3	3	0	0	40	60

Course Objective

To inculcate in students the knowledge of simulation of real time wireless communication systems.

Course Outcomes

After the completion of the course, the student will be able to:

1. Study the role of simulation in communication system and random processes.
2. Review stochastic processes and parameter estimation.
3. Model wireless communication systems through numerical methods.
4. Study communication channel models and perform Monte Carlo Simulation.

Unit I Introduction to simulation approach: Methods of performance evaluation-simulation approach-Advantages and limitations. System model steps and its types involved in simulation study. Error sources in simulation. Role of simulation in communication system and random process. Introduction to random variables - univariate models (discrete and continuous) and multi-variate models.

Unit II Review of Stochastic process and parameter estimation: Stochastic process: Definitions, properties – stationarity, time averaging and ergodicity, random process models. Parameter estimation: Quality of an estimator, estimating average power probability density function, estimation of power spectral density of a process, delay and phase. SNR estimation and importance sampling.

Unit III Numerical methods for wireless Communication Systems: numerical differentiation, integration, differential equation.

Unit IV Monte Carlo simulation: concepts and integration, Application in wireless Communication Systems.

Unit V Modelling of Communication systems: properties, generation and techniques for generating random numbers and processes. Introduction to modeling of communication systems - Information sources, source coding, base band modulation, channel coding, RF and optical modulation, filtering, multiplexing, detection/demodulation- carrier and timing recovery for BPSK and QPSK. Modeling considerations for PLL.

Unit VI Communication channel models

Statistical characterization of multipath channels and time-varying channels with Doppler effects, models for multipath fading channels. Finite state channel models – channels with and without memory. Methodology for simulating communication systems operating over fading channels.

Recommended Books

- M. C. Jeruchim, Philip Balaban, K. Sam shanmugam, Simulation of communication systems, Plenum Press, New York, 1992
- M. Law, W. David Kelton, Simulation Modelling and analysis, McGraw Hill, New York, 1999
- K. Hayes, Modelling and Analysis of computer communication networks, Plenum press, New York, 1984
- Banks, J. S. Carson, Nelson, D. M. Nicol, Discrete–Event system simulation, Prentice Hall of India, 4th Edition, 2005
- Z. Peebles , Probability, Random Variable and Random Signal Principles, Tata McGraw Hill, 4th Edition 2007

MTWC-105-18	Credits	L	T	P	Internal	External
WIRELESS COMMUNICATION SIMULATION LAB	2	0	0	4	40	60

Course Objective

This Laboratory will help the PG students to understand and learn to implement programs related to Simulation of Wireless Communication.

Course Outcomes

1. To understand the programming of OFDM based Transmitter & Receiver.
2. To learn and practice MATLAB programming for implementing Digital modulation techniques.
3. To find the vacant spaces for secondary users in Cognitive Radio Networks..

List of experiments:

1. Develop MATLAB code to design OFDM based transmitter and receiver for different channel environment conditions.
2. Estimate and analyze the lifetime of 100 nodes in WSN using LEACH Protocol.
3. Develop MATLAB codes to Implement Digital Modulation techniques (i)ASK (ii) FSK (iii) M-PSK (iv) M-QAM (v)PCM.
4. Find the vacant spaces for Secondary Users in Cognitive Radio Network using Spectrum Sensing Techniques (i)Energy detection (ii)Matched Filter detection (iii) Cyclostationary Detection.
5. Design OFDM System with 2x2, 2x4 and 4x4 MIMO System.

MTWC-MP1-18	Credits	L	T	P	Internal	External
MINI PROJECT	2	0	0	4	40	60

Course Objective

To implement the knowledge gained during course practically.

Course Outcomes

After the completion of the course, the student will be able to:

1. Acquire practical knowledge of the chosen field.
2. Identify, analyze, formulate & handle programming projects with systematic approach.
3. Contribute as a team leader in the development of technical projects.
4. Develop communication skills for the presentation of project related activities.

PROGRAM ELECTIVES - III

MTWC-PE3A-18	Credits	L	T	P	Internal	External
Smart Antennas	3	3	0	0	40	60

Course Objective

This Elective course is meant to recall the important concepts of Smart Antennas, their significance, applications and understand the behavior and working of Smart antennas with the help of the beam forming and other techniques.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the significance of smart antennas and its historical development.
2. Know the architecture of Smart antennas, types, applications
3. Learn antenna array fundamentals criteria and beam forming basics.
4. Explain the Spatial Processing techniques for CDMA Smart Antennas.

Unit I Introduction to Smart Antennas: Why smart antennas, benefits of smart antennas, spatial processing for wireless systems, wideband smart antennas, historical development

Unit II Antenna Fundamentals: Antenna field regions, power density, radiation intensity, antenna nomenclature, Friis transmission formula, linear antennas, loop antennas.

Unit III Array Fundamentals: Linear arrays, array weighting, circular arrays, rectangular arrays, fixed beam and retrodirective arrays.

Unit IV Beam Forming Basics: Maximum signal to interference ratio, minimum mean square ratio, minimum variance, adaptive beamforming, description of new SDMA receiver, software radios for smart antennas.

Unit V Smart Antenna Techniques for CDMA: Non-coherent CDMA spatial processors, coherent CDMA spatial processors and the spatial processing rake receiver, multi-user spatial processing, dynamic re-sectoring using smart antennas, downlink beam forming for CDMA.

Recommended Books

- Gross F. B., Smart Antennas for Wireless Communications with MATLAB, McGraw-Hill, New York, 2005.
- Balanis A., Antenna Theory Analysis and Design, John Wiley and Sons, New York, 1982
- Joseph C. Liberti, Theodore S. Rappaport, Smart Antennas for Wireless Communications: IS95 and third generation CDMA Applications, Prentice Hall Communications Engineering and Emerging Technologies Series

MTWC-PE3B-18	Credits	L	T	P	Internal	External
Wireless Network Planning, Optimization and Management	3	3	0	0	40	60

Course Objective

This Elective course is meant to recall the important fundamentals of Wireless Network Planning, its significance, applications and understand their optimization and management.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the Radio Network planning and optimization.
2. Know the technologies of WCDMA and GSM
3. Learn the fundamentals of Radio Resource Management

Unit I Introduction to Radio Network Planning and Optimisation - Future Trends -Towards a Service-driven Network Management - Wireless Local Area Networks (WLANs) - Next-generation Mobile Communication

Unit II WCDMA Radio Network Planning: WCDMA Radio Network Planning: Dimensioning - Detailed Planning - Verification of Dimensioning with Static Simulations - Verification of Static Simulator with Dynamic Simulations - Optimisation of the Radio Network Plan.

UNIT III WCDMA–GSM Co-Planning Issues: WCDMA–GSM Co-planning Issues - Radio Frequency Issues – Radio Network Planning Issues; Coverage and Capacity Enhancement Methods - Techniques for Improving Coverage - Techniques for Improving Capacity

Unit IV Radio Resource Management: Radio Resource Utilisation: Introduction to Radio Resource Management - Power Control - Handover Control - Congestion Control – Resource Management; RRU for High-speed Downlink Packet Access (HSDPA) - Impact of Radio Resource Utilisation on Network Performance.

Unit V Radio Network Optimisation: Radio Network Optimisation Process - Introduction to Radio Network Optimisation Requirements - Introduction to the Telecom Management Network Model - Tools in Optimisation; Advanced Analysis Methods and Radio Access Network Autotuning - Advanced Analysis Methods for Cellular Networks - Automatic Optimisation.

Recommended Books

- Jaana Laiho, Achim Wacker, Tomas Novosad, Radio Network Planning and Optimisation, John Wiley, 2006
- Morten Tolstrup, Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS and HSPA, John Wiley, 2008
- IanaSiomina, Radio Network Planning and Resource Optimization, LiU-Tryck, Linköping, Sweden, 2007

MTWC-PE3C-18	Credits	L	T	P	Internal	External
Microwave and RF Design	3	3	0	0	40	60

Course Objective

This Elective course is meant to recall the important fundamentals of the designs at Microwave and RF frequencies, its significance, applications and understand their technical concepts.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the significance of Microwave and RF designs.
2. Know the fundamentals behind Microwave Amplifiers/Oscillators designs
3. Technical know-how of Microwave and RF antennas concepts

Unit I Networks and Matrices: Scattering and chain scattering matrices, Generalized scattering matrix, Analysis of two port networks, Interconnection of networks. Positive real concepts, scattering matrix, representation of microwave components (directional coupler, circulators, hybrids and isolators).

Unit II High Frequency Circuit Design: Tuned Circuits, Filter design- Butterworth filter, Chebyshev filter, impedance matching. High frequency amplifier, BJT and FET amplifier, Broadband Amplifiers RF Oscillators, Colpitts, Hartley Oscillators, PLL. High Frequency Integrated Circuits.

Unit III Microwave Amplifier Design: Types of amplifiers, Power gain equations. Introduction to narrow band amplifiers basic concepts, Maximum gain design, Low noise design. High power design, Negative resistance, reflection amplifiers – various kinds – stability considerations, Microwave transistor amplifier design – input and output matching networks – constant noise figure circuits.

Unit IV Microwave Transistor Oscillator Design: One port and two port negative resistance oscillators. Oscillator configurations, Oscillator design using large signal measurements, Introduction to Microwave CAD packages, Microwave integrated circuits, MIC design for lumped elements.

Unit V RF and Microwave Antennas: Radiation from surface current and line current distribution, Basic Antenna parameters, Feeding structure-Patch Antenna, Ring Antenna, Micro strip dipole, Micro strip arrays, Traveling wave Antenna, Antenna System for Mobile Radio-Antenna Measurements and Instrumentation. Propagation characteristics of RF and Microwave signals, Introduction to EBG structures.

Recommended Books

- Matthew M. Radmanesh, RF and Microwave Design Essentials, Author House, Bloomington, 2007
- Daniel Dobkin, RF Engineering for Wireless Networks, Elsevier, London, 2005
- Reinhold Ludwig, Gene Bogdanov, RF Circuit Design – Theory and Applications, 2nd Edition, Pearson, 2012
- E.da Silva, High Frequency and Microwave Engineering, Butterworth Heinmann Publications, Oxford, 2001.
- David M. Pozar, Microwave Engineering, John Wiley and Sons, 3rd Edition, 2005
- Kraus J. D, Marhefka. R. J. Khan A. S. Antennas for All Applications, 3rd Edition, Tata McGraw Hill, 2006
- Balanis A, Antenna Theory Analysis and Design, John Wiley and Sons, New York, Third Edition, 2005

MTWC-PE3D-18	Credits	L	T	P	Internal	External
Multimedia Communication and Technology	3	3	0	0	40	60

Course Objective

This Elective course is meant to recall the important fundamentals of the designs at Microwave and RF frequencies, its significance, applications and understand their technical concepts.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the fundamentals of multimedia system design..
2. Apply compression and decompression techniques to image, audio and video signals.
3. Differentiate between various multimedia input-output technologies and storage-retrieval technologies.
4. Learn the design aspects of multimedia applications

Unit I Multimedia Communication: An Introduction: Multimedia Information representation, Multimedia Networks: Telephone Network, Data Network, Broadcast Network etc, Multimedia Applications: Interpersonal communications, Entertainment applications etc, Application and Networking: Media Types, Network types etc, Technology of Multimedia.

Unit II Multimedia Information Representation: Introduction, Digitization principles: Analog Signals, Encoder design, Decoder Design, Text: Unformatted Text, Formatted text, Images: Graphics, Digitized documents etc, Audio: PCM speech, CD-quality audio, Video: Broadcast television.

Unit III Multimedia Compression (Text and Image): Introduction, Multimedia compression principles: Source encoders and destination decoders, Lossless and lossy compression, Entropy encoding, Source encoding, Text Compression: Static Huffman coding, Dynamic Huffman coding, Image compression: GIF, TIFF etc,

Unit IV Multimedia Compression (Audio and Video): Audio Compression: Differential pulse code modulation, Linear predictive coding MPEG audio coders etc, Video Compression: Video compression principles, H.261, MPEG etc. Recent trends in Multimedia communication.

Recommended Books

- Andleigh P. K., Thakrar K., Multimedia Systems, Addison Wesley Longman, 1999
- Fred Halsall, Multimedia Communications, Pearson Education, 2000
- Ralf Steinmetz, Klara Nahrstedt, Multimedia, Computing, Communications and Applications, Prentice Hall, 1995
- Tay Vaughan, Multimedia making It work, TMH, 5th Edition 2001
- Weixel, Fulton, Barksdale.Morse, Multimedia Basics, Easwar Press, 2004

PROGRAM ELECTIVES - IV

MTWC-PE4A-18	Credits	L	T	P	Internal	External
Cryptography and Wireless Security	3	3	0	0	40	60

Course Objective

This is one of the Elective courses that is meant to understand the important concepts of Cryptography, its mathematical formulation, applications, Authentication and system security techniques.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the significance of Cryptography
2. Know its Integrity, Authentication and Management
3. Learn the concepts of Security and threats to wireless systems.

Unit I Number Theory and Cryptography: Mathematics of cryptography - integer arithmetic, modular arithmetic, linear congruence, GF (2n), algebraic structures, primes, Euler's phi & totient functions, Fermat's and Euler's theorem, primality testing, factorization, CRT, quadratic congruence, exponentiation and logarithm, elliptic curve cryptosystem, symmetric key cryptography - substitution, transposition, modern block ciphers, and its applications.

Unit II Integrity, Authentication and Key Management: Introduction to message integrity, hash functions and digital signature, SHA-512, MAC & MDC, HMAC, CMAC, digital signature- DSA, ECDSA, Entity

authentication-passwords, challenge-response, zero-knowledge, key management-PKI, symmetric key agreement, RSA ,ElGammal, information theory, and elementary probability, complexity of algorithm.

Unit III Security Practice & System Security: Electronic Mail Security – PGP, S/MIME, IPSec, Secure Electronic Transaction, web security considerations – SSL, TLS, IDS-password management, viruses and related threats, viruses counter measures, firewalls design principles, types of firewalls, configurations, trusted systems.

Unit IV Wireless Threats: Introduction to wireless technologies- history, challenges, risks, advances in wireless security, Radio Frequency –RF Terminology, interference, covert channels, and hardware. Hacking 802.11 wireless technologies- eavesdropping, jamming - wireless channel vulnerability analysis, Wi-Fi cyber crimes and awareness- countermeasures - wireless security standards wireless setup, risks and security controls.

Unit V Wireless Security: 802.11i - Attacks, WPA-EAP, Attacking 802.11 Networks- Basic Types Of Attacks, Security Through Obscurity, Defeating WEP, WEP attacks, 802.11 Authentication Types, Attacking WPA-Protected 802.11, Breaking WPA, LEAP,EAP-TLS, Tunneling EAP Techniques, Hacking Attacking 802.11i wireless technologies- Hacking hotspots, client attacks resources, threats of Bluetooth- advanced attacks- layer 2 fragmentations breaking the silence, layer 2 and layer 3 resolutions.

Recommended Books

- Behrouz Forouzan, Cryptography & Network Security, Tata McGraw Hill, 2008
- Johnny Cache, Vincent Liu, Hacking Exposed Wireless: Wireless Security secrets And Solutions, Tata McGraw Hill, 2007
- William Stallings, Cryptography & Network Security – Principles and Practices, Pearson Education, Fourth Edition, 2006
- Douglas R. Stinson, Cryptography-Theory and Practice, CRC Press,1995
- Wolfgang Osterhage, Wireless Security, CRC Press, 2011

- Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Cengage Learning, 4th Edition, 2011

MTWC-PE4B-18	Credits	L	T	P	Internal	External
Software Defined radios and Cognitive Radio	3	3	0	0	40	60

Course Objective

This is an interesting Elective course that is meant to understand the important concepts of Software defined Radios (SDR) as well as Cognitive radios, their significance, implementation and applications.

Course Outcomes

After the completion of this course, the student will be able to:

1. Learn Software Defined Radio concepts, architecture and SDR based end-to -end communication.
2. Understand communication setup between client and server through CORBA.
3. Apply SDR principles to smart antenna
4. Know the importance of frequency reuse through Cognitive Radio. Locate vacant spaces in spectrum through spectrum sensing techniques.

Unit I SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA. Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems.

Unit II Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance, Radio Frequency design, Baseband Signal Processing, Radios with intelligence.

Unit III Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future For Software Defined Radio.

Unit IV Cognitive Radio, concepts & history, frequency spectrum allocation, vacant spectrum sensing techniques.
Efficient utilization of vacant holes in cognitive radio networks

Recommended Books

- Dillinger, Madani, Alonistioti (Eds.), Software Defined Radio, Architectures, Systems and Functions, Wiley, 2003
- Reed, Software Radio, Pearson
- Paul Burns, Software Defined Radio for 3G, 2002
- Tafazolli (Ed.), Technologies for the Wireless Future, Wiley 2005
- Bard, Kovarik, Software Defined Radio, the Software Communications Architecture, Wiley, 2007

MTWC-PE4C-18	Credits	L	T	P	Internal	External
Wireless and Optical Communication Networks	3	3	0	0	40	60

Course Objective

This is an interesting Elective course that is meant to understand the important concepts of Wireless as well as Optical Communication networks, their significance, network components applications.

Course Outcomes

After the completion of this course, the student will be able to:

1. Learn Wireless Communication Network layers/technology .
2. Understand basic network components of Wireless and Optical Networks.

3. Explain their applications

4. Know the importance of frequency reuse through Cognitive Radio. Locate vacant spaces in spectrum through spectrum sensing techniques.

Unit I Wireless Communication Networks: 3G Overview, Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, 4G features and challenges, Technology path, IMS Architecture - Introduction to wireless LANs -IEEE 802.11 WLANs - Physical Layer- MAC sublayer.

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

Unit III Optical Communication networks: Introduction: circuit switching and packet switching, optical layer, network evolution. Optical networking components/building blocks: Optical fibers, Optical transmitter, receiver and filters, multiplexers, switching elements, wavelength converter, and optical amplifiers. Client layers of the optical layer, WDM network elements. Optical switching: Packet switching, burst switching, MEMs based switching.

Unit IV Optical Metro Network: SONET/SDH, Fault management in SONET/SDH. Optical Access Network: Access networks, Photonic packet switching. Deployment considerations. Overview of PON technologies, Ethernet access network, WDM-PON. Control and management, network survivability, protection schemes.

Recommended Books

- Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
- HARRY R. ANDERSON, “Fixed Broadband Wireless System Design” John Wiley – India, 2003.
- Andreas.F. Molisch, “Wireless Communications”, John Wiley – India, 2006.
- Simon Haykin & Michael Moher, “Modern Wireless Communications”, Pearson Education, 2007.

- Rappaport. T.S., “Wireless communications”, Pearson Education, 2003.
- John M. senior, ‘Optical fiber communication,’ PHI
- G.E. Keiser, ‘Optical fiber communication,’ McGraw Hill
- P.E. Green, Jr., “Fiber Optic Networks”, Prentice Hall, NJ

MTWC-PE4D-18	Credits	L	T	P	Internal	External
MIMO Systems	3	3	0	0	40	60

Course Objective

output The purpose of the course is to provide a comprehensive coverage of coding techniques for multiple-input, multiple-output (MIMO) communication systems.

Course Outcomes

After completing this course the student will be able to:

1. Understand Basic MIMO communication systems
2. Explore Space-time block codes & Space-time trellis codes
3. MIMO systems for frequency-selective (FS) fading channels

fading **Unit I** FADING CHANNEL AND DIVERSITY TECHNIQUES: Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

noisy, AWGN **Unit II** CAPACITY AND INFORMATION RATES OF MIMO CHANNELS: Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.

scheme – **Unit III** SPACE TIME BLOCK AND TRELLIS CODES: Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal spacetime block codes – Linear dispersion codes – Generic

space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis

Unit IV FREQUENCY SELECTIVE FADING CHANNELS MIMO: frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space - time coding and Channel detection for MIMO FS channels – MIMO OFDM systems.

Recommended Books

- Tolga M. Duman and Ali Ghayeb, “Coding for MIMO Communication systems”, John Wiley & Sons, West Sussex, England, 2007.
- A.B. Gershman and N.D. Sidiropoulos, “Space-time processing for MIMO communications”, Wiley, Hoboken, NJ, USA, 2005.
- E.G. Larsson and P. Stoica, “Space-time block coding for Wireless communications”, Cambridge University Press, 2003.
- M. Janakiraman, “Space-time codes and MIMO systems”, Artech House, 2004.
- H. Jafarkhani, “Space-time coding: Theory & Practice”, Cambridge University Press, 2005.

MTAXX-18 Audit Courses II

MTA105-18	Credits	L	T	P	Internal	External
Audit Course 2 Constitution of India	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to

1. Understand the premises informing the twin themes of liberty and freedom from a civilrights 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 Outcomes

Students will be able to:

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.

Unit 1:

History of Making of the Indian Constitution:History, Drafting Committee, (Composition & Working).

Unit 2:

Philosophy of the Indian Constitution:Preamble, Salient Features.

Unit 3:

Contours of Constitutional Rights & Duties:Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State PolicyFundamental Duties.

Unit 4:

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.

Unit 5:

Local Administration: District's Administration head: Role and Importance,Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO ZilaPachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials,Importance of grass root democracy.

Unit 6:

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.

Recommended Books :

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.

MTA106-18	Credits	L	T	P	Internal	External
Audit Course 2 Pedagogy Studies	Non-credit	0	0	0	S/US	S/US

Course Objective

This course is to inculcate better teaching methods/tools for future teachers to build a better education system to compete with the developed nations pedagogical practices

Course Outcomes

Students will be able to understand:

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?

Unit 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.

Unit 2:

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit 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, Strength and nature of the body of evidence foreffective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

Unit 4:

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.

Unit 5:

Research gaps and future directions- Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Recommended Books :

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. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? *International Journal Educational Development*, 33 (3): 272–282.
5. Alexander RJ (2001) *Culture and pedagogy: International comparisons in primary education*. Oxford and Boston: Blackwell.
6. Chavan M (2003) *Read India: A mass scale, rapid, 'learning to read' campaign*.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

MTA107-18	Credits	L	T	P	Internal	External
Audit Course 2 Stress Management By Yoga	Non-credit	0	0	0	S/US	S/US

Course Objective

This course helps to achieve overall health of body and mind and overcome stress

Course Outcomes

Students will be able to:

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

Unit 1:

Definitions of Eight parts of yog. (Ashtanga)

Unit 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.

Unit 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.

Recommended Books :

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

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MTA108-18	Credits	L	T	P	Internal	External
Audit Course 2 Personality Development Through Life Enlightenment Skills	Non-credit	0	0	0	S/US	S/US

Course Objective

This course helps to learn to achieve the highest goal happily, become a person with stable mind, pleasing personality and determination and awaken wisdom in students

Course Outcomes

Students will be able to

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 of students.

Unit 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 (don't's), Verses- 71,73,75,78 (do's).

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Unit 2:

Approach to day to day work and duties, Shrimad BhagwadGeeta : 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.

Unit 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.

Recommended Books :

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya SanskritSansthanam, New Delhi.

THIRD SEMESTE

PROGRAM ELECTIVES - V

MTWC-PE5A-18	Credits	L	T	P	Internal	External
Millimeter Wave Communication and Technology	3	3	0	0	40	60

Course Objective

This is one of the Elective courses that is meant to understand the important concepts of MM Wave Communication & Technology, its characteristics, standards, applications.

Course Outcomes

After the completion of this course, the student will be able to:

1. Learn millimetre wave characteristics, standards and applications.
2. Recognize design considerations for millimetre wave antenna, concepts of beamforming and beam steering.
3. Learn modulation techniques used in transceiver design and link budget.
4. Explain MIMO system for millimetre wave communication.

Unit I Multi Gigabit 60-GHz Millimeter Wave Radios: Millimeter wave characteristics-Channel performance at 60GHz, Gigabit wireless communication, Comparison of Three Technologies for Gigabit Wireless Communications, Possible Applications for Millimeter Wave Communications, Coexistence with wireless backhaul.

Unit II Millimeter Wave Transceivers: Millimeter wave link budget, 60 GHz transmitter, receiver, and wireless link, Modulation techniques-OOK, PSK, FSK, QAM, OFDM.

Unit III Advanced Beam Steering and Beam Forming: Need for beam steering and beam forming, Beam steering of a narrow-beam antenna having a main antenna radiation pattern, System model of phase array antennas,

UNIT IV Adaptive frame structure: Frame structure to enable beam steering or beam forming, Channel sounding frame and data frame, Adaptive frame structure to reduce the CSF overhead, Long data frame and short data frame, Advanced beam steering technology, Acquisition and tracking algorithm for beam steering, Flowchart of beam steering algorithm, Advanced beam forming technology, Advanced antenna ID technology.

Unit V Millimeter Wave MIMO: Spatial diversity of antenna arrays, Multiple antennas, Multiple transceivers.

Recommended Books

- Kao-Cheng Huang, Zhaocheng Wang, *Millimeter wave communication systems*, John Wiley & Sons, Hoboken, New Jersey, 2011
- Jonathan Wells, *Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications*, Artech House, 2010
- Su-Khiong Yong, Pengfei Xia, Alberto Valdes-Garcia, *60GHz Technology for Gbps WLAN and WPAN: From Theory to Practice*, Wiley 2010

MTWC-PE5B-18	Credits	L	T	P	Internal	External
Space Time Wireless Communication	3	3	0	0	40	60

Course Objective

This is one of the Elective courses that is meant to understand the important concepts of Space time Wireless Communication, Channel, Multiple Antenna Propagation, Capacity and Space diversity.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand Space Time Channel Characterization
2. Explain Capacity of Multiple Antenna Channels
3. Learn ST OFDM, Spread Spectrum

Unit I Multiple Antenna Propagation and ST Channel Characterization: Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

Unit II Capacity of Multiple Antenna Channels: Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

Unit III Spatial Diversity: Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

Unit IV Multiple Antenna Coding and Receivers: Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers (SISO, SIMO, MIMO), Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.

Unit V OFDM, Spread Spectrum and MIMO Multiuser Detection: SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMO- OFDM,SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO- S.MIMO-MAC,MIMO-BC, Outage performance for MIMO-MU,MIMO-MU with OFDM,CDMA and multiple antennas.

Recommended Books

- Paulraj, Rohit Nabar, Dhananjay Gore, *Introduction to Space Time Wireless Communication Systems*, Cambridge University Press, 2003
- Sergio Verdu, *Multi User Detection*, Cambridge University Press, 1998
- Andre Viterbi, *Principles of Spread Spectrum Techniques*, Addison Wesley 1995

MTWC-PE5C-18	Credits	L	T	P	Internal	External
Advanced Techniques for Wireless Reception	3	3	0	0	40	60

Course Objective

This Elective course is meant to explore the important concepts of Wireless Reception taking due consideration on Wireless signaling environment, Multiuser detection, CDMA, OFDM, MIMO Systems

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand Wireless Signaling Environment
2. Explain the usage of Multiuser detection
3. Learn CDMA, OFDM, MIMO systems

Unit I: Wireless signaling environment, Basic signal processing for wireless reception. Linear receivers for synchronous CDMA. Blind and group-blind multiuser detection methods.

Unit II: Robust multiuser detection for non Gaussian channels; asymptotic performance. Adaptive array processing in TDMA systems. Optimum space-time multiuser detection.

Unit III: CDMA- Encoder and decoder, difference between IS-95 and WCDMA, RAKE receiver- basic idea, propagation of transmitted signal, multipath, applications of RAKE receiver.

Unit IV: OFDM system and principle, multicarrier modulation, guard interval and inter symbol interference, cyclic prefix, equalization, advantages and disadvantages.

Unit V: MIMO multi input multi output, history, wireless channel and its characteristics, capacity of MIMO system, MIMO design criterion, diversity, space time for wireless communication, variants of multiple antenna system.

Recommended Books

- X. Wang, H. V. Poor, Wireless Communication Systems, Pearson, 2004
- R. Janaswamy, Radio Wave Propagation and Smart Antennas for Wireless Communication, Kluwer, 2001
- Mohamed Ibnkahla, Signal Processing for Mobile Communications, CRC Press, 2005

- V. H. Sheikh, Wireless Communications Theory & Techniques, Kluwer Academic Publications, 2004
- Paulraj, Introduction to Space-time Wireless Communications, Cambridge University Press, 2003

MTWC-PE5D-18	Credits	L	T	P	Internal	External
Emerging Technologies of Wireless Communication	3	3	0	0	40	60

Course Objective

This Elective course is meant to explore the important concepts of Wireless Communication and its emerging technologies like GPRS, UMTS, WiFi, WiMAX, UWB, CDMA, OFDM, MIMO Systems

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the concept of cellular/wireless communication
2. Explain the Mobile Radio Propagation and Multiuser systems
3. Learn technologies of GPRS, UMTS, WiFi, WiMAX, Ultra Wideband communications, 4G and beyond 4G

Unit I Introduction to Wireless Communication: The Cellular concept, System design, Capacity improvement in cellular systems, Co channel interference reduction. Intelligent cell concept and applications. Technical Challenges.

Unit II Mobile Radio Propagation: Reflection, Diffraction. Fading. Multipath Propagation. Channel modeling, Diversity Schemes and Combining Techniques. Design parameters at the base station, Practical link budget design using path loss models. Smart antenna systems, Beam forming. MIMO Systems. RAKE receiver.

Unit III Multiuser Systems: CDMA- Principle, Network design, Link capacity, Power control, CDMA Network planning, MC-CDMA, OFDM.

Unit IV Cellular mobile communication beyond 3G: GSM, IS-95, GPRS, UMTS, WiFi, WiMAX, Ultra Wideband communications, 4G and beyond 4G.

Recommended Books

- F. Molisch, Wireless Communications, Wiley, 2005
- Goldsmith, Wireless Communications, Cambridge University Press, 2005
- P. Muthu Chidambara Nathan, Wireless Communications, PHI, 2008
- Ke-Lin Du, M. N. S. Swamy, Wireless Communication Systems”, Cambridge University Press, 2010
- K. Fazel, S. Kaiser, Multi-carrier and Spread Spectrum Systems, Wiley, 2003
- S.G. Glisic, Advanced Wireless Communications, 4G Technologies, Wiley, 2004
- W. C. Y.Lee, Mobile Communication Engineering, 2nd Edition, McGraw- Hill, 1998.
- S.G. Glisic, Adaptive CDMA, Wiley, 2003

MTWC-PE5E-18	Credits	L	T	P	Internal	External
Microstrip Antennas	3	3	0	0	40	60

Course Objective

This Elective course is meant to explore the important concepts of Micro-strip Antenna systems, methods to analyze them, their configurations, applications.

Course Outcomes

After the completion of this course, the student will be able to:

1. Understand the basic concept of micro-strip antennas, methods of analysis and configurations.
2. Explain micro-strip antennas arrays.
3. Understand the physical significance of discontinuities.
4. Learn coupled micro-strip line with multiband and broadband behavior.

UNIT I - Micro-Strip Lines: Introduction of Planar Transmission Structures, Micro-strip Field Configuration, Micro-strip Dispersion Models, Micro-strip Transitions, Micro-strip measurement, Methods of Full wave Analysis, Analysis of an Open Micro-strip, Analysis of an Enclosed Micro strip, Design Considerations, Suspended and Inverted Micro-strip Lines, Multilayered Dielectric Micro-strip, Thin Film Micro-strip (TFM), Valley Micro-strip Lines, Micro-strip Applications.

UNIT II - Micro-Strip Antenna Arrays: Array theory, Array calculations and analysis, array architectures, corporate array design, Resonant series fed array design, Series fed traveling wave array design. Micro-Strip Discontinuities: Introduction of Quasi-Static Analysis and Characterization, Discontinuity Capacitance Evaluation, Discontinuity Inductance Evaluation, Characterization of Various Discontinuities, Planar Waveguide Analysis, Full wave Analysis of Discontinuities, Discontinuity Measurements.

UNIT III - Slot-Line: Introduction of Slot-lines, Slot-line Analysis, Design Considerations, Slot-line Discontinuities, Slot-line Transitions, Slot-line Applications. Coplanar Lines and Wave Guides: Introduction of Coplanar Waveguide and Coplanar Strips, Quasi-Static Analysis, Design Considerations, Losses, Effect of Tolerances, Comparison with Micro-strip Line and Slot-line, Transitions, Discontinuities in Coplanar Waveguide, Coplanar Line Circuits.

UNIT IV - Coupled Micro-Strip Lines: Introduction of Coupled Micro-strip Lines, General Analysis of Coupled Lines, Characteristics of Coupled Micro-strip Lines, Measurements on Coupled Microstrip Lines, Design Considerations for Coupled Micro-strip Lines, Coupled Multi conductor Micro-strip Lines, Discontinuities in Coupled Micro-strip Lines. Micro-Strip Circuit Design: impedance transformers, filters, isolators and phase shifters.

Recommended Books

- Gupta, K.C. and Garg, Ramesh, Micro-strip lines and slot lines, Artech house (1996).
- Sainiti, Robert A., CAD of Micro-strip Antenna for Wireless Applications, Artech House (1996).
- Lu, Wong Kim, Planar antennas for Wireless applications, John Wiley and Sons (2003).
- Simons, Rainee N., Coplanar Waveguide Circuits, Components, and Systems, John Wiley and Sons (2001).

MTOE-301X-18 Open Electives

MTOE-301A-18	Credits	L	T	P	Internal	External
Open Elective Cost Management of Engineering Projects	3	3	0	0	40	60

Course Objective

This is course deals with strategic cost management for engineering projects and useful quantitative techniques to implement

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand the cost calculation for decision-making about an engineering research project
2. Able to define Role of each member in the project team
3. Manage the project by applying Quantitative techniques for cost management

Unit 1

Introduction and Overview of the Strategic Cost Management Process

Unit 2:

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Unit 3:

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process. Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Unit 4:

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Recommended Books :

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

MTOE-301B-18	Credits	L	T	P	Internal	External
Open Elective Composite Materials	3	3	0	0	40	60

Course Objective

This is course deals with Composite Materials and preparation/manufacturing of Metal Matrix Composites

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand the characteristics of Composite materials and their advantages and applications
2. Get exposure to Manufacturing of Metal Matrix Composites: Knitting, Braiding, Weaving and estimate Strength

Unit 1

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Unit 2:

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostressconditions.

Unit 3:

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

Unit 4:

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications

Unit 5:

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Recommended Books :

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

MTOE-301C-18	Credits	L	T	P	Internal	External
Open Elective Waste to Energy	3	3	0	0	40	60

Course Objective

This is course deals with effective and cheap methods to convert waste into useful energy.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand various methods to convert agro, forest and industrial residue to useful energy
2. Get exposure Biomass Combustion, Biomass Gasification etc.

Unit 1

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit 2:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit 3:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit 4:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design,construction and operation - Operation of all the above biomass combustors.

Unit 5:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion -Types of biogas Plants – Applications – Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

Recommended Books :

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996

MTWC-DS1-18	Credits	L	T	P	Internal	External
DISSERTATION PHASE I	10	0	0	20	60	40

Course Objectives: To prepare the students to develop research expertise and knowledge in the area of particular interest.

Course Outcomes: After the completion of the course, the student will be able to:

1. Critically analyse and evaluate existing knowledge about the chosen problem.
2. Find the gaps and motivation through literature survey.
3. Design the framework to optimize the solution for the problem.
4. Construct the research proposal.

FOURTH
SEMESTER

MTWC-DS2-18	Credits	L	T	P	Internal	External
DISSERTATION PHASE II	16	6	0	20	60	40

Course Objective: To enable the student to implement the proposed research work and publish their authentic results.

Course Outcomes: After the completion of the course, the student will be able to:

1. Implement the proposed framework practically or through simulation.
2. Gather the results and publish in the research articles.
3. Write-up the proposed work, results with conclusion and future work in the form of thesis.
4. Present the research work before a committee.