NOIDA INTERNATIONAL UNIVERSITY
GAUTAM BUDH NAGAR, UP

EVALUATION SCHEME & SYLLABUS

FOR

MASTER OF TECHNOLOGY

In

Communications (Regular)

AS PER
AICTE MODEL CURRICULUM
[Effective from the Session: 2019-20]

Program Outcomes (POs)

Students will be able to

1. Ability to apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

2. Ability to identify, formulate and solve engineering problems in the broad areas like Systems Design using communication and networking platforms and tools. Explore recent developments in areas like optical communication, satellite communication, wireless communication, networking, RF-microwave, antennas, measurements and standards in communication.

3. Ability to understand and use different software tools for Design, Analysis and Verification in the domain of communication and networking. System results are obtained through progressive steps such as Design entry, Synthesis, Functional and Timing Simulation.

4. Ability to design and conduct experiments, analyze and interpret data, imbibe programming skills for development of simulation experiments.

5. Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility.

Semester-1								
Paper code	**Subject**	**L**	**T**	**P**	**Marks(ISA)**	**Marks(ESE)**	**Total**	**Credit**
DPCT1	Advanced Communication Networks	3	0	0	40	60	100	3
DPCT2	Wireless and Mobile Communication	3	0	0	40	60	100	3
DPE1x	Program Elective-1 (1) Wireless Sensor Networks (2) Optical Networks (3) Statistical Information Processing	3	0	0	40	60	100	3
DPE2x	Program Elective-2 (1) Cognitive Radio (2) RF and Microwave Circuit Design (3) DSP Architecture	3	0	0	40	60	100	3
MTC01	Research Methodology and IPR	2	0	0	40	60	100	2
	Audit Course-1	2	0	0	40	60	100	0
DPCL1	Advanced Communication Networks Lab	0	0	4	40	60	100	2
DPCL2	Wireless and Mobile Communication Lab	0	0	4	40	60	100	2
Total							**800**	**18**

Semester-2								
Paper code	**Subject**	**L**	**T**	**P**	**Marks(ISA)**	**Marks(ESE)**	**Total**	**Credit**
DPCT3	Antenna & Radiating Systems	3	0	0	40	60	100	3
DPCT4	Advanced Digital Signal Processing	3	0	0	40	60	100	3
DPE3x	Program Elective-3 (1) Satellite Communication (2) Internet of Things (3) Voice and Data Networks	3	0	0	40	60	100	3
DPE4x	Program Elective-4 (1) Markov Chain and Queueing System (2) MIMO System (3) Programmable Networks – SDN, NFV	3	0	0	40	60	100	3
	Audit Course-2	2	0	0	40	60	100	0
MTC02	Mini Project with Seminar	0	0	4	100	0	100	2
DPCL3	Antenna & Radiating Systems Lab	0	0	4	40	60	100	2
DPCL4	Advanced Digital Signal Processing Lab	0	0	4	40	60	100	2
Total							**800**	**18**

Audit course 1 & 2

MAC01. English for Research Paper Writing
MAC02. Disaster Management
MAC03. Sanskrit for Technical Knowledge
MAC04. Value Education
MAC05. Constitution of India
MAC06. Pedagogy Studies
MAC07. Stress Management by Yoga
MAC08. Personality Development through Life Enlightenment Skills

Semester-3								
Paper code	**Subject**	**L**	**T**	**P**	**Marks(ISA)**	**Marks(ESE)**	**Total**	**Credit**
DPE5x	Program Elective-5 (1) High Performance Networks (2) Pattern Recognition and Machine Learning (3) Remote Sensing	3	0	0	40	60	100	3
	Open Elective	3	0	0	40	60	100	3
MTC03	Dissertation Phase-1	0	0	20	500	0	500	10
Total							**700**	**16**

Semester-4								
Paper code	**Subject**	**L**	**T**	**P**	**Marks(ISA)**	**Marks(ESE)**	**Total**	**Credit**
MTC04	Dissertation Phase-2	0	0	32	500	200	700	16
Total							**700**	**16**

GRAND TOTAL	**3000**	**68**

Open Elective

MOE01. Business Analytics
MOE02. Industrial Safety
MOE03. Operations Research
MOE04. Cost Management of Engineering Projects
MOE05. Composite Materials
MOE06. Waste to Energy

Course Code: DPCT1 **Course Name: Advanced Communication Networks**
Course Credit: 3 **Total Contact Hour: 40hr**

Course Objective:

- To develop understanding of some fundamental techniques used to model and analyze communication networks.
- To expose students to additional depth in computer communication systems and networks topics.

Course Description:

This course provides the understanding this material can help one to develop intuition about some of the important issues in networking and provide the background needed to do research in this field. It includes the key issues and challenges in the use of technology, including scale, performance (and measurement), and security / privacy.

Course Contents:

Unit 1: Overview of Internet-Concepts, challenges and history, overview of ATM, TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

Unit 2: Real Time Communications over Internet, Adaptive applications, Latency and throughput issues, Integrated Services Model (intServ), Resource reservation in Internet, RSVP, Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP), Leaky bucket algorithm and its properties.

Unit 3: Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service
Connections, GPS, WFQ and Rate proportional algorithms, High speed scheduler design, Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic, Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

Unit 4: IP address lookup-challenges, Packet classification algorithms and Flow Identification-
Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Unit 5: Admission control in Internet, Concept of Effective bandwidth, Measurement based admission control, Differentiated Services in Internet (DiffServ), DiffServ architecture and framework.

Unit 6:IPV4, IPV6, IP tunnelling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching, MPLS architecture and framework, MPLS Protocols, Traffic engineering issues in MPLS.

Course Learning Outcomes (CLOs):

- Understand advanced concepts in Communication Networking.

- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimise the Network Design

Text books:

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

Reference books:

- Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach", Morgan Kaufman Publishers, 2004.

Online links for study & reference materials :
https://nptel.ac.in/courses/117/105/117105076/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPCT2 **Course Name: Wireless & Mobile Communication**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

- To provide an overview of Wireless Communication networks area and its applications in communication engineering.
- To appreciate the contribution of Wireless Communication networks to overall technological growth.
- To explain the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.
- To enable students to compare and contrast multiple division techniques, mobile communication systems, and existing wireless networks.

Course Description:

This course builds an understanding of the core issues encountered in the design of wireless (vs wired) networks. It also exposes students to fairly recent paradigms in wireless communication.

Course Contents:

Unit 1: Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM
Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE

Unit 2: Spectral efficiency analysis based on calculations for multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations)

Unit 3: Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

Unit 4: Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

Unit 5: Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

Unit 6: Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Understand fundamentals of wireless communications.
- Analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.
- Demonstrate basic skills for cellular networks design.
- Apply knowledge of TCP/IP extensions for mobile and wireless networking.

Text books:

- V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
- V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.

Reference books:

- T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI, 2002.
- William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 1995.
- Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Boston, London, 1997.

Online links for study & reference materials:

https://nptel.ac.in/courses/106/106/106106167/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE11 **Course Name:** Wireless Sensor Network
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand architecture and application of wireless sensor network.
- To analyze the hardware and software required.
- To understand the programming and related tools.
- To understand data transmission, data processing, energy conservation, and sensor development mechanism.

Course Description:

This course emphasizes on the fundamental of wireless sensor networks. This course starts with the architecture and then focus on hardware and software requirements. This course contains programming and application of wireless sensor networks. This course give an understanding of data processing, data transmission ,energy conservation, and sensor development.

Course Contents:

Unit 1: Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

Unit 2: Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.

Unit 3: Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Unit 4: Overview of sensor network protocols (details of atleast 2 important protocol per layer):Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

Unit 5: Data dissemination and processing; differences compared with other database management systems, data storage; query processing.

Unit 6: Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and enabling technologies in wireless sensor network.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Design wireless sensor network system for different applications under consideration.

- Understand the hardware details of different types of sensors and select right type of sensor for various applications.
- Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
- Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
- Handle special issues related to sensors like energy conservation and security challenges.

Text books:

- H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012.
- C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks", Springer Verlag, 1st Indian reprint, 2010.

Reference books:

- F. Zhao and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann, 1st Indian reprint, 2013.
- YingshuLi, MyT. Thai, Weili Wu, "Wireless sensor Network and Applications", Springer series on signals and communication technology, 2008.

Online links for study & reference materials:

https://nptel.ac.in/courses/106/105/106105160/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE12 **Course Name:** Optical Network
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand optical network architecture.
- To analyze different network elements and their functions.
- To understand characteristics of network management.
- To understand the access and use of optical networks.

Course Description:

This course emphasizes on the fundamental of optical networks. This course contains architecture, elements, management and application of optical network. This course provides an basic idea of implementation of an optical network

Course Contents:

Unit 1: SONET/SDH: optical transport network, IP, routing and forwarding, multiprotocol label switching.

Unit 2: WDM network elements: optical line terminals and amplifiers, optical add/drop multiplexers, OADM architectures, reconfigurable OADM, optical cross connects.

Unit 3: Control and management: network management functions, optical layer services and interfacing, performance and fault management, configuration management, optical safety.

Unit 4: Network Survivability: protection in SONET/SDH & client layer, optical layer protection schemes

Unit 5: WDM network design: LTD and RWA problems, dimensioning wavelength routing networks, statistical dimensioning models.

Unit 6: Access networks: Optical time division multiplexing, synchronization, header processing, buffering, burst switching, test beds, Introduction to PON, GPON, AON.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Understand the architecture of optical network
- Implement and Manage optical network.
- Design & analyze optical networks.

Text books:

- Rajiv Ramaswami, Sivarajan, Sasaki, “Optical Networks: A Practical Perspective”, MK, Elsevier, 3 rd edition, 2010.

Reference books:

- C. Siva Ram Murthy and Mohan Gurusamy, “WDM Optical Networks: Concepts Design, and Algorithms”, PHI, EEE, 2001.

Online links for study & reference materials:

https://nptel.ac.in/courses/117/101/117101054/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE13 **Course Name:** Statistical Information Processing
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand random variables and their application.
- To analyze random signal modelling.
- To understand statistical detection theory and spectral analysis.
- To understand concepts of information theory and coding.

Course Description:

This course emphasizes on the fundamental of statistical information processing. The course starts with random variable and the application are introduced. This course contains signal modelling, detection theory, and spectral analysis. This course focus on information theory and coding and various algorithm related.

Course Contents:

Unit 1: Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization, Tchebaychef inequality theorem, Central Limit theorem, Discrete &Continuous Random Variables. Random process: Expectations, Moments, Ergodicity, Discrete-Time Random Processes Stationary process, autocorrelation and auto covariance functions, Spectral representation of random signals, Properties of power spectral density, Gaussian Process and White noise process.

Unit 2: Random signal modelling: MA(q), AR(p), ARMA(p,q) models, Hidden Markov Model & its applications ,Linear System with random input , Forward and Backward Predictions, Levinson Durbin Algorithm.

Unit 3: Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-ary Hypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing. Parameter Estimation Theory: Maximum Likelihood Estimation, Generalized Likelihood Ratio Test, Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean-Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate, Multiple Parameter Estimation Best Linear Unbiased Estimator, Least-Square Estimation Recursive Least-Square Estimator.

Unit 4: Spectral analysis: Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

Unit 5: Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, Shanon Fano, Arithmetic, Adaptive coding, RLE, LZW Data compaction, , LZ-77, LZ-78. Discrete Memory less channels,

Mutual information, channel capacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

Unit 6: Application of Information Theory: Group, Ring & Field, Vector, GF addition, multiplication rules. Introduction to BCH codes, Primitive elements, Minimal polynomials, Generator polynomials in terms of Minimal polynomials, Some examples of BCH codes & Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

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

Text books:

- Papoulis and S.U. Pillai, "Probability, Random Variables and Stochastic Processes", 4th Edition, McGraw-Hill, 2002.
- D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, 2000.

Reference books:

- Mourad Barkat , "Signal Detection and Estimation", Artech House, 2nd Edition, 2005.
- Rosen K.H, "Elementary Number Theory", Addison-Wesley, 6th edition, 2010.

Online links for study & reference materials:

https://nptel.ac.in/courses/108/103/108103158/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE21 **Course Name: Cognitive Radio**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

- Learn the design of the wireless networks based on the cognitive radios
- Understand the concepts of wireless networks and next generation networks.

Course Description:

Cognitive radio (CR) based systems and networks are a revolutionary new concept in wireless communications. Such systems are built on the novel software defined radio (SDR) architecture and have powerful signal processing capabilities to sense spectrum underutilization or spectral holes. The cognitive abilities in the embedded processors emulate the human brain by continuously analyzing the radio scene through an aggregation of external radio stimuli provided by the end devices. These networks can thus dynamically allocate spectrum to multiple users thereby easing network congestion.

Course Contents:

Unit 1: Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Unit 2: Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Unit 3: Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

Unit 4: Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit 5: Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Unit 6: Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Describe the basics of the software defined radios.
- To learn the hardware and software architecture of software defined radio
- Design the wireless networks based on the cognitive radios.

- Gives an understanding of cognitive radio architecture

Text books:

- Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
- Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
- Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.

Reference books:

- Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
- Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
- Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Online links for study & reference materials:

https://nptel.ac.in/courses/108/107/108107107/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE22 **Course Name:** RF & Microwave Circuit Design
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand Basic RF frequency advantages and circuit design process.
- To impart the knowledge of basic resonant and impedance matching circuits.
- To understand the basic calculations using smith chart.

Course Description:

This course includes the concepts of design and analysis of modern RF and wireless communication integrated circuits. In this course mainly concentrated on microwave frequency circuits, the way of design, different applications like RADAR, Navigation, RF Identification. There after different RF electronic components and some parameters calculation based on Smith Chart.

Course Contents:

Unit 1 : Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.

Unit 2 : Microwave Network Analysis: Impedance and equivalent voltage and current, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.

Unit 3 : Microwave Components: Microwave resonators, Microwave filters, power dividers and directional couplers, Ferromagnetic devices and components.

Unit 4 : Nonlinearity and Time Variance Inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Unit 5 : Microwave Semiconductor Devices and Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Unit 6: Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high power and broadband amplifier, oscillators,Mixers design.

Course Learning Outcomes (CLOs):

- Understand the behaviour of RF passive components and model active components.
- Demonstrate use of Smith Chart for high frequency circuit design.
- Justify the choice/selection of components from the design aspects.
- Contribute in the areas of RF circuit design.

Text books:

- D.M.Pozar, " Microwave engineering" ,Wiley, 4th edition, 2011.
- R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc, 2009.

Reference books:

- S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall 1987.
- Radmanesh, "RF and Microwave Electronics Illustrated" , Pearson Education, 2004.

Online links for study & reference materials:

https://nptel.ac.in/courses/117/102/117102012/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE23 **Course Name: DSP Architecture**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors.

Course Description:

DSP Architecture course provides an introduction on the industry based DSP processor's architecture and their algorithms. Students will learn about the addressing modes, instruction set and memory allocation of the TMS320C67XX processor.

Course Contents:

Unit 1: Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed and Floating Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Unit 2: Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

Unit 3:VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly Language programming, On-chip peripherals, Simple applications developments as an embedded environment.

Unit 4: Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).

Unit 5:FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor.

Unit 6: High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Recognize the fundamentals of fixed and floating point architectures of various DSPs.
- Learn the architecture details and instruction sets of fixed and floating point DSPs
- Infer about the control instructions, interrupts, and pipeline operations.
- Illustrate the features of on-chip peripheral devices and its interfacing along with its programming details.

Text books:

- M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.
- Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011
- Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, DrorMaydan, Jeff McDonald,"Parallel Programming in OpenMP", 1st Edition, Morgan Kaufman, 2000.

Reference books:

- Ann Melnichuk, Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.
- Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.
- E. S. Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands, 2007.

Online links for study & reference materials:

https://nptel.ac.in/courses/108/106/108106149/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: MTC01 **Course Name**: Research Methodology and IPR
Course Credit: 2 **Total Contact Hour** : 20 hr

Course Objective :

- Identify an appropriate research problem in their interesting domain
- To explain various research designs and their characteristics
- To explain the art of interpretation, art of writing research reports and presentation skills
- To explain various forms of intellectual property, its relevance and business impact in the changing global business environment

Course Description:

This course emphasizes on the fundamental of research. The student first taught about research formulation and then what are the research designs needed according to research formulation. To understand and formulate the research problem the student should be aware of the aspect of effective literature review and the sources of information.to be taken to conduct literature review. Students are exposed to application of research design through which they understand that how, when and which design is required. In concurrence with this , the analysis part will be taught. Finally concepts related to patents, trademark and copyright will be taught.

Course Content:

UNIT1: Meaning of research problem, sources of research problem, characteristics of good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation. Necessary instrumentation

UNIT2: Effective literature studies approaches, analysis, plagiarism and research ethics

UNIT3: Effective technical writing, how to write report, paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT4: Nature of Intellectual property; patents, designs, trade and copyright. Process of patenting and development: technological research, innovation, patenting, development, International Scenario; International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT5: Patent Rights; Scope of Patents Rights, Licensing and transfer of technology; Patent information and databases, geographical Indications.

UNIT6: New development in IPR, Administration of patent system, New developments in IPR, IPR of Biological system, Computer software etc. Traditional knowledge case studies, IPR and IITs.

Course Learning Outcomes (CLOs):

- Understand the characteristics, objects of good research problem.
- Understand concepts of data collection, analysis

- Understand significance, effective technical writing and report
- Understand the patent rights and transfer of technology

Text books:

- Stuart Melville and Wayne Goddard,'' Research methodology: an introduction for science and engineering student''
- Wayne Goddard and Stuart Melville, '' Research Methodology: An Introduction''

Reference books:

- Ranjit Kumar, 2nd Edition,''Research Methodology: A step by step Guide for beginners''
- Halbert, '' Resisting Intellectual Property'', Taylor and Francis Ltd, 2007
- Mayali,'' Industrial Design'', McGraw Hill, 1992.

Online links for study and reference materials:

https://nptel.ac.in/courses/121/106/121106007/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: MAC04 **Course Name:** Value Education
Course Credit: 0 **Total Contact Hour:** 20hr

Course Objective:

1. To make students understand the relevance of individual values in everyday lives
2. To help students imbibe different individual values in their personality
3. To help students develop good moral values and positive character
4. To help students learn the significance of self-management and self-control

Course Description:

The course is an appropriate combination of theoretical and industry specific contents on values and works ethics aimed at developing students into professionals. The course enables students learn concepts related to values and description of different types of values like individual values, social values, organizational values, etc. The course emphasizes on significance of cultivation of individual values that are essential in a personality and lists out various individual values to be imbibed in a student preparing for professional world. The course also describes various practical aspects of value education like managing good health, self-control, science of reincarnation, religious tolerance and role of women, which are pre-requisites for good moral character and competence.

Course Contents: The course is divided into 4 broad units namely:

1. **Unit-1: Values and Self-development**, Social Values and Individual attitudes, work ethics and Indian vision of humanism, moral and non-moral valuation, standards and principles, value judgments
2. **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
3. **Unit-3: Personality and Behavior Development,** soul and scientific attitude, positive thinking, integrity and discipline, punctuality, love and kindness, avoid fault thinking, freedom from anger, dignity of labour, universal brotherhood, religious tolerance, true friendship, happiness vs suffering, love for truth, aware of self-destructive habits, association and cooperation, doing best for saving nature
4. **Unit-4: Character and Competence,** holy book vs blind faith, self-management and good health, science of reincarnation, equality, non-violence, humility, role of women, all religions and same message, mind yourself, self-control, honesty, studying effectively

Course Learning Outcomes (CLOs):

CLO-1: The students will be able to relate to concepts related to value education in their everyday lives.

CLO-2: The students will be able to demonstrate individual values cultivated in their respective workplaces or professional world.

CLO-3: The students will be able to differentiate between the different types of values and imbibe them as part of their self-development.

CLO-4: The students will be able to learn and practice techniques of managing good health, self-control, gender sensitivity and religious tolerance.

Text books:

1. Indrani Majhi, Ganesh Das, VALUE EDUCATION, 1, 2017, Laxmi Publications Pvt Ltd, ISBN: 9789352741120, 9352741129
2. Sharma Sandeep, Encyclopedia of Indian Ethos and Values in Management, Anmol Publications Pvt Ltd, ISBN: 9788126139187, 9788126139187

Reference books:

1. UN-HABITAT**,** Human Values And Ethics In Workplace: Improving Leadership And Performance In The Water Education, Water Supply And Sanitation Sector, 2006, United Nations Human Settlements Programme (UN-HABITAT)
2. Ganesh A. Gayatri, Values Attitude and Practices, Publisher: Discovery Publishing Pvt. Ltd, ISBN: 9789350561287, 9789350561287
3. Atkinson Camille E., Women, Ethics and the Workplace, ABC-CLIO, ISBN: 9780275960919, 9780275960919
4. Green Connie Ragen, Rethinking the Work Ethic, Hunter's Moon Publishing, ISBN: 9781937988333, 9781937988333

Online links for study & reference materials:

1. https://www.researchgate.net/publication/228079327
2. https://www.researchgate.net/publication/49586890
3. https://www.researchgate.net/publication/258040203
4. https://www.enterpreneur.com/amphtml/310254
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3705678

Assessment method :(Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid-term exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPCL1 **Course Name: Advanced Communication Networks Lab**
Course Credit: 2 **Total Contact Hour:** 40hr

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
    a. Configuring NIC's IP Address.
    b. Determining IP Address and MAC Address using if-config command.
    c. Changing IP Address using if-config.
    d. Static IP Address and Configuration by Editing.
    e. Determining IP Address using DHCP.
    f. Configuring Hostname in /etc/hosts file.
3. Design TCP iterative Client and Server application to reverse the given input sentence.
4. Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call "select".
5. Design UDP Client Server to transfer a file.
6. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.
    a. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.
7. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.
8. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.
9. Signaling and QoS of labeled paths using RSVP in MPLS.
10. Find shortest paths through provider network for RSVP and BGP.
11. Understand configuration, forwarding tables, and debugging of MPLS.

Course Code: DPCL2 **Course Name: Wireless &Mobile Communication Lab**
Course Credit: 2 **Total Contact Hour:** 40hr

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi path environment, Coverage and Capacity issues using communication software.

2. Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release, Security and Power Control, Handoff Process and types, Rake Receiver etc.

3. Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).

4. To study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.

5. To study various GSM AT Commands their use and developing new application using it. Understating of 3G Communication System with features like; transmission of voice and video calls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.

6. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.

7. To learn and develop concepts of Software Radio in real time environment by studying the building blocks like Base band and RF section, convolution encoder, Interleaver and De-Interleaver.

8. To study and analyze different modulation techniques in time and frequency domain using SDR kit.

Course Code: DPCT3 **Course Name:** Antenna & Radiating Systems
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To learn the basic parameters of an antenna and its radiation mechanism.
- To understand the Vector potentials and radiation integrals.
- To understand the radiation characteristics of various antennas.
- To understand the radiation pattern of an array (uniform and non-uniform) and apply the principle of multiplication of patterns.

Course Description:

The objective of this course is to provide an in-depth understanding of modern antenna concepts, and practical antenna design for various applications. The course will explain the theory of different types of antennas used in communication systems.

Course Contents:

Unit 1: Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna. Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Unit 2: Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Unit 3: Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration.

Unit 4: Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture .Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns.

Unit 5: Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis,Rectangular Patch, Circular Patch.

Unit 6: Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors, Introduction to MIMO.

Course Learning Outcomes (CLOs):

- Understanding antenna concepts
- Knowledge of antenna properties and mechanisms for radiation from general current sources in free space
- Determine the radiation patterns (in principal planes) of antennas.

Text books:

- Constantine A. Balanis, "Antenna Theory Analysis and Design", John Wiley & Sons, 4th edition, 2016.
- John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for All Applications", Tata McGraw-Hill, 2002.

Reference books:

- R.C. Johnson and H.Jasik, "Antenna Engineering hand book", Mc-Graw Hill, 1984.

Online links for study & reference materials:

https://nptel.ac.in/courses/108/101/108101092/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPCT4 **Course Name: Advanced Digital Signal Processing**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

At the completion of this course, the student should have in depth knowledge of processing digital signals.

Course Description:

Digital Signal Processing (DSP) is at the heart of many applications in a wide array of fields: speech and audio processing, system monitoring and fault detection, biomedical signal analysis, mobile and internet communications, radar and sonar, vibration measurement and analysis, seismograph analysis, image/video coding and decoding etc. The objective of this course is to strengthen the students' knowledge of DSP fundamentals, and to familiarize them with the practical aspects of DSP algorithm development and implementation.

Course Contents:

Unit 1: Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

Unit 2: Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub-band coding.

Unit 3: Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Unit 4: Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm.

Unit 5: Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

Unit6: Application of DSP & Multi rate DSP, Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Know the analysis of discrete time signals.
- To study the modern digital signal processing algorithms and applications.
- Have an in-depth knowledge of use of digital systems in real time applications

- Apply the algorithms for wide area of recent applications.

Text Books

- Digital Signal Processing Principles, Algorithms, and Applications John G. Proakis, PrenticeHall International.Inc, 4th Edition, 2012.
- Theory and Application of Digital Signal Processing by Lawrence R.Rabiner and Bernard Gold.

Reference Books

- Oppenheim, Alan V. Discrete-time signal processing. Pearson Education India, 1999.
- 2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach. Vol. 2. New York: McGraw-Hill Higher Education, 2006.

Online links for study & reference materials:

https://nptel.ac.in/content/storage2/courses/108105057/Pdf/Lesson-7.pdf

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE31 **Course Name:** Satellite Communication
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand the dynamic of a satellite.
- To analyze the satellite subsytem.
- To understand application of satellite communication.
- To understand concepts of link budget.

Course Description:

This course emphasizes on the satellite communication. This course contains architecture of satellite, application of satellite and control of satellite. This course includes the dynamics of satellite motion in space.

Course Contents:

Unit 1: Architecture of Satellite Communication System: Principles and architecture of satellite communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Unit 2: Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

Unit 3: Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

Unit 4: Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Unit 5: Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.

Unit 6: Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ISRO, GPS.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Understand the dynamics of the satellite.
- Understand the communication satellite design.
- Know how analog and digital technologies are used for satellite communication networks.
- Able to design of satellite links.

Text books:

- Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.
- S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011

Reference books:

- Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.

- Dennis Roddy, “Satellite Communication”, McGraw Hill, 4th Edition, 2008.

Online links for study & reference materials:
https://nptel.ac.in/courses/117/105/117105131/
Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE32 **Course Name: INTERNET OF THINGS**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

- Understand the definition and significance of the Internet of Things
- Discuss the architecture, operation, and business benefits of an IoT solution
- Examine the potential business opportunities that IoT can uncover
- Explore the relationship between IoT, cloud computing, and big data
- Identify how IoT differs from traditional data collection systems

Course Description:

The Internet of Things (IoT) is everywhere. It provides advanced data collection, connectivity, and analysis of information collected by computers everywhere—taking the concepts of Machine-to-Machine communication farther than ever before. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions.

Course Contents:

Unit 1: Smart cities and IoT revolution, Fractal cities, From IT to IoT, M2M and peer networking concepts, Ipv4 and IPV6.

Unit 2: Software Defined Networks SDN, From Cloud to Fog and MIST networking for IoT communications, Principles of Edge/P2P networking, Protocols to support IoT communications, modular design and abstraction, security and privacy in fog.

Unit 3: Wireless sensor networks: introduction, IOT networks (PAN, LAN and WAN), Edge resource pooling and caching, client side control and configuration.

Unit 4: Smart objects as building blocks for IoT, Open source hardware and Embedded systems platforms for IoT, Edge/gateway, IO drivers, C Programming, multithreading concepts.

Unit 5: Operating systems requirement of IoT environment, study of mbed, RIoT, Contiki operating systems, introductory concepts of big data for IoT applications.

Unit 6: Applications of IoT, Connected cars IoT Transportation, Smart Grid and Healthcare sectors using IoT, Security and legal considerations, IT Act 2000 and scope for IoT legislation.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Able to understand the application areas of IOT ·
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks ·
- Able to understand building blocks of Internet of Things and characteristics.

Text Books

- A Bahaga, V. Madisetti, “Internet of Things- Hands on approach”, VPT publisher, 2014.
- A. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.

Reference Books

- CunoPfister, “Getting started with Internet of Things”, Maker Media, 1st edition, 2011.
- Samuel Greenguard, “Internet of things”, MIT Press, 2015.

Online links for study & reference materials:

https://onlinecourses.nptel.ac.in/noc21_cs17/preview

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE33 **Course Name: Voice And Data Networks**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

To learn voice over IP as a real-time interactive audio/video service.

Course Description:

This course provides an introduction to voice and data networking technologies, including public and private voice services, Ethernet & Internet data technologies, network security, business applications and network management.The structure, regulation, andhistory of the telecom and data network industry will be discussed as well.

Course Contents:

Unit 1: Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

Unit 2: Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit 3: Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission, Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

Unit 4: Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, Examples of Local area networks

Unit 5: Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet, End to End Protocols, TCP and UDP, Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery.

Unit 6: Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Implement local area networks using both static and dynamic addressing techniques including sub netting.
- Install, configure, and troubleshoot server and client operating systems.
- Disassemble, troubleshoot/debug, upgrade, replace basic components, and reassemble servers and client systems
- Explain the concept of encapsulation and its relationship to layering in the network models.

Text Books

- D. Bertsekas and R. Gallager, “Data Networks”, 2nd Edition, Prentice Hall, 1992.
- L. Peterson and B. S. Davie, “Computer Networks: A Systems Approach”, 5th Edition, Morgan Kaufman, 2011.
- Kumar, D. Manjunath and J. Kuri, “Communication Networking: An analytical approach”, 1st Edition, Morgan Kaufman, 2004.

Reference Books

- Walrand, “Communications Network: A First Course”, 2nd Edition, McGraw Hill, 2002.
- Leonard Kleinrock, “Queueing Systems, Volume I: Theory”, 1st Edition, John Wiley and Sons, 1975.
- Aaron Kershenbaum, “Telecommunication Network Design Algorithms”, McGraw Hill, 1993.
- Vijay Ahuja, “Design and Analysis of Computer Communication Networks”, McGraw Hill, 1987.

Online links for study & reference materials:

https://nptel.ac.in/courses/106/105/106105082/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE41 **Course Name: Markov Chains And Queueing Systems**
Course Credit: 03 **Total Contact Hour:** 40hr

Course Objective:

- To make students familiar with stochastic process theory and its applications.
- To develop mathematical and modeling skills required for evaluating queueing systems performance.
- To give a theoretical background needed to understand academic literature on the subject

Course Description:

This course gives a detailed introduction into queueing theory along with insights into stochastic processes and simulation techniques useful for modeling queueing systems.

Course Content

Unit 1: Introduction: Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem.

Unit 2: Renewal Processes: Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Poisson process, Walds equation, Blackwell's theorem.

Unit 3: Discrete time Markov chains: definitions and properties, matrix representation, Perron- Frobenius theory.

Unit 4: Continuous time Markov chains: basic definitions, Q-matrix, birth-death processes, quasi birth death processes, Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.

Unit 5: Fundamental queuing results: Little's theorem, invariance of the mean delay, Conservation law. Markovian queues: Jackson and BCMP networks, numerical Algorithms. M/G/1 & G/M/1 queues and G/G/1 queues.

Unit 6: Advanced queuing models: priority, vacation and retrials in queues.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- be able to describe the structure of a certain queueing system
- to know characteristics of queueing processes
- to know common areas of queueing theory application
- be able to find steady-state solutions for basic stochastic processes and queueing models

Text Books

- Cliffs, “Stochastic Modelling and the Theory Queues”, Prentice Hall, 1989.
- P.Bremaud, “Markov Chains”, Springer-Verlag, 1999.

Reference Books

- R.Gallager, “Discrete Stochastic Processes”, Kluwer Academic Press, 1996.
- L.Kleinrock, “Queuing Systems”, vols I and II, John Wiley and Sons 1976.

Online links for study & reference materials:

https://www.hse.ru/en/edu/courses/375292113

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE42 **Course Name:** MIMO Systems
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To explain multiple antenna and space time communications that include MIMO models, fading channels, space time modulation, ML detection and frequency selective channels.
- To introduce and explain multicarrier.

Course Description:

This course covers the fundamentals of multiple input multiple output (MIMO) antenna based wireless communication systems. MIMO is now an essential part of modern wireless communication systems, such as 3G, 4G, WLAN / WiFi, LTE, WiMax, etc. MIMO brings to the domain of wireless communications, spectral efficiency and reliability gains.

Course Contents:

Unit 1: Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems.

Unit 2: Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.

Unit 3: The generic MIMO problem, Singular Value Decomposition, Eigen values and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Pre distortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of pre-coding and combining, Channel state information.

Unit 4: Codebooks for MIMO, Beamforming, Beamforming principles, Increased spectrum efficiency, Interference cancellation, Switched beamformer, Adaptive beamformer, Narrowband beamformer, Wideband beamformer.

Unit 5: Case study: MIMO in LTE, Code words to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models.

Unit 6: Channel Estimation, Channel estimation techniques, Estimation and tracking, Training based channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA, Channel estimation for OFDM.

Course Learning Outcomes (CLOs):

- Classify and explain the diversity schemes involved in MIMO with advantages, applications, channel models and power allocation.
- Calculate the capacity of deterministic and random MIMO channels and fading channels.
- Describe various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE.

Text books:

- Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design", Academic Press, 1st edition, 2010.

Reference books:

- Mohinder Janakiraman, “Space - Time Codes and MIMO Systems”, Artech House Publishers, 2004.

Online links for study & reference materials:

https://nptel.ac.in/courses/117/105/117105132/

Assessment method: (Continuous Internal Assessment = 40%, Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE43 **Course Name:** Programmable Network-SDN,NFV
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To understand programmable network and their characteristics.
- To analyze the control and data plane.
- To understand characteristics of network virtualization.
- To understand concepts of programming SDN

Course Description:

This course emphasizes on the fundamental of programmable networks.. This course contains the topics which are important the development of understanding and concept of programing networks. This course provide an idea of real time implementation of concept s of programmable network .

Course Contents:

Unit 1: Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.

Unit 2: Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.

Unit 3: Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.

Unit 4: Control Plane: Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hadrware-based; Programmable Network Hardware.

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

Unit 6: Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies.Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Course Learning Outcomes(CLOs) :

At the end of this course students will demonstrate the ability to

- Understand advanced concepts in Programmable Networks.
- Understand Software Defined Networking, an emerging Internet architectural framework.

- Implement the main concepts, architectures, algorithms, protocols and applications in SDN and NFV.

Text books:

- Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, August 2013.
- Paul Goransson, Chuck Black, Timothy Culver. "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publishers, 2016.

Reference books:

- Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2014.
- Nick Feamster, Jennifer Rexford and Ellen Zegura, "The Road to SDN: An Intellectual History of Programmable Networks" ACM CCR April 2014.

Online links for study & reference materials:

https://nptel.ac.in/courses/106/105/106105166/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Midexam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPCL3 **Course Name: Antennas And Radiating Systems Lab**
Course Credit: 3 **Total Contact Hour:** 40hr

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

Course Code: DPCL4 **Course Name:Advanced Digital Signal Processing Lab**
Course Credit:2 **Total Contact Hour:** 40hr

1. Basic Signal Representation
2. Correlation Auto and Cross
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT of Input Sequence
5. Butterworth Low pass and High pass Filter Design
6. Chebychev Type I, II Filter
7. State Space Matrix from Differential Equation
8. Normal Equation Using Levinson Durbin
9. Decimation and Interpolation Using Rationale Factors
10. Maximally Decimated Analysis DFT Filter
11. Cascade Digital IIR Filter Realization
12. Convolution and M Fold Decimation &PSD Estimator
13. Estimation of PSD
14. Inverse Z Transform
15. Group Delay Calculation
16. Separation of T/F
17. Parallel Realization of IIR filter

Course Code: DPE51 **Course Name:** High Performance Networks
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To reinforce an understanding of LAN technologies which have lead to high speed LANs.
- To understand ATM technology.
- To introduce high speed switching concepts.
- To consider Quality of Service and congestion control issues.

Course Description:

High Performance Networks replaces the Local Area Networks course which was the second course in a group of graduate courses introduced under the CCN initiative. This introductory course in the networking sequence is a prerequisite for this course. This change was made to provide a course which includes emerging technologies outside the LAN realm.

Course Contents:

Unit 1: Types of Networks, Network design issues, Data in support of network design. Network design tools, protocols and architecture, Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, beyond best effort, scheduling and policing mechanism, integrated services, and RSVP-differentiated services.

Unit 2: VoIP system architecture, protocol hierarchy, Structure of a voice endpoint, Protocols for the transport of voice media over IP networks, Providing IP quality of service for voice, signalling protocols for VoIP, PSTN gateways, VoIP applications.

Unit 3:VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlaynetworks-P2P connections.

Unit 4: Traffic Modeling: Little's theorem, Need for modeling, Poisson modeling, Non-poisson models, Network performance evaluation.

Unit 5: Network Security and Management: Principles of cryptography, Authentication, integrity, key distribution and certification, Access control and fire walls, attacks and counter measures, security in many layers.

Unit 6: Infrastructure for network management, internet standard management framework –SMI, MIB, SNMP, Security and administration, ASN.1.

Course Learning Outcomes (CLOs):

- Demonstrate the knowledge of network planning and optimization.
- Develop an in-depth understanding, in terms of architecture, protocols and applications, of major high performance networking technologies.

- Evaluate various technologies and identify the most suitable one to meet a given set of requirements for a hypothetical corporate network

Text books:

- Kershenbaum A., "Telecommunications Network Design Algorithms", Tata McGraw Hill,1993.
- Larry Peterson & Bruce David, "Computer Networks: A System Approach", Morgan Kaufmann, 2003.

Reference books:

- Warland J., Varaiya P., "High-Performance Communication Networks", Morgan Kaufmann, 1996.

Online links for study & reference materials:

https://nptel.ac.in/courses/106/108/106108055/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE52 **Course Name:** Pattern Recognition & Machine Learning
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To equip students with basic mathematical and statistical techniques commonly used in pattern recognition.
- To introduce students to a variety of pattern recognition algorithms.
- Enable students to apply machine learning concepts in real life problems.

Course Description:

This course will serve as a comprehensive introduction to various topics in machine learning. At the end of the course the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.

Course Contents:

Unit 1: Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error Analysis

Unit 2: Linear models: Linear Models for Regression, linear regression, logistic regression Linear Models for Classification.

Unit 3: Neural Network: perceptron, multi-layer perceptron, back propagation algorithm, error surfaces, practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep Learning

Unit 4: Linear discriminant functions - decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine

Unit 5: Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers

Unit 6: Unsupervised learning and clustering – k-means clustering, fuzzy k-means clustering, hierarchical clustering

Course Learning Outcomes (CLOs):

- Understand machine learning concepts and range of problems that can be handled by machine learning.
- Compare and parameterize different learning algorithms.
- Apply the machine learning concepts in real life problems.

Text books:

- Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, 2nd Edition John Wiley & Sons, 2001.

- Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.

Reference books:

- C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Online links for study & reference materials:

https://nptel.ac.in/courses/117/108/117108048/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Course Code: DPE53 **Course Name:** Remote Sensing
Course Credit: 3 **Total Contact Hour:** 40hr

Course Objective:

- To provide background knowledge and understanding of principles of RS, RS Sensors and systems.
- Overview of information retrieval of earth surface features using multi-resolution, multi-scale and multi-temporal imagery.
- Introduction of image processing and classification techniques

Course Description:

The course provides basic understanding about satellite based Remote Sensing technology. Presently, remote sensing datasets available from various earth orbiting satellites are being used extensively in various domains including in civil engineering, water resources, earth sciences, transportation engineering, navigation etc.

Course Contents:

Unit 1: Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in remote sensing.

Unit 2: Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned spacecrafts–sun synchronous and geo synchronous satellites –Types and characteristics of different platforms LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD etc

Unit 3: Photographic products, B/W, color, color IR film and their characteristics –resolving power of lens and film -Opto mechanical electro optical sensors –across track and along track scanners-multispectral scanners and thermal scanners–geometric characteristics of scanner imagery -calibration of thermal scanners.

Unit 4: Scattering System: Microwave scatterometry, types of RADAR –SLAR –resolution –range and azimuth –real aperture and synthetic aperture RADAR. Characteristics of Microwave images topographic effect-different types of Remote Sensing platforms –airborne and space bornesensors -ERS, JERS, RADARSAT, RISAT -Scatterometer, Altimeter-LiDAR remote sensing, principles, applications.

Unit 5: Thermal And Hyper Spectral Remote Sensing: Sensors characteristics-principle of spectroscopy-imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing –thermal sensors, principles, thermal data processing, applications.

Unit 6: Data Analysis: Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics-visual and digital

interpretation–Basic principles of data processing –Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping.

Course Learning Outcomes (CLOs):

- Analyse the principles and components of photogrammetry and remote sensing.
- Describe the process of data acquisition of satellite images and their characteristics.
- Compute an image visually and digitally with digital image processing techniques.

Text books:

- Lillesand T.M., and Kiefer,R.W. Remote Sensing and Image interpretation, John Wiley &Sons-2000, 6thEdition
- John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective,2nd Edition, 1995.

Reference books:

- Charles Elachi and Jakob J. van Zyl , Introduction To The Physics and Techniques of Remote Sensing , Wiley Series in Remote Sensing and Image Processing, 2006.

Online links for study & reference materials:

https://nptel.ac.in/courses/121/107/121107009/

Assessment method: (Continuous Internal Assessment = 40% , Final Examination = 60%)

Assessment -1	- 05%
Assessment-2	- 05%
Assessment-3(Mid exam)	- 20%
Assessment-3	- 05%
Assessment-4	- 05%
Total Internal Assessment	**- 40%**

Dissertation

Dissertation Phase – I and Phase - II

Teaching Scheme **Paper Code: MTC03 & MTC04**

Lab work: 20 and 32 hrs/week

Course Outcomes:

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

- Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem.
- Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
- Ability to present the findings of their technical solution in a written report.
- Presenting the work in International/ National conference or reputed journals.

Syllabus Contents:

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

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

The student should complete the following:

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

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

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

Guidelines for Dissertation Phase – I and II:

- As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.
- The dissertation may be carried out preferably in-house i.e. departments laboratories and centers OR in industry allotted through departments T & P coordinator.

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