Course Structure & Syllabus
of
M. Tech. Programme

in
Electronics & Telecommunication Engineering

with Specialization in

COMMUNICATION SYSTEM ENGINEERING

Academic Year – 2019–20

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY,
Burla, Sambalpur-768018, Odisha
www.vssut.ac.in

DEPARTMENT VISION:

Developing new ideas in the field of communication to enable students to learn new technologies, assimilate appropriate skills and deliver meaningful services to the global society and improve the quality of life by training them with strength of character, leadership and self-attainment.

DEPARTMENT MISSION:

- Imparting futuristic technical education to the students.
- Promoting active role of Industry in student curriculum, projects, R&D and placements. Organizing collaborative academic and non-academic programmes with institutions of national and international repute for all round development of students.
- Organizing National and International seminars and symposium for exchange of innovation, technology and information.
- Expanding curricula to cater to demands of higher studies in internationally acclaimed institutes. Preparing students for promoting self-employment.
- Develop the department as a center of excellence in the field of VLSI and communication technology by promoting research, consultancy and innovation.

Course Structure
Semester I

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1		Advanced Signal Processing	3	0	0	3
2	Core-2		Advance Communication Techniques	3	0	0	3
3	PE-1			3	0	0	3
4	PE-2			3	0	0	3
5	Common		Research Methodology & IPR	2	0	0	3
6	Lab-1		Design & Simulation Lab	0	0	3	2
7	Lab-2		TSE Lab	0	0	3	2
8	Audit -1		English for Research Paper Writing				
Total Credits							19

Semester II

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3		Pattern Recognition & Machine Learning	3	0	0	3
2	Core-4		Advanced Wireless Communication	3	0	0	3
3	PE-3			3	0	0	3
4	PE-4			3	0	0	3
5	Common		Term Paper	0	0	4	2
6	Lab-3		Advanced Wireless Communication Lab	0	0	3	2
7	Lab-4		Pattern Recognition & Machine Learning Lab	0	0	3	2
8	Audit -2		Pedagogy Studies				
Total Credits							18

Semester III

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-5			3	0	0	3
2	OE-1			3	0	0	3
3	Minor Project		Project Progress Report	0	0	20	10
Total Credits							16

Semester IV

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Major Project		Project & Thesis	0	0	32	16
Total Credits							16

List of Professional Elective		
Sl. No.	Category	Subject Name
1	PE-I	Analog & Digital VLSI Design
2		Wireless Sensor Networks
3		Optical Communication Networks
4		Satellite Communication
1	PE-II	Advanced Electromagnetics
2		Cognitive Radio
3		Coding Theory
4		Digital Image & Video Processing
1	PE-III	Advanced Antenna Technology
2		DSP Architecture
3		Audio & Video Coding & Compression
4		Robotics & Computer Vision
1	PE-IV	Digital Switching & Telecommunication Networks
2		Cryptography & network Security
3		Digital Control System
4		JTFA & MRA
1	PE-V	Internet of Things
2		Biomedical Signal Processing
3		Artificial Intelligence & Soft-computing

List of Open Elective
Basics of Communication Engineering
Digital Television

Advanced Signal Processing

1st semester

COURSE OBJECTIVE

This subject aims to provide the students to

1. Analyze the process of Sampling, aliasing and the relationship between discrete and continuous signals.
2. Implement the Filter design techniques, structures and numerical round-off effects.
3. Analyze Wiener filters, LMS adaptive filters, and applications, Multi-rate signal processing.

MODULE	CONTENTS	HOURS
MODULE 1	**Multi-Rate Digital Signal Processing**: Introduction, Decimation by A Factor D, Interpolation by A Factor I, Sampling Rate Conversion by Rational Factor I/D, Filter Design and Implementation for Sampling-Rate, Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Band-Pass Signal, Application of Multi Rate Signal Processing: Design of Phase Shifters, Implementation pf Narrowband Low Pass Filters. Implementation of Digital Filter Banks.	8
MODULE 2	**Linear Prediction and Optimum Linear Filters**: Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of The Normal Equations, Properties of The Linear Prediction Error Filters, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filter For Filtering and Prediction: FIR Wiener Filter, Orthogonality, Principle in Linear Mean-Square Estimation.	8
MODULE 3	**Power Spectrum Estimation**: Estimation of Spectra from Finite-Duration Observation of Signals, Non-Parametric Method for Power Spectrum Estimation: Bartlett Method, Blackman and Turkey Method, Parametric Method for Power Estimation: Yuke-Walker Method, Burg Method, MA Model and ARMA Model. Filter Bank and - Filters and Its Applications.	8
MODULE 4	Adaptive Signal Processing Least Mean Square Algorithm, Recursive Least Square Algorithm, Variants of LMS Algorithm: SK-LMS, N-LMS, FX-LMS. Adaptive FIR & IIR Filters, Application of Adaptive Signal Processing: System Identification, Channel Equalization, Adaptive Noise Cancellation, Adaptive Line Enhancer.	10
MODULE 5	HOS- Higher Order Statistics: Definitions and Properties, Moments, Cumulants, Blind Parameters and Order Estimation of MA & ARMA Systems. Application of Higher Order Statistics: Applications to Signal Processing and Image Processing.	6
TEXT BOOKS	1. J.G. Proakis and D.G. Manolakis, “Digital Signal Processing”, 3rd Edition, PHI.	
REFERENCE BOOKS	1. Oppenheim and Schafer, “Digital Signal Processing”, PHI 2. B. Widrow and Stern, “Adaptive Signal Processing”, PHI,1985	

COURSE OUTCOME

After completion of this course, students should be able to

1. Have a more thorough understanding of the relationship between time and frequency domain interpretations.
2. Implementations of signal processing algorithms.
3. Be familiar with some of the most important advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques
4. Understanding power spectrum estimation techniques.
5. Understand and be able to implement adaptive signal processing algorithms based on second order statistics.

Advanced Communication Techniques

COURSE OBJECTIVE:
1. Understanding the band pass modulation and demodulation.
2. Understanding of multiple access and spread spectrum concepts.
3. To understand the advance concepts of Fading and Synchronization.

MODULE	CONTENT	HOURS
MODULE 1	Baseband Demodulation: Signals and Noise, Detection of Binary Signals in Gaussian Noise, Intersymbol Interference, Equalization Bandpass Modulation and demodulation: Digital Bandpass Modulation Techniques, Detection of Signals in Gaussian Noise, Coherent Detection, Noncoherent Detection, Complex Envelope, Error Performance for Binary Systems, M-ary Signaling and Performance, Symbol Error Performance for M-ary Systems.	
MODULE 2	Multiplexing and Multiple Access: Allocation of the Communications Resources, Multiple Access, Communications System and Architecture, Access Algorithms, Multiple Access Techniques Employed with INTELSAT, Multiple Access Techniques for Local Area Network.	
MODULE 3	Spread Spectrum Techniques: Spread-Spectrum Overviews, Pseudo noise Sequences, Direct Sequence, Spread-Spectrum Systems, Frequency Hopping Systems, Synchronization, Jamming Considerations, Commercial Applications, Cellular Systems, Introduction to OFDM.	
MODULE 4	Synchronization: Introduction, Receiver Synchronization, Network Synchronization Communications Link Analysis: Channel and sources of signal loss, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, and System Temperature, Sample Link Analysis, Satellite Repeaters.	
MODULE 5	Fading Channels: The Challenge of Communicating over Fading Channels, Characterizing, Mobile-Radio Propagation, Signal Time-Spreading, Time Variance of the Channel Caused by Motion Mitigating the Degradation Effects of Fading, Summary of the Key Parameters Characterizing Fading Channels, Applications: Mitigating the Effects of Frequency Selective Fading.	
TEXT BOOK	1. Digital Communications - Fundamentals and applications by Bernard Sklar, 2nd Edition of Pearson education Publication 2. Digital Communications - J. G. Proakis, 3rd edition, McGraw Hill Publication.	
REFERENCE BOOK	1. J.G. Proakis, M. Salehi, Communication Systems Engineering, Pearson Education International, 2002. 2. Lee & Moseschmitt, Digital Communication, Springer, 2004. 3. R. Prasad, OFDM for Wireless Communications Systems, Artech House, 2004.	

COURSE OUTCOME: After completion of course student should be able to
1. Understand various formatting & modulation process in digital communication.
2. Understand the concepts communication link analysis.
3. Understanding of Spread Spectrum Techniques, Fading Channels, etc.
4. Understand the effects of mitigating Fading.
5. Understand the commercial applications of recent Cellular Systems.

Analog and Digital VLSI Design (PE-I)

<table>
<tr><td colspan="3">COURSE OBJECTIVE
1. Analyse, design, optimize and simulate analog and digital circuits using CMOS constrained by the design metrics.
2. Connect the individual gates to form the building blocks of a system.
3. Use EDA tools like Cadence, Mentor Graphics and other open source software tools like Ngspice.</td></tr>
<tr><td>MODULE</td><td>CONTENT</td><td>HOURS</td></tr>
<tr><td>MODULE 1</td><td>Review: Basic MOS Structure and its Static Behaviour, Quality Metrics of a Digital Design: Cost, Functionality, Robustness, Power, And Delay, Stick Diagram and Layout, Wire Delay Models. Inverter: Static CMOS Inverter, Switching Threshold and Noise Margin Concepts and their Evaluation, Dynamic Behaviour, Power Consumption.</td><td>6</td></tr>
<tr><td>MODULE 2</td><td>Physical Design Flow: Floor Planning, Placement, Routing, CTS, Power Analysis and IR Drop Estimation-Static and Dynamic, ESD Protection-Human Body Model, Machine Model. Combinational Logic: Static CMOS Design, Logic Effort, Ratioed Logic, Pass Transistor Logic, Dynamic Logic, Speed and Power Dissipation in Dynamic Logic, Cascading Dynamic Gates, CMOS Transmission Gate Logic.</td><td>6</td></tr>
<tr><td>MODULE 3</td><td>Sequential Logic: Static Latches and Registers, Bi-Stability Principle, MUX Based Latches, Static SR Flip-Flops, Master-Slave Edge-Triggered Register, Dynamic Latches and Registers, Concept of Pipelining, Pulse Registers, Non-Bistable Sequential Circuit. Advanced Technologies: Giga-Scale Dilemma, Short Channel Effects, High–K, Metal Gate Technology, FinFET, TFET Etc.</td><td>12</td></tr>
<tr><td>MODULE 4</td><td>Single Stage Amplifier: CS Stage with Resistance Load, Diode Connected Load, Current Source Load, Triode Load, CS Stage with Source Degeneration, Source Follower, Common Gate Stage, Cascade Stage, Choice of Device Models. Differential Amplifiers: Basic Difference Pair, Common Mode Response, Differential Pair with MOS Loads, Gilbert Cell. Passive and Active Current Mirrors: Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors. Frequency Response of Amplifiers: CS Stage, Source Followers, Common-Gate Stage, Cascode Stage and Difference Pair.</td><td>10</td></tr>
<tr><td>MODULE 5</td><td>Operational Amplifiers: One Stage Op Amp, Two Stage Op Amp Gain Boosting, Common Mode Feedback, Slew Rate, PSRR, Compensation of Two-Stage Op Amp, Other Compensation Techniques.</td><td>6</td></tr>
<tr><td>TEXT BOOKS</td><td colspan="2">1. J P Rabaey, A P Chandrakasan, B Nikolic, “Digital Integrated circuits: A design perspective”, Prentice Hall electronics and VLSI series, 2nd Edition.
2. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, TMH, 2007.</td></tr>
<tr><td>REFERENCE BOOKS</td><td colspan="2">1. Baker, Li, Boyce, “CMOS Circuit Design, Layout, and Simulation”, Wiley, 2nd Edition.
2. Neil H. E. Weste, D. Harris and A. Banerjee, “CMOS VLSI Design: A Circuit and Systems Perspective”, Pearson Education, 3rd Edition.</td></tr>
</table>

COURSE OUTCOME
After completion of course student should be able to 1. Understand the basic concepts of MOS and MOS inverters. 2. Learn the physical design flow of VLSI logic. 3. Design of different logic circuits and have an idea of advanced technologies. 4. Learn design of single stage and differential amplifiers in addition to current mirror circuits. 5. Understand the basic design procedures of Op Amp design.

Wireless Sensor Networks (PE-I)

COURSE OBJECTIVE:

1. Understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology
2. Understand the medium access control protocols and address physical layer issues
3. Learn key routing protocols for sensor networks and main design issues.

MODULE	CONTENT	HOURS
MODULE 1	Components of a wireless sensor node, Motivation for a Network of Wireless Sensor Nodes, Classification of sensor networks, Characteristics of wireless sensor networks, Challenges of wireless sensor networks, Comparison between wireless sensor networks and conventional wireless networks, Limitations in wireless sensor networks, Design challenges, Hardware architecture and applications.	8
MODULE 2	Physical Layer, Basic Components, Source Encoding, Channel Encoding, Modulation Medium Access Control: Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols.	8
MODULE 3	Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols Node and Network Management: Power Management, Local Power Management aspects, Dynamic Power Management, Conceptual Architecture.	8
MODULE 4	Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols Localization: Ranging Techniques, Range-Based Localization, Range-Free Localization, Event Driven Localization.	8
MODULE 5	Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks , Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and Zig Bee Security.	8
TEXT BOOK	1. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley 2010 2. Mohammad S. Obaidat, Sudip Misra, "Principles of Wireless Sensor Networks", Cambridge, 2014	
REFERENCE BOOK	1. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley 2010 2. C S Raghavendra, K M Sivalingam, Taieb Znati, "Wireless Sensor Networks", Springer, 2010 3. C. Sivarm murthy & B.S. Manoj, "Adhoc Wireless Networks", PHI-2004 4. FEI HU., XIAOJUN CAO, "Wireless Sensor Networks", CRC Press, 2013 5. Feng ZHAO, L GUIBAS, " Wireless Sensor Networks", ELSEVIER , 2004	

COURSE OUTCOME: After completion of course student should be able to 1 Understand and explain common wireless sensor node architectures. 2. Be able to carry out simple analysis and planning of WSNs. 3. Demonstrate knowledge of MAC protocols developed for WSN. 4. Demonstrate knowledge of routing protocols developed for WSN. 5. Understand and explain mobile data-centric networking principles.

Optical Communication Networks (PE-I)

COURSE OBJECTIVE:
1. To Learn Principles and architecture of Optical Communication, Signal attenuation and losses.
2. To teach about the various optical sources, optical detectors and different types of fiber connectors
3. To familiarize with Link Power budget and with measurements techniques of Optical Networks systems.

MODULE	CONTENT	HOURS
MODULE 1	Introduction to optical Fiber: Evolution of fiber optic system- Element of an Optical Fiber Transmission link, Total Internal Reflection, Acceptance angle, Numerical aperture, Skew rays, Ray Optics, Optical Fiber Modes and Configurations, Mode theory of Circular Wave guides, Overview of Modes-Key Modal concepts- Linearly Polarized Modes, Single Mode Fibers, Graded Index fiber.	8
MODULE 2	Signal Degradation in Optical fiber: Attenuation, Absorption losses, scattering losses, Bending Losses, Signal Distortion in Optical Wave guides, Dispersion: Intramodal, Intermodal, Dispersion modified single mode fibers, Polarization, modal birefringence.	8
MODULE 3	Optical sources: Direct and indirect Band gap materials, Light source materials, LED power and efficiency, LED structures, LED characteristics, Modulation of a LED, lasers Diodes: Modes and Threshold Condition, Rate equations, External Quantum efficiency, Resonant frequencies, Quantum laser, Fiber amplifiers, Power Launching and coupling, Fiber -to- Fiber joints, connectors.	8
MODULE 4	Optical Detectors: Optical detection principles, Absorption, quantum efficiency, Responsivity, p-n photodiode, p-i-n photodiode. Optical Fiber measurements- Dispersion measurements, Attenuation measurements, Fiber Refractive index profile measurements, Fiber cut- off Wave Length Measurements and Fiber Numerical Aperture measurement.	8
MODULE 5	Optical Networks systems: Basic Networks, SONET/ SDH, Broadcast and select WDM Networks, Wavelength Routed Networks, Nonlinear effects on Network performance, Link Power budget –Rise time budget, Noise Effects on System Performance, Principles of WDM, Performance of WDM + EDFA system, Optical CDMA.	8
TEXT BOOK	1. John M. Senior, “Optical Fiber Communication”, Second Edn, Pearson Education, 2007. 2. Gerd Keiser, "Optical Fiber Communication" McGrawHill International, 4th Edition., 2010.	
REFERENCE BOOK	1. Joseph C. Palais. Fiber Optics Communications 5th Edition, Pearson Education, 2005. 2. Ramaswami, Sivarajan and Sasaki “Optical Networks”, Morgan Kaufmann, 2009. 3. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.	

COURSE OUTCOME: After completion of course student should be able to
1. Visualize the concept of Optical communication system using ray optics.
2. Solve numerical problems related to Signal Degradation and losses in Optical fiber for various parameters and conditions.
3. Analyze the design and concept of Optical sources and their Power Launching and coupling capacity to the optical fibers.

4. State the Optical detection principles and design of various types of optical detectors.
5. Identify different types of Optical Networks systems and analyze their System Performance using Link budget.

Satellite Communication (PE-I)

COURSE OBJECTIVE:
1. To familiarize the students with Principles and architecture of satellite Communication.
2. To learn about the Orbital Mechanics and architecture of satellite sub-systems.
3. To teach the students to the satellite link budget design and C/N ratio calculations for different weather conditions.

MODULE	CONTENT	HOURS
MODULE 1	Introduction 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.	8
MODULE 2	Orbital Mechanics: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity of a satellite, concepts of Solar day and Sidereal day, Doppler frequency shift phenomena and expression for Doppler shift. Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies	10
MODULE 3	Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.	6
MODULE 4	Satellite link Design: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, satellite link budget and C/N ratio calculations in clear air and rainy conditions, Personal Communication system using LEO.	8
MODULE 5	Modulation and Multiple Access techniques: Frequency Modulation, Analog FM transmission, digital transmission, Digital modulation and demodulation, FDMA, TDMA, CDMA. VSAT, DBS-TV satellites and GPS.	8
TEXT BOOK	1. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010. 2. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.	
REFERENCE BOOK	1. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008. 2. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.	

COURSE OUTCOME: After completion of course student should be able to
1. Visualize the architecture of satellite systems with a means of high speed, high range communication system.
2. State various aspects of Orbital Mechanics in order to develop the orbital equations for different types of satellite.
3. Analyze the Architecture and Roles of satellite sub-systems.
4. Solve numerical problems related to satellite link budget design and C/N ratio calculations for the given parameters and conditions.
5. State the different mechanism related to satellite systems such as modulation and multiple access schemes.

Advanced Electromagnetics (PE-II)

COURSE OBJECTIVE:

1. To acquire the knowledge of Advanced Electromagnetic field theory.
2. To identify, formulate and solve fields and electromagnetic waves propagation problems.
3. To provide the students with a solid foundation in engineering fundamentals required to solve problems and to pursue higher studies.

MODULE	CONTENT	HOURS
MODULE 1	The Dirac Delta & its representation for infinitesimal dipole, magnetic current & magnetic current density, inadequacies in Maxwell's equations, impossibility of TEM in waveguide.	8
MODULE 2	Huygens's principle, Babinet's principle, holography, correlation between circuit theory & field theory, derivation of circuit relations from field theory, bridging the gap between electricity & magnetism using relativity, interaction of fields & matter.	8
MODULE 3	Dielectric slab waveguide & its application to optical communication, plasma oscillations & wave propagation in plasma, dielectric resonator, Faraday rotation, Schumann resonance, tropo-scatter propagation, earth as a cavity resonator, scattering & diffraction.	8
MODULE 4	Bio-electromagnetics: Introduction, the axon, retinal optical fibers, heart dipole field, defibrillators & pacemakers, biological fields, electromagnetic hazards & environment.	8
MODULE 5	Introduction of tensors, Special theory of relativity & its applications in electromagnetics.	8
TEXT BOOK	1. Electromagnetic Waves & Radiating Systems, By Jordan & Balmain, PHI. 2. Maxwell's Equations & The Principles of Electromagnetism, By R. Fitzpatric, Infinity Science Press LLC.	
REFERENCE BOOK	1. Classical Electrodynamics, By J D Jackson, Wiley. 2. Introduction to Electromagnetic Fields, By C. R. Paul, K. W. Whites, Syed A. Nasar, McGraw Hill. 3. Concepts of Modern Physics, By A. Beiser, Mc Graw Hill	

COURSE OUTCOME: After completion of course student should be able to

1. Solve inadequacies in Maxwell's equations and correlating between circuit theory and field theory.
2. Understand and explain Huygens's, Babinet's, and holographic principles.
3. Correlate and derive the circuits relations from field theories and vice versa.
4. Demonstrate knowledge of dielectric slab waveguides, Schumann resonance, and tropo-scatter propagation.
5. Understand and explain bio-electromagnetics.

Cognitive Radio (PE-II)

COURSE OBJECTIVE: 1. Know the basics of the software defined radios 2. Learn the design of the wireless networks based on the cognitive radios 3. Evaluate different spectrum sensing mechanisms in cognitive radio.		
MODULE	CONTENT	HOURS
MODULE 1	Essential functions of the SDR, SDR architecture, design principles of SDR, traditional radio implemented in hardware and SDR, transmitter architecture and its issues, A/D & D/A conversion, parameters of practical data converters, techniques to improve data converter performance, complex ADC and DAC architectures, digital radio processing, reconfigurable wireless communication systems..	8
MODULE 2	Cognitive Radio (CR) features and capabilities, CR functions, CR architecture, components of CR, CR cycle, CR and dynamic spectrum access, interference temperature, CR architecture for next generation networks, CR standardization.	8
MODULE 3	Spectrum sensing and identification, primary signal detection. Energy detector, cyclo stationary feature detector, matched filter, cooperative sensing, spectrum opportunity, spectrum opportunity detection, fundamental trade-offs: performance versus constraint, sensing accuracy versus sensing overhead.	8
MODULE 4	Spectrum management of cognitive radio networks, spectrum decision, spectrum sharing and spectrum mobility, mobility management of heterogeneous wireless networks, research challenges in CR.	8
MODULE 5	Cognitive radio networks (CRN) architecture, terminal architecture of CRN, diversity radio access networks, routing in CRN, Control of CRN, Self-organization in mobile communication networks, security in CRN, cooperative communications, cooperative wireless networks, user cooperation and cognitive systems.	8
TEXT BOOK	1. Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009	
REFERENCE BOOK	1. Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles and Practice”, Elsevier Inc., 2010. 2. Jeffrey H. Reed “Software Radio: A Modern Approach to radio Engg”, Pearson Education Asia. 3. Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, “Cognitive Radio Communication and Networks,” Elsevier, 2010.	
COURSE OUTCOME: After completion of course student should be able to 1. Demonstrate an understanding on software defined radio architecture and design principles. 2. Demonstrate an understanding on cognitive radio components, functions and capabilities. 3. Evaluate different spectrum sensing mechanisms in cognitive radio. 4. Analyse the spectrum management functions using cognitive radio systems and cognitive radio networks. 5. Demonstrate an understanding on cooperative communications		

Coding Theory (PE-II)

COURSE OBJECTIVE: The aim of this course is
1. To make students interested in digital communication coding techniques.
2. To make students understand the concept, importance & applications of different channel codes used in a digital communication system.
3. To make students aware of the different coding trade-offs used in a practical communication system.

MODULE	CONTENT	HOURS
MODULE 1	Waveform coding: Antipodal and Orthogonal signals, Orthogonal and Biorthogonal codes, waveform coding system example, Types of error control: Terminal connectivity, automatic repeat request Structured Sequence: Channel models, Channel capacity, Channel coding, Introduction to Error correcting codes, code rate & redundancy, parity check codes: Single parity check code, Rectangular code	6
MODULE 2	Linear Block codes: vector spaces, vector subspaces, Generator matrix, systematic linear block codes, parity check matrix, syndrome testing, error correction, Decoder implementation, Error Detecting & Correcting Capability: weight & distance of binary vectors, minimum distance of linear code, error detection & correction, erasure correction, Usefulness of Standard Array, estimating code capability, error detection vs. error correction trade-off Cyclic Codes: algebraic structures of cyclic code, binary cyclic code properties, encoding in systematic form, circuit for dividing polynomial, systematic encoding with an (n-k)-stage shift register, error detection with an (n-k)-shift register Introduction to Hamming codes, Extended Golay code, and BCH codes.	10
MODULE 3	Convolutional Encoding, Convolutional Encoder Representation: connection representation, state representation & the state diagram, the tree diagram, the trellis diagram Formulation of the Convolutional Decoding Problem: maximum likelihood decoding, channel models: hard versus soft decisions, Viterbi Convolutional Decoding Algorithm, decoder implementation, path memory and synchronization Properties of Convolutional Codes: distance properties of convolutional codes, systematic & non-systematic convolutional codes, catastrophic error propagation in convolutional codes, performance bounds for convolutional codes, coding gain, convolutional code rate trade-off, soft-decision Viterbi decoding Other Convolutional Decoding Algorithms: sequential decoding, comparisons & limitations of Viterbi & sequential decoding, feedback decoding.	10
MODULE 4	Reed-Solomon Codes: Reed-Solomon Error Probability, Why R-S codes perform well against burst noise, R-S performance as a function of size, redundancy, and code rate Interleaving & Concatenated Codes: Block interleaving, Convolutional interleaving, concatenated codes Coding & Interleaving Applied to CD Digital Audio System: CIRC encodings, CIRC decoding, interpolation & muting , turbo code concepts	7
MODULE 5	Modulation and Coding Trade Offs Goals of the Communications System Designer, Error Probability Plane, Nyquist Minimum Bandwidth, Shannon-Hartley Capacity Theorem, Bandwidth Efficiency Plane, Modulation and Coding Trade-Offs, Defining, Designing, and Evaluating Digital Communication Systems, Bandwidth Efficient modulation, Modulation and Coding for Bandlimited Channels, Introduction to Trellis-Coded Modulation, Source coding and its implementation.	7
TEXT BOOK	1. Digital Communications - Fundamentals and Applications - Bernard Sklar, 2nd Edition, Pearson Education Publication. 2. Information Theory, Coding & Cryptography - Ranjan Bose, TMH Publication.	

REFERENCE BOOK	1. Digital Communications – Simon Haykin, Wiley Edition.

COURSE OUTCOME: After completion of this course, the students will be able to

1. Develop an understanding about the concept of waveform coding & structured sequences in relation with communication channel.
2. Conversant with the concept of linear block codes and cyclic codes for encoding and decoding.
3. Conversant with convolutional codes.
4. Understand Reed-Solomon & concatenated codes and their application to CD digital audio system.
5. Understand different modulation & coding trade-offs of communication systems.

Digital Image & Video Processing (PE-II)

COURSE OBJECTIVE:

1. Learn different techniques for image enhancement, video and image recovery.
2. Understand techniques for image and video segmentation.
3. Study techniques for image and video compression and object recognition

MODULE	CONTENT	HOURS
MODULE 1	**Digital Image and Video Fundamentals:** Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms, Need for image transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform.	
MODULE 2	**Image and Video Enhancement and Restoration:** Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery).	
MODULE 3	**Image and Video Segmentation:** Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation, Morphological image processing.	
MODULE 4	**Colour image Processing:** Colour fundamentals, Colour models, Conversion of colour models, Pseudo colour image processing, Full colour processing. Image and Video Compression: Lossless image compression including entropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG 2000, MPEG-2/4, H.264, SVC), Video Quality Assessment.	
MODULE 5	**Object recognition:** Image Feature representation and description-boundary representation, boundary descriptors, regional descriptors, feature selection techniques, introduction to classification, supervised and unsupervised learning, Template matching, Bayes classifier.	
TEXT BOOK	1. Ed. Al Bovik," Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000. 2. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.	
REFERENCE BOOK	1. J. W. Woods, "Multidimensional Signal, Image and Video Processing and coding",2nd Edition, Academic Press, 2011. 2. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015. 1. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.	

COURSE OUTCOME: After completion of course student should be able to 1. Understand basics of Image and Video signals 2. Learn different techniques for image enhancement, video and image recovery 3. Understand techniques for image and video segmentation 4. Study techniques of colour image processing 5. Study techniques for image and video compression and object recognition.

Design and Simulation Lab

SESSIONAL OBJECTIVE:
1. To educate students with the knowledge of verilog coding and test becnch, to write verilog code for all logic gates, flip-flops, counters and adders etc.
2. Students will be able to compile, simulate and synthesize the verilog code
3. Students will be able to know use of different software tools related to VLSI.

Experiment No.	CONTENT
1	Design of Half adder and Half substractor using Verilog HDL.
2	Design of Full adder and 4-bit binary adder using Verilog HDL.
3	Design of Multiplexers and Decoders using Verilog HDL.
4	Design a parity generator and comparator using Verilog HDL.
5	Design of 4-bit Multiplier using Verilog HDL.
6	Design an 8-bit ALU using Verilog HDL.
7	Design a RS & JK flip-flop using Verilog HDL
8	Design of MOD-10 updown counter using Verilog HDL.
9	Design of sequence detector using Verilog HDL.
10	Design of Vending Machine using Verilog HDL.
SUPPLEMENTARY BOOK(If Any)	1. Palnitkar, S. (2003). Verilog HDL: a guide to digital design and synthesis. Pearson Education India. 2. Brown, S. D. (2007). Fundamentals of digital logic with Verilog design. Tata McGraw-Hill Education.

SESSIONAL OUTCOME: After completion of the sessional student should be able to
1. Analyze different types of digital electronic circuit using various mapping and logical tools.
2. Develop competence in Combinational Logic Problem formulation and Logic Optimisation.
3. Develop competence in analysis of synchronous and asynchronous sequential circuits.
4. Knowledge in various simulation softwares like Xilinx ISE, Vivado and Modelsim etc.
5. Knowledge of implementation of VLSI circuits on FPGA boards.

Telecommunication System Engineering Laboratory

Experiment No.	CONTENT
1	Plot the histogram of an image and perform histogram equalization
2	Implement segmentation algorithms
3	Perform video enhancement
4	Perform video segmentation
5	Perform image compression using lossy technique
6	Perform image compression using lossless technique
7	Perform image restoration
8	Convert a colour model into another
9	Calculate boundary features of an image
10	Calculate regional features of an image
SESSIONAL OUTCOME: After completion of the sessional student should be able to 1. Perform basic operations on images and videos. 2. Perform image and video enhancement. 3. Perform image and video segmentation. 4. Perform image and video compression and restoration. 5. Detect an object in an image/video.	

Pattern Recognition & Machine Learning

MODULE	CONTENT	HOURS
COURSE OBJECTIVE: 1. Study the parametric and linear models for classification 2. Design neural network and SVM for classification 3. Develop machine independent and unsupervised learning techniques.		
MODULE 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.	
MODULE 2	**Linear models:** Linear Models for Regression, linear regression, logistic regression Linear Models for Classification.	

MODULE 3	**Neural Network**: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning.	
MODULE 4	**Linear discriminant functions:** decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine. Algorithm independent machine learning - lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.	
MODULE 5	**Unsupervised learning and clustering:** k-means clustering, fuzzy k-means clustering, hierarchical clustering.	
TEXT BOOK	1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001. 2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.	
REFERENCE BOOK	1. C. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006.	

COURSE OUTCOME: After completion of course student should be able to

1. Understand principles of pattern recognition.
2. Study the parametric and linear models for classification.
3. Design neural network and SVM for classification.
4. Understand linear discriminant functions.
5. Develop machine independent and unsupervised learning techniques.

Advanced Wireless Communication

COURSE OBJECTIVE:

1. Expose the students to understand mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards.
2. Appreciate the contribution of Wireless Communication networks to overall technological growth.
3. Understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.

MODULE	CONTENT	HOURS
MODULE 1	BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Altamouti scheme.	8
MODULE 2	Introduction to Wireless Communications, Broadband Wireless Channel Models, Diversity, Equalization and Estimation Techniques and Cellular Communications.	6
MODULE 3	OFDM: Basic principle of Orthogonality, Single vs multicarrier system, OFDM Block Diagram and ITS Explanation, OFDM mathematical representation, Selection Parameters for modulation, Pulse shaping in OFDM Signal and spectral efficiency, windowing in OFDM signal and spectral efficiency, Synchonization in OFDM, Pilot Insertion in OFDM, Amplitude limitations in OFDM, CDMA vs OFDM, Hybrid OFDM and variants of OFDM.	10

MODULE 4	MIMO: Space Diversity and systems based on space diversity, Smart antenna system and MIMO, MIMO Based system architecture, MIMO exploits Multipath, Space-Time Processing, Antenna considerations for MIMO, MIMO channel modeling, measurement, and Capacity, Cyclic Delay Diversity (CDD), Space-Time coding, Advances and Applications of MIMO, MIMO-OFDM.	10
MODULE 5	Simulation of communication Systems and Software Defined Radio (SDR): Simulation methodology, Multidisciplinary aspects of simulation, Modelling of system, Deterministic simulation, Stocastic simulation, General steps of simulation, SDR, Need for SDR, General structure of the transceiver for SDR, 3G SDR system architecture, Present and future trends in SDR, Cognitive Radio (CR).	8
TEXT BOOK	1. Wireless Communications: Principles and Practice, T. S. Rappaport, Prentice Hall 2. Wireless Communication, Upena Dalal, Oxford University Press. 3. MIMO Wireless Communications, E. Biglieri, Cambridge University Press	
REFERENCE BOOK	1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990. 2. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993. 3. Raymond Steele, Mobile Radio Communications, IEEE Press, NY, 1992. 4. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995. 5. VK Garg &JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996. 6. Fundamentals of Wireless Communications, By D.Tse and P.Viswanath, Cambridge University Press.	
COURSE OUTCOME: After completion of course student should be able to 1. Analyze different digital modulation techniques. 2. Understand broadband wireless channel models. 3. Discuss OFDM and variants of OFDM 4. Understand design and application of MIMO and MIMO-OFDM. 5. Discuss simulation of communication systems and Software Defined Radio.		

Advanced Antenna Technology (PE-III)

COURSE OBJECTIVE:
1. To impart the knowledge on performance of different types of broadband antennas.
2. To impart the knowledge on different types of antennas for special application.
3. To impart the knowledge on different types of low profile antennas and it's feeding.

MODULE	CONTENT	HOURS
MODULE 1	Biconical antenna, Discone and conical skirt monopole, theory behind frequency independent antenna, equiangular spiral antenna, fractal antenna concept and technology, corrugated horn antenna, multimode horn antenna.	08
MODULE 2	Smart antenna systems, benefit, drawbacks of Smart antenna, array design for smart antennas, adaptive beamforming, MANET, array theory, Electrically & Physically small & big antenna.	08
MODULE 3	Artificial dielectric lens antenna, Luneburg & Einstein lenses, electrically and small antenna, ground plane antenna, sleeve antenna, turnstile antenna, submerged antenna, surface wave and leaky wave antenna, weather-vane antenna, flagpole antenna, chimney antenna, ILS antenna, sugar-scoop antenna, asteroid detection antenna, embedded antenna, plasma antenna.	08

MODULE 4	Microstrip and other planar antennas, Various types of feeding methods for microstrip antenna (Co-axial, Inset, Aperture/Slot Coupled, Proximity coupled and Corporate feeding for Arrays); Analysis of rectangular Patch Antenna, Cavity/ Modal Expansion Technique, microstrip antenna array.	10
MODULE 5	Conventional Scanning Techniques, Feed Networks for phased Arrays, Frequency Scanned Array Design, Target indicators, Search Patterns.	06
TEXT BOOK	1. Antennas Theory – Analysis and Design, By C. Balanis, Wiley India Edition 2. Antennas, By J. D. Kraus & others, McGraw Hill-Special Indian Edition	
REFERENCE BOOK	1. Phased Array Antennas, By A. A. Ollinerand G.H. Knittel,Artech House 2. Introduction to Radar Systems, By M. L. Skolnik, McGraw Hill	

COURSE OUTCOME: After completion of course student should be able to
1. Understand different design and operation of broadband antennas including comparison of its associated parameters.
2. Understand different design and operation of Smart antennas including associated networks.
3. Understand several advanced antennas for special application.
4. Understand different design and operation of different types of patch antennas and their feedings.
5. Understand different scanning techniques.

DSP Architecture (PE-III)

COURSE OBJECTIVE
1. To shift gradually from the design of DSP systems and algorithms to efficient implementation of the systems and algorithms.
2. To give an exposure to the concepts of real-time DSP and bridge the gap between theoretical signal processing and real-time implementations.
3. To know how the DSP processor is used in an embedded system with a minimum amount of external hardware to support its operation and interface it to the outside world

MODULE	CONTENTS	HOURS
MODULE 1	**Introduction**: A Digital Signal-Processing System, Analysis and Design Tool for DSP Systems, **Computational Accuracy in DSP Implementations**: Number Formats for Signals and Coefficients in DSP Systems, Dynamic Range and Precision, Sources of Error in DSP Implementations-A/D Conversion Errors, DSP Computational Errors, D/A Conversion Errors	08
MODULE 2	**Architecture for Programmable DSP Devices**: Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Module, Programmability and Program Execution, Execution Control-Hardware Looping, Interrupts, Stacks, Relative Branch Support, Speed Issues, Pipelining-Pipelining and Performance, Pipeline Depth, Interlocking, Branching Effects, Interrupt Effects, Pipeline Programming Models. Features for External Interfacing	08
MODULE 3	**Programmable Digital Signal Processors**: Commercial Digital Signal-Processing Devices, The Architecture of TMS320C54XX Processors, Data Addressing Modes of TMS320C54XX Processors, Memory Space of TMS320C54XX Processors, Program Control, TMS320C54XX Instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX Processors, Pipeline Operation of TMS320C54XX Processors.	08
MODULE 4	**Implementation of DSP Algorithms**: -The Q-Notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, An FFT Algorithm for DFT Computation, A Butterfly Computation-Overflow and Scaling, Bit-Reversed Index	08

	Generation, An 8-Point FFT Implementation on The TMS320C54XX, Computation of the Signal Spectrum.	
MODULE 5	**Interfacing Memory and Peripherals to DSP Processor**: -Memory Space Organization, External Bus Interfacing Signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA). A Multichannel Buffered Serial Port (MCBSP), MCBSP Programming, A CODEC Interface Circuit, CODEC Programming, A CODEC-DSP Interface Example.	08
TEXT BOOKS	1. Singh, A. and Srinivasan, S., "Programmable DSP Architecture and Applications" Thomson, 2004. / Brooks/ Cole, a part of CENGAGE Learning 2004. 2. Lapsley, P. et.al, "DSP Processor Fundamentals: Architectures and Features", John Wiley & Sons 1996 3. Sen M. Kuo, Woon-Seng Gan "Digital Signal Processors-Architecture, Implementations and Applications", Pearson,2005.	
REFERENCE BOOKS	1. Bateman, A. and Yates, W. "Digital Signal Processing Design", Computer Science Press, 1989. 2. Texas Instrument "Digital Signal Processing Applications with the TMS320 Family", Prentice-Hall, 1988. 3. Texas Instruments, "Linear Circuits: Data Conversion, DSP Analog Interface, and Video Interface", 1992	

COURSE OUTCOME

After completion of this course, students should be able to

1. Know the important basic concepts of Digital Signal Processing and the issues related to computational accuracy of algorithms when implemented using Programmable Digital Signal Processors.
2. Architectural features of programmable DSP devices based on the DSP operations.
3. Know the architecture and programming of programmable DSP devices.
4. Implementation of basic DSP algorithms in programmable DSP devices.
5. Interfacing memory and serial and parallel I/O peripherals to programmable DSP devices (DSP320C54XX Processor).

Audio & Video Coding & Compression (PE-III)

COURSE OBJECTIVE:

1. Introduce multimedia systems.
2. Study of compression standards.
3. Understand audio and video coding and multimedia synchronization techniques.

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Multimedia Systems and Processing, Lossless Image Compression Systems Image Compression Systems, Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques.	
MODULE 2	Lossy Image Compression Systems, Theory of Quantization, Delta Modulation and DPCM, Transform Coding & K-L Transforms, Discrete Cosine Transforms, Multi-Resolution Analysis, Theory of Wavelets, Discrete Wavelet Transforms, Still Image Compression Standards: JBIG and JPEG.	
MODULE 3	Video Coding and Motion Estimation: Basic Building Blocks & Temporal Redundancy, Block based motion estimation	

	algorithms, Other fast search motion estimation algorithms.	
MODULE 4	Video Coding Standards MPEG-1 standards, MPEG-2 Standard, MPEG-4 Standard, H.261, H.263 Standards, H.264 standard. Audio Coding, Basic of Audio Coding, Audio Coding, Transform and Filter banks, Polyphase filter implementation, Audio Coding, Format and encoding, Psychoacoustic Models.	
MODULE 5	Multimedia Synchronization, Basic definitions and requirements, References Model and Specification, Time stamping and pack architecture, Packet architectures and audio-video interleaving, Multimedia Synchronization, Playback continuity, Video Indexing and Retrieval: Basics of content based image retrieval, Video Content Representation, Video Sequence Query Processing.	
TEXT BOOK	1. Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", Wiley, 2003. 2. Khalid Sayood, "Introduction to Data Compression", 4th Edition, Morgan Kaufmann, 2012	
REFERENCE BOOK	1. Mohammed Ghanbari, "Standard Codecs: Image Compression to Advanced Video Coding", 3rd Edition, The Institution of Engineering and Technology, 2011. 2. Julius O. Smith III, "Spectral Audio Signal Processing", W3K Publishing, 2011. 3. Nicolas Moreau, "Tools for Signal Compression: Applications to Speech and Audio Coding", Wiley, 2011.	

COURSE OUTCOME: After completion of course student should be able to

1. Familiarity to lossy and lossless compression systems.
2. Study of Video coding techniques and standards.
3. Understand audio coding and multimedia synchronization techniques.
4. Understand motion estimation techniques.
5. Understand Multimedia synchronization and applications.

Robotics & Computer Vision (PE-III)

COURSE OBJECTIVE:

1. To introduce the functional elements of Robotics, direct and inverse kinematics
2. To educate on various path planning techniques
3.

MODULE	CONTENT	HOURS
MODULE 1	Brief history-Types of Robot–Technology-Robot classification and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages. DIRECT AND INVERSE KINEMATICS Mathematical representation of Robots - Position and orientation – Homogeneous transformation Various joints-Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots-Solvability – Solution methods-Closed form solution.	8

MODULE 2	Path planning Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.	8
MODULE 3	Image Processing, Computer Vision and Computer Graphics, Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.	8
MODULE 4	Monocular imaging system, Radiosity: The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, color, etc, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading , Photometric Stereo, Depth from Defocus , Construction of 3D model from images.	8
MODULE 5	Image preprocessing, Image representations (continuous and discrete), Edge detection, Regularization theory, Optical computation , Stereo Vision , Motion estimation , Structure from motion, Pattern recognition methods, HMM, GMM and EM.	8
TEXT BOOK	1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005. 2. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010. 3. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall.	
REFERENCE BOOK	1. JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009. 2. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998. 3. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010.	
COURSE OUTCOME: After completion of course student should be able to 1. Understand basic concept of robotics. 2. To analyze Instrumentation systems and their applications. 3. To know about the various path planning techniques. 4. To develop applications using computer vision techniques. 5. To implement fundamental image processing techniques required for computer vision.		

Digital Switching & Telecommunication Networks (PE-IV)

COURSE OBJECTIVE: 1. Learn the basics of switching systems. 2. Understand requirements of modern telephone exchange. 3. Understand traffic engineering and modern telecommunication networks.		
MODULE	CONTENT	HOURS
MODULE 1	Overview of switching systems, Electronic switching and stored program control systems, Centralized SPC, Availability, Distributed SPC, Enhanced services.	
MODULE 2	Digital switching: time switching, space switching, time and space switches, Switching techniques: Circuit Switching, Message and Packet Switching.	
MODULE 3	Computer controlled switching systems: Introduction, Call processing, signal exchange diagram, state transition diagram, hardware configuration, switching system software organization, software classification and interfacing,	

	Maintenance software, call processing software, Administration software, Electronic Exchanges in India.	
MODULE 4	Traffic engineering: Traffic pattern, Grade of Service and Blocking probability, Modeling of switching systems: Markov Process, Birth-Death Process. Telephone network organization: Network management, Network services.	
MODULE 5	Networking plans, types of networks, Routing plan, International numbering plan, National numbering plan, Numbering plan in India, Signaling: in channel signaling, common channel signaling. Overview of ISDN, VPN, VOIP, IP switching.	
TEXT BOOK	1. Telecommunication Switching Systems and Networks, by Thiagarajan Viswanathan, PHI. 2. Telecommunication Systems Engineering, R. L. Freeman, 4/e, Wiley publication, 2010	
REFERENCE BOOK	1. Telecommunication Switching and Networks. By P.Gnanasivam, New Age International.	

COURSE OUTCOME: After completion of course student should be able to

1. Explain the working principle of switching systems involved in telecommunication switching.
2. Design multi stage switching structures involving time and space switching stages.
3. Analyze basic telecommunication traffic theory.
4. Design and modelling of switching systems.
5. Understand concepts of IP switching and apply the principles of switching to new technology exchanges.

Cryptography & Network Security (PE-IV)

COURSE OBJECTIVE:

1. Have a fundamental understanding of the objectives of cryptography and network security.
2. Become familiar with the cryptographic techniques that provide information and network security.
3. Be able to evaluate the security of communication systems, networks and protocols based on a multitude of security metrics.

MODULE	CONTENT	HOURS
MODULE 1	Introduction and Mathematical Foundations– Introduction, Overview on Modern Cryptography, Number Theory, Probability and Information Theory. Classical Cryptosystems, Cryptanalysis of Classical Cryptosystems, Shannon's Theory: I, Shannon's Theory: II, Shannon's Theory: III.	
MODULE 2	Symmetric Key Ciphers – Symmetric Key Ciphers, Modern Block Ciphers (DES), Modern Block Cipher (AES). Cryptanalysis of Symmetric Key Ciphers – Linear Cryptanalysis, Differential Cryptanalysis, Other Cryptanalytic Techniques, Overview on S-Box Design Principles, Modes of operation of Block Ciphers. Stream Ciphers and Pseudo randomness – Stream Ciphers, Pseudorandom functions.	
MODULE 3	Hash Functions and MACs – Hash functions: The Merkle Damgard Construction, Message Authentication Codes (MACs). Asymmetric Key Ciphers: Construction and Cryptanalysis – More Number Theoretic Results, The RSA Cryptosystem, Primality Testing, Factoring Algorithms, Other attacks on RSA and Semantic Security of RSA, The Discrete Logarithm Problem (DLP) and the Diffie Hellman Key Exchange algorithm, The ElGamal Encryption Algorithm, Cryptanalysis of DLP.	
MODULE 4	Digital Signatures – Signature schemes: I, Signature schemes: II. Modern Trends in Asymmetric Key Cryptography – Elliptic curve based cryptography: I, Elliptic curve based cryptography: II.	
MODULE 5	Network Security –Secret Sharing Schemes, Kerberos, Pretty Good Privacy (PGP), Secure Socket Layer (SSL), Intruders and Viruses, Firewalls.	

TEXT BOOK	1. Douglas Stinson, “Cryptography Theory and Practice”, 2nd edition, Chapman & Hall/CRC. 2. B. A. Forouzan, “Cryptography & Network Security”, McGrawHill.
REFERENCE BOOK	1. W. Stallings, Cryptography and Network Security, Pearson Education.

COURSE OUTCOME: After completion of course student should be able to

1. Understand the foundations of network security and cryptographic techniques.
2. Understanding and applying classical cryptosystems.
3. Demonstrate detailed knowledge of the role of encryption to protect data.
4. Understand hash functions and MACs.
5. Analyse and Apply asymmetric key ciphers/digital signatures.

Digital Control System (PE-IV)

COURSE OBJECTIVE:
1. Introduces the fundamental concepts of control system.
2. Explains various aspects of digital control engineering.
3. Learn state variable model.

MODULE	CONTENT	HOURS
MODULE 1	Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction, Modeling discrete-time systems by pulse transfer function, Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph.	
MODULE 2	Stability analysis of discrete time systems, Jury stability test, Stability analysis using bi-linear transformation, Time response of discrete systems, Time response parameters of a prototype second order system, Root locus method, Controller design using root locus.	
MODULE 3	Nyquist stability criteria, bode plot, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead compensator design in frequency domain, Deadbeat response design, Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response.	
MODULE 4	Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete Controllability and observability state equation, Stability, Lyapunov stability theorem, Pole placement by state feedback, Set point tracking controller.	
MODULE 5	Full order observer, reduced order observer, output feedback design, basics of optimal control, performance indices, LQR design.	
TEXT BOOK	1. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007. 2. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.	
REFERENCE BOOK	1. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003. 2. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000. 3. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.	

COURSE OUTCOME: After completion of course student should be able to
1. Understand the principles of digital control.
2. Explain stability analysis of discrete systems.
3. Learn sampled data control systems.
4. Understand and analyze state variable model.
5. Implement the design principles of digital control.

JTFA & MRA (PE-IV)

COURSE OBJECTIVE:
1. Introduction to Transforms in signal processing
2. To understand Time –Frequency Analysis & Multiresolution Analysis
3. Study of Wavelets and its Applications

MODULE	CONTENT	HOURS
MODULE 1	Introduction: Review of Fourier transform, Parseval theorem and need for Joint Time-Frequency Analysis (JTFA), concept of non-stationary signals, Short-time Fourier transforms (STFT), Uncertainty principle, and	8

	Localization/Isolation in time and frequency, Hilbert Spaces, Banach spaces, and Fundamentals of Hilbert Transform.	
MODULE 2	Bases for Time-Frequency Analysis: Wavelet Bases and filter Banks, Tilings of Wavelet Packet and Local Cosine Bases, Wavelet Transform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous Frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic wavelet Transform, Construction of Haar and Roof scaling function using dilation equation and graphical method.	8
MODULE 3	Multiresolution Analysis: Haar Multiresolution Analysis (MRA), MRA Axioms, Spanning Linear Subspaces, nested subspaces. Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks. Study of up samplers and down samplers. Conditions for alias cancellation and perfect reconstruction. Discrete wavelet transform and relationship with filter Banks. Frequency analysis of Haar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstruction of given signal using orthogonal framework of Haar 2 band filter bank.	8
MODULE 4	Wavelets: Daubechies Wavelet Bases, Daubechies compactly supported family of wavelets, Daubechies filter coefficient calculations, Case study of Daub-4 filter design, Connection between Haar and Daub-4, Concept of Regularity, Vanishing moments. Other classes of wavelets like Shannon, Meyer, and Battle-Lamarie.	6
MODULE 5	Bi-orthogonal wavelets and Applications: Construction and design. Case studies of biorthogonal 5/3 tap design and its use in JPEG 2000. Wavelet Packet Trees, Time-frequency localization, compactly supported wavelet packets, case study of Walsh wavelet packet bases generated using Haar conjugate mirror filters till depth level 3. Lifting schemes for generating orthogonal bases of second-generation wavelets. JTFA Applications: Riesz Bases, Scalograms, Time-Frequency distributions: fundamental ideas, Applications: Speech, audio, image and video compression; signal denoising, feature extraction, inverse problem.	10
TEXT BOOK	1. S. Mallat, "A Wavelet Tour of Signal Processing," 2nd Edition, Academic Press, 1999. 2. L. Cohen, "Time-frequency analysis," 1st Edition, Prentice Hall, 1995. 3. G.Strang and T. Q. Nguyen, "Wavelets and Filter Banks," 2nd Edition, Wellesley Cambridge Press, 1998.	
REFERENCE BOOK	1. I. Daubechies, "Ten Lectures on Wavelets," SIAM, 1992. 2. P. P. Vaidyanathan, "Multirate Systems and Filter Banks," Prentice Hall, 1993. 3. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995	

COURSE OUTCOME: After completion of course student should be able to

1. Get a survey on evolution of JTFA from the classical transforms
2. Realize the role of wavelets as bases of time-frequency analysis
3. Have an in-depth theoretical & mathematical investigation of wavelets
4. Explore the applications of wavelets and JTFA
5. Understand application of wavelets in compression.

Advanced Wireless Communication Laboratory

SESSIONAL OBJECTIVE:
1. To understand the multipath wireless environment
2. To analyse and simulate Fading Channel Model
3. To Gain knowledge about MIMO Transmitter and Receiver used in 4G/5G communication.

Experiment No.	CONTENT
1	Simulation of Large Scale Path Loss Model
2	Simulation of Small Scale Fading and Multi-path Model
3	Simulation of QPSK/QAM Transmitter and Receiver
4	Simulation of DS Spread Spectrum Transmitter and Receiver
5	Simulation of Channel Equalizer for Wireless Channel
6	Study and simulation of MIMO transmitter and receiver using Constellation Diagram (NI-USRP Module)
7	BER Analysis of Fading Channels using QAM and QPSK
8	Simulation of Transmit Diversity using Alamouti coding
9	Generation and Detection of FSK and MSK signal
10	Calculation of Channel Capacity using Fading Channels

SESSIONAL OUTCOME:
After completion of the sessional student should be able to
1. Design and simulate multipath fading wireless channels between base station and mobile station.
2. Develop modulation format suitable for transmission.
3. Design and simulate the equalizer for wireless channels.
4. Design and simulate MIMO Fading channel model.
5. Make BER and channel capacity analysis using different modulation techniques.

Pattern Recognition & Machine Learning Laboratory

Experiment No.	CONTENT
1	Implement maximum likelihood algorithm
2	Implement Bayes classifier
3	Implement linear regression
4	Design a classifier using perceptron rule
5	Design a classifier using feedforward back-propagation and delta rule algorithms
6	Implement deep learning algorithm
7	Implement linear discriminant algorithm
8	Design a two class classifier using SVM
9	Design a multiclass classifier using SVM
10	Perform unsupervised learning

SESSIONAL OUTCOME: After completion of the sessional student should be able to

1. Perform linear regression
2. Perform Bayes classifier
3. Design a classifier using neural network
4. Implement deep learning algorithm
5. Design classifiers using SVM

IoT (PE-V)
3rd semester

<table>
<tr><td colspan="3">COURSE OBJECTIVE:
1. Computer science, information technology and Electronics & Telecommunication engineering to understand the interconnection and integration of the physical world with the cyber space and begin designing and developing simple IoT devices.
2. Illustrates end-to-end framework for Wireless Sensor Networks in IoT.
3. Illustrates the IoT Standards and Protocols, Sensors and Actuators in IoT and IoT in the Cloud</td></tr>
<tr><td>MODULE</td><td>CONTENT</td><td>HOURS</td></tr>
<tr><td>MODULE 1</td><td>Emergence of IoT: Background and Vision, IoT as a Disruptive Technology, Standardization. Concept of Smart Things / Objects: Thing in the context of IoT, Needs of an IoT Thing, Commonly used Things can become smart, Machine to Machine (M2M) Technology</td><td>8</td></tr>
<tr><td>MODULE 2</td><td>Wireless Sensor Networks in IoT: Introduction, Types of WSN and Their Architecture, Characteristics of Wireless Sensor Network, Network Topologies in Wireless Sensor Network, WSN Communication Protocols, Security in WSN, Distributed Sensor Network, Wireless Sensor Network Data Aggregation Approaches, Real World WSN Applications, Evolution of WSN Towards Internet of Things, Quality of Information in WSN.</td><td>8</td></tr>
<tr><td>MODULE 3</td><td>IoT Standards and Protocols: An overview of Internet Principles, IPv6 and Its Role in IoT, Low Power Wide Area Network (LPWAN), Wireless Technologies supporting IoT applications.
Sensors and Actuators in IoT: Perception Layer of IoT, Understanding Various Commonly Used Sensors, Environment Measuring Sensors, Medical Sensors, Flow and Fluid Measuring Sensors, Range and Motion Capture Sensors, Actuators, IoT Examples.</td><td>8</td></tr>
<tr><td>MODULE 4</td><td>Big IoT Data Science: Foundations and Principles of Big Data Science, Concept of a Data Lake/Swamp, Relation between Big Data and IoT, Big Data Analytics in IoT, Machine Learning and Deep Learning Tools.</td><td>8</td></tr>
<tr><td>MODULE 5</td><td>IoT in the Cloud: Cloud Computing and IoT: Introduction, Integrating Cloud computing with IoT, Cloud services oriented towards IoT, Selected Cloud Service providers, RESTful Web API design.</td><td>8</td></tr>
<tr><td>TEXT BOOK</td><td colspan="2">1. Internet of Things, by Surya Durbha, Jyoti Joglekar, Oxford University Press
2. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay audisetti, University Press.</td></tr>
<tr><td>REFERENCE BOOK</td><td colspan="2">1. The Internet of things: connecting objects to the web, by Hakima Chaouchi, Willey.
2. The Internet of Things, by Michael Millen, Pearson
3. Internet of Things Principles and Paradigms, Rajkumar Buyya and Amir Vahid Dastjerdi, Morgan Kaufmann, Elsevier.</td></tr>
<tr><td colspan="3">COURSE OUTCOME: After completion of course student should be able to
1. Understand various concept of smart things and Internet of Things (IoT)
2. Understand the evolution of WSN towards IOT
3. Understanding of various IoT standards and measuring sensors.
4. Understand the effects in Big data science.
5. Understand the effects of Cloud services oriented towards IoT.</td></tr>
</table>

Biomedical Signal Processing (PE-V)

COURSE OBJECTIVE:
1. Understand different types of biomedical signal.
2. Identify and analyze different biomedical signals.
3. Find applications related to biomedical signal processing

MODULE	CONTENT	HOURS
MODULE 1	Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters.	
MODULE 2	Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering.	
MODULE 3	Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant). Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.	
MODULE 4	Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio-Signals analysis Multiresolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA).	
MODULE 5	Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.	
TEXT BOOK	1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993. 2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son's publication, 2001.	
REFERENCE BOOK	1. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009. 2. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005. 3. Katarzyn J. Blinowska, JaroslawZygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press, 2011.	

COURSE OUTCOME: After completion of course student should be able to
1. Understand different types of biomedical signal.
2. Identify and analyse different biomedical signals.
3. Find applications related to biomedical signal processing.
4. Understand dimension reduction algorithms.
5. Understand Pattern classification algorithms.

Artificial Intelligence & Soft Computing (PE-V)

COURSE OBJECTIVE:

1. Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.
2. Understanding reasoning and fuzzy logic for artificial intelligence.
3. Understanding game playing and natural language processing

MODULE	CONTENT	HOURS
MODULE 1	Artificial Intelligence: The AI Problems, The Underlying Assumption, AI Techniques, The Level of the Model, Criteria for Success, Some General References, One Final Word Problems, State Space Search & Heuristic Search Techniques: Defining The Problems as A State Space Search, Production Systems, Production Characteristics, Production System Characteristics, and Issues in The Design of Search Programs, Additional Problems. Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.	
MODULE 2	Knowledge Representation Issues: Representations and Mappings, Approaches to Knowledge Representation. Using Predicate Logic: Representation Simple Facts in Logic, Representing Instance and Isa Relationships, Computable Functions and Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.	
MODULE 3	Symbolic Reasoning Under Uncertainty: Introduction to No Monotonic Reasoning, Logics for Non-Monotonic Reasoning. Statistical Reasoning: Probability and Bays' Theorem, Certainty Factors and Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory.	
MODULE 4	Fuzzy Logic. Weak Slot-and-Filler Structures: Semantic Nets, Frames. Strong Slot-and-Filler Structures: Conceptual Dependency, Scripts, CYC. Game Playing: Overview, And Example Domain: Overview, MiniMax, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques.	
MODULE 5	Introduction to Soft Computing, components of soft computing, traditional computing and drawbacks, advantages of soft computing techniques. Basic concept of genetic algorithm, comparison of GA and traditional techniques, objective function and fitness function, crossover, mutation, GA search, applications of GA. Evolutionary computation techniques overview.	
TEXT BOOK	1. Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Mcgraw-Hill, 2005. 2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.	
REFERENCE BOOK	1. J.S.R. Jang, C.T. Sun, E. Mizutani - Neuro-fuzzy and soft computing, PHI. 2. Rajasekaran and Pai – Neural Networks , Fuzzy Logic and Genetic algorithms: Synthesis and Application, PHI	

COURSE OUTCOME: After completion of course student should be able to

1. Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.
2. Understanding reasoning and fuzzy logic for artificial intelligence.
3. Understanding game playing and natural language processing.
4. Understand knowledge representation issues.
5. Understand symbolic reasoning under uncertainty.

Digital TV (OE)

<table>
<tr><td colspan="3">COURSE OBJECTIVE:
1. To introduce the study and analyze of transmission & reception for audio and video systems.
2. To study the principle of monochrome and color TV.
3. To study the principle of CCTV, MATV. CATV, HDTV, LED TV and LCD TV.</td></tr>
<tr><td>MODULE</td><td>CONTENT</td><td>HOURS</td></tr>
<tr><td>MODULE 1</td><td>Introduction to Television & Television Picture: Picture transmission, TV transmitter, Receiver controls, Aspect ratio, Image continuity, No. of scanning lines, Interlaced scanning, Resolution, Brightness, Contrast. Video signal dimensions, Horizontal & Vertical sync details, Perception of brightness and colour, Additive and subtractive Colour mixing, Video signals for colour, Luminance signal (Y), Compatibility, Colour difference signals, encoding of colour difference signals, Formation of chrominance signals.</td><td></td></tr>
<tr><td>MODULE 2</td><td>Color Television Receiver: RF Tuner, IF Subsystem, Video amplifier, Sound section, Sync separation and processing, Deflection circuits, Scanning Currents in the yoke, DC power supplies, Chroma decoder, Separation of U and V colour phasors, Synchronous demodulators, Sub carrier generation and control, Matrixing for drive circuits.</td><td></td></tr>
<tr><td>MODULE 3</td><td>Digital Television-Transmission And Reception: Digital System Hardware, Signal Quantization and Encoding, Digital Satellite Television, Direct-to-Home Satellite Television, Digital TV Receiver, Merits of Digital TV Receivers.</td><td></td></tr>
<tr><td>MODULE 4</td><td>Digital Techniques in Television Engineering: Basic principles of Digital TV broadcasting, Digitization of video signals, Digitization formats. Digital television systems – ATSC, DVB-T, ISDB, DTMB. Compression of video audio signals & compression standards, scrambling algorithm.</td><td></td></tr>
<tr><td>MODULE 5</td><td>Global View of transmission and reception process, Composition of Integrated Decoder CATV, projection Television – Flat panel display TV receiver , Stereo sound in TV ,3D TV Evolution of the set top box, High-Definition Television (HDTV), Digital TV over IP, Digital terrestrial television for mobiles Text.</td><td></td></tr>
<tr><td>TEXT BOOK</td><td colspan="2">1. R.R. Gulati, Monochrome & Color TV, 3rd Edition, PHI Learning, 2014
2. A M. Dhake, TV and Video Engineering, 2nd Edition, Tata McGraw-Hill Education, 2001.</td></tr>
<tr><td>REFERENCE BOOK</td><td colspan="2">1. R G Gupta, Television Engineering and Video Systems, 2nd Edition, Tata McGraw-Hill Education, 2011
2. Jerry Whitaker, Blair Benson, Standard Handbook of Video and Television, Engineering, 4th Edition, Tata McGraw-Hill Education, 2003</td></tr>
<tr><td colspan="3">COURSE OUTCOME: After completion of course student should be able to
1. Understand the fundamental concepts of Television Transmitter & Receiver Systems.
2. Compare performance of various camera tubes.
3. Understand the different types of picture tubes
4. To study the various Color Television systems with a greater emphasis on PAL system
5. Co-relate the fundamentals with modern television technologies</td></tr>
</table>

Basics of Communication Engineering (OE)

COURSE OBJECTIVE:

The course objective to understand

1. The need of modulation, modulation processes and different analog modulation schemes.
2. The influence of noise over analog and digital modulation schemes through random process and noise theory
3. Applications of analog and digital communication techniques.

MODULE	CONTENT	HOURS
MODULE 1	Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.	8
MODULE 2	Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and Deemphasis, Threshold effect in angle modulation.	8
MODULE 3	Sampling Theorem, Low Pass Signal, Band Pass Signal, Signal Reconstruction, Practical Difficulties, The Treachery of Aliasing, The Anti-aliasing Filter, Application of Sampling Theorem, PAM, PWM and PPM Signal Generation and Detection.	8
MODULE 4	Pulse Code Modulation: Quantization of Signals, Uniform and Non-Uniform Quantization, The Compander, The encoder, Transmission Bandwidth and output SNR, Digital multiplexer, Synchronizing and Signaling, Differential PCM, Delta Modulation, Adaptive Delta Modulation, Output SNR, Comparison with PCM. Noise in PCM and DM: Calculation of Quantization Noise Power, Output Signal Power, and the Thermal Noise Power, Output SNR of PCM using different modulation techniques. Output SNR of DM.	10
MODULE 5	Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.	10
TEXT BOOK	1. Haykin S., "Communications Systems", John Wiley and Sons, 2001. 2. Modern Digital and Analogue Communication Systems by B.P.Lathi, 3rd Edition, Oxford University Press. 3. Taub H. and Schilling D.L., "Principles of Communication Systems”, Tata McGraw Hill, 2001.	
REFERENCE BOOK	1. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002 2. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965. 3. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.	

COURSE OUTCOME:

After completion of course student should be able to

1. Understand basic elements of a communication system.
2. Conduct analysis of baseband signals in time domain and in the frequency domain.
3. Demonstrate understanding of various analog and digital modulation and demodulation techniques.

4. Analyze the performance of modulation and demodulation techniques in various transmission environments.
5. Appreciate the importance of synchronization in communication systems.