Course Structure & Syllabus of

Master of Technology

in

Electronics & Telecommunication Engineering

Specialization in

COMMUNICATION SYSTEM ENGINEERING

Academic Year: 2019–2020

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

NAME OF THE PG PROGRAMME: COMMUNICATION SYSTEM ENGINEERING

Vision:

To be recognised as a centre of excellence in education and research in the field of Electronics & Telecommunication Engineering by producing innovative, creative and ethical Electronics Engineering professionals for socio-economic upliftment of society in order to meet the global challenges.

Mission:

The Electronics & Telecommunication Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1. Maintaining state of the art research facilities to provide conducive environment to create, analyze, apply and disseminate knowledge.

M2. Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil 'Make in India' policy of the Government.

M3. Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PEOs:

The program educational objectives of Electronics & Telecommunication Engineering of VSSUT, Burla are to prepare its graduates:

PEO1. To acquire competency in solving real-life problems and to design/develop sustainable and cost effective products according to the prevailing socio-economic context.

PEO2. To make them enable to excel in their professional career/entrepreneurial skill/research and higher studies.

PEO3. To provide opportunity to work and communicate effectively in a team and to engage in the process of life-long learning.

PEO-MISSION MATRIX

	M1	M2	M3
PEO1	3	1	1
PEO2	1	3	2
PEO3	2	3	3

POs:

The program outcomes of Electronics & Telecommunication Engineering programme of VSSUT, Burla are to prepare its graduates with:

PO1. An ability to independently carry out research/investigation and development work to solve practical problems related to communication system engineering.

PO2. An ability to write and present a substantial technical report/document.

PO3. An ability to demonstrate a degree of mastery over Communication System Engineering, which is at a level higher than the requirements in the undergraduate program in Electronics & TelecommunicationEngineering.

PO4. An ability to apply appropriate methodology and modern engineering tools for design and implementation of specific problem domain.

PO5. An ability to meet international standards in the field of Communication System Engineering through their team playing and self-learning capabilities.

PO6. Acquire integrity and ethics of research to execute projects efficiently and independently.

PSOs:

The program specific outcomes of Electronics & Telecommunication Engineering of VSSUT, Burla are to prepare its graduates with:

PSO1. An ability to apply conventional and modern state of the art tools and techniques for development of communication engineering.

PSO2. An ability to study the courses in VLSI, Signal Processing, Embedded and Communication Systems to develop solutions to real world problems.

CourseStructure

SemesterI

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1	MECCS101	Advanced Signal Processing	3	0	0	3
2	Core-2	MECCS102	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	3	0	0	3
6	Lab-1	MECCS103	Design & Simulation Lab	0	0	3	2
7	Lab-2	MECCS104	TSE Lab	0	0	3	2
8	Audit -1		English for Research Paper Writing				
Total Credits							19

SemesterII

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3	MECCS201	Pattern Recognition & Machine Learning	3	0	0	3
2	Core-4	MECCS202	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	MECCS203	AdvancedWireless CommunicationLab	0	0	3	2
7	Lab-4	MECCS204	Pattern Recognition & Machine Learning Lab	0	0	3	2
8	Audit -2		Pedagogy Studies				
				Total Credits			18

SemesterIII

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

SemesterIV

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

Grand Total Credits: 19+18+16+16 = 69

List of Professional Elective			
Sl. No.	Category	Course Code	Subject Name
1	PE-I	MCSPE101	Analog & Digital VLSI Design
2		MCSPE102	Wireless Sensor Networks
3		MCSPE103	Optical Communication Networks
4		MCSPE104	Satellite Communication
1	PE-II	MCSPE105	Advanced Electromagnetics
2		MCSPE106	Cognitive Radio
3		MCSPE107	Coding Theory
4		MCSPE108	Digital Image & Video Processing
1	PE- III	MCSPE201	Advanced Antenna Technology
2		MCSPE202	DSP Architecture
3		MCSPE203	Audio & Video Coding & Compression
4		MCSPE204	Robotics & Computer Vision
1	PE-IV	MCSPE205	Digital Switching & Telecommunication Networks
2		MCSPE206	Cryptography & network Security
3		MCSPE207	Digital Control System
4		MCSPE208	JTFA & MRA
1	PE-V	MCSPE301	Internet of Things
2		MCSPE302	Biomedical Signal Processing
3		MCSPE303	Artificial Intelligence & Soft-computing

List of Open Elective
Basics of Communication Engineering (MCSOE301)
Digital Television (MCSOE302)

AUDIT COURSE

Sl.No.	Course Code	Subject Name
1.	BCAC1001	English for Research Paper Writing
2.	BCAC1002	Disaster Management
3.	BCAC1003	Sanskrit for Technical Knowledge
4.	BCAC1004	Value Education
5.	BCAC2001	Constitution of India
6.	BCAC2002	Pedagogy Studies
7.	BCAC2003	Stress Management by Yoga
8.	BCAC2004	Personality Development through Life Enlightenment Skills.

Advanced Signal Processing
1st semester

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	AdaptiveSignalProcessing:LeastMeanSquareAlgorithm,Recursive Least Square Algorithm, Variants of LMS Algorithm: SK-LMS, N-LMS,FX-LMS.AdaptiveFIR&IIRFilters,ApplicationofAdaptive SignalProcessing:SystemIdentification,ChannelEqualization,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 BOOK	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.	

COURSE OUTCOME
After completion of this course, students will be able to:
CO1. Define the relationship between time and frequency domains.
CO2. Analyze the techniques of power spectrum estimation.
CO3. Apply multi-rate processing and time-frequency analysistechniques.
CO4. Describe working principles of adaptive filters.
CO5. Implement adaptive signal processing algorithms based on higher orderstatistics.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	2	1
CO2	3	2	3	2	1	2
CO3	3	2	3	1	2	2
CO4	3	2	3	-	3	1
CO5	3	2	3	2	1	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Advanced Communication Techniques

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.	8
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.	8
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.	8
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.	8
MODULE 5	Fading Channels: The Challenge of Communicating over Fading Channels, Characterizing, Mobile-Radio Propagation, Signal Time-Spreading, Time VarianceoftheChannelCausedbyMotionMitigatingtheDegradationEffects of Fading, Summary of the Key Parameters Characterizing Fading Channels, Applications: Mitigating the Effects of Frequency SelectiveFading.	8
TEXT BOOK	1. Digital Communications - Fundamentals and applications by Bernard Sklar,2nd Edition of Pearson educationPublication 2. Digital Communications - J. G. Proakis, 3rd edition, McGraw HillPublication.	
REFERENCE BOOK	1. J.G. Proakis, M. Salehi, Communication Systems Engineering, Pearson Education International, 2002. 2. Lee & Messerschmitt, Digital Communication, Springer,2004. 3. R. Prasad, OFDM for Wireless Communications Systems, Artech House,2004.	

COURSE OUTCOME

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

CO1. Apply various formatting and modulation process in digitalcommunication.

CO2. Analyze the concepts of communication linkanalysis.

CO3. Implement Spread Spectrum Techniques, Synchronizationetc.

CO4. Define the effects of mitigatingFading.

CO5. Describethe commercial applications of recent CellularSystems.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	-
CO2	2	3	2	2	2	1
CO3	3	2	3	2	2	1
CO4	3	1	2	3	2	1
CO5	3	2	2	3	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	2	2	2	1

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Analog and Digital VLSI Design

MODULE	CONTENT	HOURS
MODULE 1	Review:BasicMOSStructureanditsStaticBehaviour,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 andNoiseMarginConceptsandtheirEvaluation,Dynamic Behaviour, Power Consumption.	6
MODULE 2	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.	6
MODULE 3	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.	12
MODULE 4	SingleStageAmplifier:CSStagewithResistanceLoad,Diode Connected Load, Current Source Load, Triode Load, CSStage 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.	10
MODULE 5	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.	6
TEXT BOOKS	1. J P Rabaey, A P Chandrakasan, B Nikolic, "Digital Integrated circuits: A design perspective", Prentice Hall electronics and VLSI series, 2nd Edition. 2. BehzadRazavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007.	
REFERENCE BOOKS	1. Baker, Li, Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, 2ndEdition. 2. Neil H. E. Weste, D. Harris and A. Banerjee, "CMOS VLSI Design:A Circuit and Systems Perspective", Pearson Education, 3rdEdition.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Recognize the basic operation of MOS and MOSinverters.

CO2. Express the physical design flow of VLSIlogic.

CO3. Design of different logic circuits.

CO4. Construct single stage amplifiers in addition to current mirrorcircuits.

CO5. Describe the basic design procedures of OPAMP.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	1
CO2	3	2	3	3	2	2
CO3	3	2	3	3	3	2
CO4	3	1	3	3	2	1
CO5	2	1	2	1	2	1

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	1

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Wireless Sensor Networks

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	FundamentalsofNetworkSecurity,ChallengesofSecurityinWireless SensorNetworks,SecurityAttacksinSensorNetworks,Protocolsand Mechanisms for Security, IEEE 802.15.4 and Zig BeeSecurity.	8
TEXT BOOKS	1. WaltenegusDargie,ChristianPoellabauer,"FundamentalsofWirelessSensor Networks: Theory and Practice", Wiley2010 2. Mohammad S. Obaidat, SudipMisra, "Principles of Wireless Sensor Networks", Cambridge,2014	
REFERENCE BOOKS	1. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley 2010 2. C S Raghavendra, K M Sivalingam, TaiebZnati, "Wireless Sensor Networks", Springer,2010 3. C. Sivarmmurthy& 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 will be able to

CO1. Define common wireless sensor node architectures.

CO2. Write simple analysis and planning ofWSNs.

CO3. Demonstrate knowledge of MAC protocols developed forWSN.

CO4. Demonstrate knowledge of routing protocols developed forWSN.

CO5. Compile and explain mobile data-centric networkingprinciples.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	3
CO2	2	2	2	2	2	2
CO3	3	2	3	3	2	1
CO4	3	2	3	3	2	1
CO5	3	3	2	2	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Optical Communication Networks

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	SignalDegradationinOpticalfiber:Attenuation,Absorptionlosses,scattering losses,BendingLosses,SignalDistortioninOpticalWaveguides,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,ExternalQuantumefficiency,Resonantfrequencies,Quantumlaser, Fiber amplifiers, Power Launching and coupling, Fiber -to- Fiberjoints, 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. GerdKeiser,"OpticalFiberCommunication"McGrawHillInternational,4thEdition., 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 will be able to

CO1. Express the concept of optical communication system using rayoptics.

CO2. Evaluate numerical problems related to signal degradation and losses in optical fiber.

CO3. Analyzetheconcept of optical sources, their power launchingandcouplingcapacity.

CO4. Define the optical detection principles and design of various types of optical detectors.

CO5. Recognize types of optical network systems and analyze their system performance using link budget.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	2	1	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	2	1	2
CO5	3	2	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Satellite Communication

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),Attitudeandorbitcontrolsystem(AOCS),Communicationsub-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 EducationIndia, 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 will be able to

CO1. Recognize the architecture of satellite systems with a means of high speed, high range communication system.

CO2. Define various aspects of orbital mechanics to develop the orbital equations for different types ofsatellites.

CO3. Analyze the architecture and role of satellitesub-systems.

CO4. SolvenumericalproblemsofsatellitelinkbudgetdesignandC/Nratiocalculations.

CO5. Describethemechanismsrelatedtosatellitesystemsuchasmodulationandmultipleaccessschemes.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	3	3
CO2	2	1	2	1	1	2
CO3	3	2	3	2	2	2
CO4	2	2	2	1	2	2
CO5	3	2	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Advanced Electromagnetics

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 betweencircuittheory&fieldtheory,derivationofcircuitrelationsfrom field theory, bridging the gap between electricity & magnetismusing 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,theaxon,retinalopticalfibers,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'sEquations&ThePrinciplesofElectromagnetism,ByR.Fitzpatric,Infinity Science PressLLC.	
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, McGrawHill. 3. Concepts of Modern Physics, By A. Beiser, Mc GrawHill	

COURSE OUTCOME

After completion of course student will be able to

CO1. Express inadequacies in Maxwell's equations and correlating between circuit theory and field theory.

CO2. Describe Huygens's, Babinet's, and holographicprinciples.

CO3. Derivethe circuit relations from field theories and viceversa.

CO4. Demonstrateknowledgeofdielectricslabwaveguides,Schumannresonance,andtropo-scatter propagation.

CO5. Definebio-electromagnetics.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	3	2	1
CO3	3	1	2	2	3	3
CO4	2	2	3	1	2	2
CO5	3	3	3	1	2	1

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Cognitive Radio

MODULE	CONTENT	HOURS
MODULE 1	Essential functions of the SDR, SDR architecture, design principlesof SDR, traditional radio implemented in hardware and SDR, transmitter architecture and its issues, A/D & D/A conversion, parameters of practicaldataconverters,techniquestoimprovedataconverter 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	Spectrummanagementofcognitiveradionetworks,spectrumdecision, spectrum sharing and spectrum mobility, mobility management of heterogeneous wireless networks, research challenges inCR.	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, MaziarNekovee, 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 EducationAsia. 3. Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, "CognitiveRadio Communication and Networks," Elsevier,2010.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Describe software defined radio architecture and designprinciples.

CO2. Describe cognitive radio components, functions andcapabilities.

CO3. Evaluate different spectrum sensing mechanisms in cognitiveradio.

CO4. Analyze the spectrum management functions using cognitive radio systems andcognitive radionetworks.

CO5. Define cooperativecommunications.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	1	2
CO2	3	3	3	1	1	2
CO3	3	3	3	1	2	1
CO4	3	3	2	1	2	1
CO5	2	2	2	2	3	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Coding Theory

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: connectionrepresentation, staterepresentation & thestatediagram, thetree diagram, the trellis diagram Formulation of the Convolutional Decoding Problem: maximum likelihood decoding, channel models: hard versussoft 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 propagationinconvolutionalcodes, performanceboundsforconvolutional codes, coding gain, convolutional code rate trade-off, soft-decisionViterbi decoding Other Convolutional DecodingAlgorithms: 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 & InterleavingAppliedtoCDDigitalAudioSystem:CIRCencodings,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 EducationPublication. 2. Information Theory, Coding & Cryptography - Ranjan Bose, TMHPublication.	

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

COURSE OUTCOME

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

CO1. Describe the concept of waveform coding & structured sequences in communicationchannel.

CO2. Define the concepts of linear block codes and cyclic codes for encoding anddecoding.

CO3. Recognize the convolutionalcodes.

CO4. AnalyzeReed-Solomon, concatenated codes and their applications.

CO5. Describe thedifferent modulation & coding trade-offs of communicationsystems.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	1
CO2	3	3	3	1	2	2
CO3	3	3	3	1	2	2
CO4	3	2	2	1	2	2
CO5	3	3	3	1	2	1

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Digital Image & Video Processing

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,Hadamardtransform,Haartransform,Wavelet transform.	8
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).	8
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.	8
MODULE 4	**Color image Processing:** Color fundamentals, Color models, Conversion of color models, Pseudo color image processing, Full color processing. ImageandVideoCompression:Losslessimagecompressionincludingentropy coding, lossy image compression, video compression techniques, and international standards for image and video compression (JPEG, JPEG2000, MPEG-2/4, H.264, SVC), Video Quality Assessment.	8
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.	8
TEXT BOOKS	1. Al Bovik," Handbook of Image and Video Processing", 2nd Edition,Academic Press, 2000. 2. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rdEdition, Prentice Hall, 2008.	
REFERENCE BOOKS	1. J.W.Woods,"MultidimensionalSignal,ImageandVideoProcessingandcoding",2nd Edition, Academic Press,2011. 2. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall,2015. 3. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Recognizethe basic properties of image and videosignals.

CO2. Apply different techniques for image enhancement, video and imagerecovery.

CO3. Apply techniques for image and videosegmentation.

CO4. Recognize techniques of color imageprocessing.

CO5. Implement techniques for image and video compression and objectrecognition.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	2
CO2	3	3	3	2	2	1
CO3	3	3	2	2	1	2
CO4	3	3	3	1	2	2
CO5	3	3	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Design and Simulation Lab

Experiment No.	CONTENT
1	Design of Half adder and Half subtractor 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	1. Palnitkar, S. (2003). Verilog HDL: a guide to digital design andsynthesis. Pearson EducationIndia. 2. Brown, S. D. (2007). Fundamentals of digital logic with Verilog design.Tata McGraw-Hill Education.

COURSE OUTCOME

After completion of the sessional student will be able to

CO1. Analyze different types of digital electronic circuit using various mapping and logicaltools.

CO2. Develop competence in combinational logic problem formulation and logicoptimization.

CO3. Develop competence in analysis of synchronous and asynchronous sequentialcircuits.

CO4. Demonstrate various simulation software like Xilinx ISE, Vivado, ModelSimetc.

CO5. Implement VLSI circuits on FPGAboards.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	2	2
CO2	3	3	3	2	2	2
CO3	3	3	3	2	2	2
CO4	3	3	2	1	3	3
CO5	3	3	2	1	3	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

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 color model into another
9	Calculate boundary features of an image
10	Calculate regional features of an image

COURSE OUTCOME

After completion of the sessional student will be able to

CO1. Demonstrate basic operations on images and videos.

CO2. Develop image and video enhancement algorithms.

CO3. Develop image and video segmentation techniques.

CO4. Develop image and video compression and restoration algorithms.

CO5. Incorporate the algorithms to detect an object in animage/video.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	2	1
CO2	3	3	3	1	2	2
CO3	3	3	3	1	2	2
CO4	3	3	2	2	1	2
CO5	3	3	2	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Pattern Recognition & Machine Learning

MODULE	CONTENT	HOURS
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 erroranalysis.	8
MODULE 2	**Linear models:** Linear Models for Regression, linear regression, logistic regression Linear Models for Classification.	8
MODULE 3	**Neural Network**: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additionalnetworks and training methods, Adaboost, Deep Learning.	8
MODULE 4	**Linear discriminant functions:** decision surfaces, two- category, multi-category, minimum squared errorprocedures, 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 classifierdesign, combining classifiers.	8
MODULE 5	**Unsupervisedlearningandclustering:**k-meansclustering,fuzzyk-means clustering, hierarchical clustering.	8
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 ofStatistical Learning", 2nd Edition, Springer, 2009.	
REFERENCE BOOK	1. C. Bishop, "Pattern Recognition and Machine Learning,"Springer, 2006.	
COURSE OUTCOME After completion of course student will be able to CO1. Describe working principles of pattern recognition. CO2. Express the parametric and linear models for classification. CO3. Design neural network and SVM architecture for classification. CO4. Define linear discriminant functions. CO5. Develop machine independent and unsupervised learning techniques.		

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	1	2	1
CO3	3	3	3	3	2	1
CO4	2	2	3	2	2	1
CO5	3	3	3	3	2	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Advanced Wireless Communication

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:BasicprincipleofOrthogonality,Singlevsmulticarriersystem, 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 spectralefficiency,SynchronizationinOFDM,PilotInsertioninOFDM, AmplitudelimitationsinOFDM,CDMAvsOFDM,HybridOFDMandvariants 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, Stochastic 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, PHI 2. Wireless Communication, UpenDalal, Oxford UniversityPress. 3. MIMO Wireless Communications, E. Biglieri, Cambridge UniversityPress	
REFERENCE BOOKS	1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990. 2. WCY Lee, Mobile Communications Design Fundamentals, PHI. 3. Raymond Steele, Mobile Radio Communications, IEEE Press, NY,1992. 4. AJViterbi,CDMA:PrinciplesofSpreadSpectrumCommunications,Addison Wesley,1995. 5. VKGarg&JEWilkes,Wireless&PersonalCommunicationSystems,PHI. 6. Fundamentals of Wireless Communications, D.Tse and P.Viswanath, Cambridge UniversityPress.	
COURSE OUTCOME After completion of course student will be able to CO1. Analyze different digital modulationtechniques. CO2. Express broadband wireless channelmodels. CO3. Analyze OFDM and variants of OFDM. CO4. Describe the design principles and application of MIMO andMIMO-OFDM. CO5. Demonstrate simulation of communication systems and Software DefinedRadio.		

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	2
CO2	3	3	3	2	3	2
CO3	3	3	3	1	2	2
CO4	3	3	2	1	1	2
CO5	3	3	3	2	1	1

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Advanced Antenna Technology

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 microstripantenna(Co-axial,Inset,Aperture/SlotCoupled,Proximitycoupled and Corporate feeding for Arrays); Analysis of rectangularPatch 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, C. Balanis, Wiley IndiaEdition 2. Antennas, J. D. Kraus & others, McGraw Hill-Special IndianEdition	
REFERENCE BOOK	1. Phased Array Antennas, A. A. Ollinerand G.H. Knittel,ArtechHouse 2. Introduction to Radar Systems, M. L. Skolnik, McGrawHill	

COURSE OUTCOME

After completion of course student will be able to

CO1. Describe thedifferent design principles and operation of broadband antennas.
CO2. Describe thedifferent design principles and operations of smart antennas.
CO3. Design several advanced antennas for specialapplication.
CO4. Recognizedifferent types of patch antennas and theirfeedings.
CO5. Describedifferent scanningtechniques.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	2	1	2	2
CO4	3	2	2	1	1	2
CO5	2	2	3	1	3	2

Program Articulation Matrix for the Course

	2.8	2.6	2.6	1.4	2.4	2.4
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

DSP Architecture

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 DSPSystems,DynamicRangeandPrecision,SourcesofErrorinDSP 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-HardwareLooping,Interrupts,Stacks,RelativeBranchSupport,Speed Issues, Pipelining-Pipelining and Performance, PipelineDepth, 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-ChipPeripherals, Interrupts of TMS320C54XX Processors, Pipeline Operationof 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 FFTAlgorithmforDFTComputation,Butterfly Computation-OverflowandScaling,Bit-ReversedIndexGeneration, An 8-Point FFT Implementation on The TMS320C54XX,Computation of the Signal Spectrum.	08
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"ThomsonLearning 2004. 2. Lapsley,P.et.al,"DSPProcessorFundamentals:ArchitecturesandFeatures", John Wiley & Sons1996 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 AnalogInterface, and Video Interface",1992	

COURSE OUTCOME

After completion of this course students will be able to

CO1. Recognize the basic concepts of digital signal processing.
CO2. Describe architectural features of programmable DSP devices based on the DSPoperations.
CO3. Develop programming of programmable DSPdevices.
CO4. Implement DSP algorithms in programmable DSPdevices.
CO5. Demonstrate interfacing of memory and serial and parallel I/O peripherals to programmable DSP devices (DSP320C54XXProcessor).

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	2
CO2	2	3	2	1	2	2
CO3	3	3	3	2	2	3
CO4	2	2	3	2	1	2
CO5	3	2	3	2	1	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Audio & Video Coding & Compression

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Multimedia Systems and Processing, Lossless Image Compression Systems Image Compression Systems,HuffmanCoding,ArithmeticandLempel-ZivCoding,Other Coding Techniques.	8
MODULE 2	Lossy Image Compression Systems, Theory of Quantization, Delta Modulation and DPCM, Transform Coding &K-L Transforms, Discrete Cosine Transforms, Multi-Resolution Analysis,TheoryofWavelets,DiscreteWaveletTransforms,Still Image Compression Standards: JBIG and JPEG.	8
MODULE 3	Video Coding and Motion Estimation: Basic Building Blocks &Temporal Redundancy, Block based motion estimation algorithms, Other fast search motion estimation algorithms.	8
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,AudioCoding,Formatandencoding,Psychoacoustic Models.	8
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.	8
TEXT BOOK	1. Iain E.G. Richardson, "H.264 and MPEG-4 Video Compression", Wiley. 2. Khalid Sayood, "Introduction to Data Compression", 4thEdition, 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: Applicationsto Speech and Audio Coding", Wiley, 2011.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Describe the principles of lossy and lossless compression systems.

CO2. Recognizevideo coding techniques and standards.

CO3. Recognize coding and multimedia synchronization techniques.

CO4. Recognize motion estimation techniques.

CO5. Describemultimedia synchronization and applications.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	2	3	3	1	2	1
CO3	3	3	3	1	3	1
CO4	3	2	3	2	2	2
CO5	3	3	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Robotics & Computer Vision

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 - Positionandorientation–HomogeneoustransformationVariousjoints-RepresentationusingtheDenavitHattenbergparameters-Degreesof 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 andorientation 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,PhotometricStereo,DepthfromDefocus,Constructionof3Dmodel 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. AshitavaGhoshal, 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 BasedIntegration, Allied Publishers, Chennai,1998. 3. Richard Szeliski, Computer Vision: Algorithms and Applications(CVAA). Springer,2010.	

COURSE OUTCOME
 After completion of course student will be able to
CO1. Recognize the basic concept ofrobotics.
CO2. Analyze instrumentation systems and theirapplications.
CO3. Analyze the various path-planningtechniques.
CO4. Develop applications using computer visiontechniques.
CO5. Implement fundamental image processing techniques required for computervision.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	2	3
CO2	3	3	3	2	3	2
CO3	3	3	3	2	1	2
CO4	3	3	3	2	1	3
CO5	2	2	3	2	2	1

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Digital Switching & 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.	8
MODULE 2	Digital switching: time switching, space switching, time and space switches, Switching techniques: Circuit Switching, Message and Packet Switching.	8
MODULE 3	Computer controlled switching systems: Introduction, Call processing,signal exchangediagram,statetransitiondiagram,hardwareconfiguration,switching system software organization, softwareclassification and interfacing, Maintenance software, call processing software, Administration software, Electronic Exchanges in India.	8
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.	8
MODULE 5	Networking plans, types of networks, Routing plan, International numbering plan,Nationalnumberingplan,NumberingplaninIndia,signaling:inchannel signaling,commonchannelsignaling.OverviewofISDN,VPN,VOIP,IP switching.	8
TEXT BOOK	1. Telecommunication Switching Systems and Networks, by ThiagarajanViswanathan, PHI. 2. Telecommunication Systems Engineering, R. L. Freeman, 4/e, Wileypublication, 2010	
REFERENCE BOOK	1. Telecommunication Switching and Networks. By P.Gnanasivam, New Age International.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Express the working principle of switching systems involved in telecommunication.
CO2. Design multi stage switching structures involving time and space switchingstages.
CO3. Analyze basic telecommunication traffictheory.
CO4. Design and modelling of switchingsystems.
CO5. Recognize the concepts of IP switching and apply the principles of switching to new technology exchanges.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	3	2	2	3
CO3	3	3	3	2	1	2
CO4	3	3	3	1	2	3
CO5	3	3	3	2	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Cryptography & Network Security

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.	8
MODULE 2	Symmetric Key Ciphers – Symmetric Key Ciphers, Modern Block Ciphers (DES),ModernBlockCipher(AES).CryptanalysisofSymmetricKeyCiphers – 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.	8
MODULE 3	Hash Functions and MACs – Hash functions: The MerkleDamgard 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)andtheDiffieHellmanKeyExchangealgorithm,TheElGamal Encryption Algorithm, Cryptanalysis of DLP.	8
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.	8
MODULE 5	Network Security –Secret Sharing Schemes, Kerberos, Pretty Good Privacy (PGP), Secure Socket Layer (SSL), Intruders and Viruses, Firewalls.	8
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 will be able to

CO1. Describe the foundations of network security and cryptographictechniques.
CO2. Recognizing and applying classicalcryptosystems.
CO3. Demonstrate role of encryption to protectdata.
CO4. Describe hash functions andMACs.
CO5. Apply asymmetric key ciphers/digitalsignatures.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	2
CO2	3	3	3	2	1	2
CO3	3	3	3	2	2	2
CO4	3	3	3	1	2	2
CO5	3	3	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Digital Control System

MODULE	CONTENT	HOURS
MODULE 1	Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction, Modeling discrete-time systems by pulsetransferfunction,RevisitingZ-transform,Mappingofs-planetoz-plane, Pulsetransferfunction,Pulsetransferfunctionofclosedloopsystem,Sampled signal flowgraph.	8
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.	8
MODULE 3	Nyquiststabilitycriteria,bodeplot,LeadcompensatordesignusingBodeplot, 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 deadbeatresponse.	8
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.	8
MODULE 5	Full order observer, reduced order observer, output feedback design, basics of optimal control, performance indices, LQR design.	8
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.AstromsandB.Wittenmark,ComputerControlledSystems-TheoryandDesign, Prentice Hall, 3/e,1997.	

COURSE OUTCOME

After completion of course student will be able to

CO1. Recognize the principles of digitalcontrol.

CO2. Express stability analysis of discretesystems.

CO3. Define sampled data controlsystems.

CO4. Analyze state variablemodel.

CO5. Implement the design principles of digitalcontrol.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	2
CO2	3	3	3	2	2	1
CO3	3	3	3	3	2	2
CO4	3	3	3	2	2	3
CO5	2	2	3	2	1	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

JTFA & MRA

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 Localization/Isolation in time and frequency, Hilbert Spaces, Banach spaces, and Fundamentals of Hilbert Transform.	8
MODULE 2	Bases for Time-Frequency Analysis: Wavelet Bases and filter Banks, TilingsofWaveletPacketandLocalCosineBases,WaveletTransform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous Frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic waveletTransform,ConstructionofHaarandRoofscalingfunction 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, Haar2-band filter Banks. Study of up samplers and down samplers.Conditions for alias cancellation and perfect reconstruction. Discrete wavelet transformandrelationshipwithfilterBanks.FrequencyanalysisofHaar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstructionof given signal using orthogonal framework of Haar 2 band filter bank.	8
MODULE 4	Wavelets:DaubechiesWaveletBases,Daubechiescompactlysupported family of wavelets, Daubechies filter coefficient calculations, Case study of Daub-4 filter design, ConnectionbetweenHaar 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 schemesforgeneratingorthogonalbasesofsecond-generationwavelets. 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.VetterliandJ.Kovacevic,"WaveletsandSubbandCoding", Prentice Hall, 1995	

COURSE OUTCOME

After completion of course student will be able to

CO1. Express evolution of JTFA from the classicaltransforms.
CO2. Recognize the role of wavelets as bases of time-frequencyanalysis.
CO3. Demonstrate in-depth theoretical & mathematical investigation ofwavelets.
CO4. Explore the applications of wavelets andJTFA.
CO5. Apply wavelets in compression.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	3	3
CO2	3	3	3	1	2	2
CO3	3	3	3	2	2	3
CO4	3	3	3	2	2	2
CO5	3	3	2	2	2	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	3

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Advanced Wireless Communication Laboratory

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

COURSE OUTCOME

After completion of the sessional student will be able to

CO1. Design and simulate multipath fading wireless channels between base station and mobile station.

CO2. Develop modulation format suitable fortransmission.

CO3. Design and simulate the equalizer for wirelesschannels.

CO4. Design and simulate MIMO fading channelmodel.

CO5. Evaluate BER and channel capacity analysis using different modulationtechniques.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	2	2	1	2	1
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	2	1	3	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

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 anddelta 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

COURSE OUTCOME

After completion of the sessional student will be able to

CO1. Demonstrate linear regression algorithm.
CO2. Implement Bayes classifier.
CO3. Design a classifier using neural network.
CO4. Implement deep learning algorithms.
CO5. Design classifiers using SVM.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	3
CO2	3	2	3	2	2	3
CO3	3	3	3	2	2	2
CO4	3	3	3	2	2	3
CO5	2	2	3	1	1	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	3

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

IoT
3rd semester

MODULE	CONTENT	HOURS
MODULE 1	**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	8
MODULE 2	**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,WirelessSensorNetworkDataAggregationApproaches,Real World WSN Applications, Evolution of WSN Towards Internetof Things, Quality of Information in WSN.	8
MODULE 3	**IoTStandardsandProtocols:**AnoverviewofInternetPrinciples,IPv6 and Its Role in IoT, Low Power Wide Area Network (LPWAN), Wireless Technologies supporting IoTapplications. **SensorsandActuatorsinIoT:**PerceptionLayerofIoT,Understanding Various Commonly Used Sensors, Environment MeasuringSensors, MedicalSensors,FlowandFluidMeasuringSensors,RangeandMotion Capture Sensors, Actuators, IoTExamples.	8
MODULE 4	**BigIoT DataScience:**FoundationsandPrinciplesofBigDataScience, Concept of a Data Lake/Swamp, Relation between Big Data and IoT, BigDataAnalyticsinIoT,MachineLearningandDeepLearningTools.	8
MODULE 5	**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.	8
TEXT BOOK	1. Internet of Things, Surya Durbha, JyotiJoglekar, Oxford UniversityPress 2. Internet of Things, A Hands on Approach, ArshdeepBahga& Vijay Audisetti, UniversityPress.	
REFERENCE BOOK	1. The Internet of things: connecting objects to the web, HakimaChaouchi, Willey. 2. The Internet of Things, Michael Millen,Pearson 3. Internet of Things: Principles and Paradigms, RajkumarBuyya and Amir VahidDastjerdi, Morgan Kaufmann,Elsevier.	
COURSE OUTCOME After completion of course student will be able to CO1. Recognizethe concept of smart things and Internet of Things(IoT). CO2. Express the evolution of WSN towardsIoT. CO3. Define various IoT standards and measuringsensors. CO4. Express the effects in BigData science. CO5. Recognize the effects of cloud services oriented towardsIoT.		

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	3
CO2	3	3	3	1	3	3
CO3	2	2	2	1	2	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Biomedical Signal Processing

MODULE	CONTENT	HOURS
MODULE 1	Acquisition,GenerationofBio-signals,Originofbio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters.	8
MODULE 2	Electrodesforbio-physiologicalsensingandconditioning, 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'sDAC's)Processing, Digital filtering.	8
MODULE 3	Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that arediagnosticallysignificant).Classificationofsignals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processingmethodsand applications.	8
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), Independentcomponent analysis (ICA).	8
MODULE 5	Pattern classification–supervised and unsupervised classification, Neural networks, Support vectorMachines, Hidden Markov models. Examples of biomedicalsignal classification examples.	8
TEXT BOOK	1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall,1993. 2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", JohnWiley & 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 will be able to

CO1. Recognize different types of biomedicalsignal.

CO2. Analyze biomedicalsignals.

CO3. Describe applications related to biomedical signalprocessing.

CO4. Develop dimension reductionalgorithms.

CO5. Develop Pattern classificationalgorithms.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	2	2
CO2	2	3	3	1	2	1
CO3	2	2	3	2	2	3
CO4	2	2	3	1	2	2
CO5	3	3	3	1	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Artificial Intelligence & Soft Computing

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,OneFinalWordProblems,StateSpaceSearch&HeuristicSearch 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,HillClimbing,Best-FirstSearch,ProblemReduction,Constraint Satisfaction, Means-Ends Analysis.	8
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.	8
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.	8
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 PlanningUsing Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques.	8
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.	8
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 Geneticalgorithms: Synthesis and Application,PHI	

COURSE OUTCOME

After completion of course student will be able to

CO1. Recognize the concept of Artificial Intelligence, search techniques.
CO2. Develop reasoning and fuzzy logic for artificialintelligence.
CO3. Implement game playing and natural languageprocessing techniques.
CO4. Express knowledge representationissues.
CO5. Recognize symbolic reasoning underuncertainty.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	2	3
CO2	2	2	2	3	2	2
CO3	2	2	2	3	2	2
CO4	3	2	3	3	2	3
CO5	3	3	3	2	3	3

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	3	2	2	3

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Digital TV

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Television & Television Picture: Picture transmission, TV transmitter,Receivercontrols,Aspectratio,Imagecontinuity,No.ofscanning 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, Luminancesignal(Y),Compatibility,Colourdifferencesignals,encodingof colour difference signals, Formation of chrominance signals.	8
MODULE 2	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.	8
MODULE 3	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.	8
MODULE 4	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.	8
MODULE 5	GlobalViewoftransmissionandreceptionprocess,CompositionofIntegrated DecoderCATV,projectionTelevision–FlatpaneldisplayTVreceiver,Stereo sound in TV ,3D TV Evolution of the set top box, High-DefinitionTelevision (HDTV), Digital TV over IP, Digital terrestrial television for mobiles Text.	8
TEXT BOOK	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.	
REFERENCE BOOK	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	

COURSE OUTCOME

After completion of course student will be able to

CO1. Describe the fundamental concepts of Television Transmitter & ReceiverSystems.
CO2. Evaluate performance of various cameratubes.
CO3. Describe the different types of picturetubes.
CO4. Recognize the various Color Television systems with a greater emphasis on PALsystem.
CO5. Develop a correlation with modern televisiontechnologies.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	2	2
CO2	2	2	3	1	2	1
CO3	2	2	3	1	2	1
CO4	2	2	3	1	2	2
CO5	3	3	3	2	2	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	3	1	2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation

Basics of Communication Engineering

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 innoise, 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 MinimumShift Keying.	6
TEXT BOOK	1. Haykin S., "*Communications Systems*", John Wiley and Sons,2001. 2. Modern Digital and Analogue Communication Systems B.P.Lathi, 3rd Edition, Oxford UniversityPress. 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 SystemsEngineering*", 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 will be able to

CO1. Recognize basic elements of a communicationsystem.

CO2. Analyze baseband signals in time domain and frequencydomain.

CO3. Demonstrate various analog/ digital modulation anddemodulation techniques.

CO4. Evaluate the performance of modulation and demodulation techniques in various transmission environments.

CO5. Expressthe importance of synchronization in communication systems.

Course Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	2	2
CO2	3	3	3	1	2	1
CO3	3	3	3	2	2	2
CO4	2	3	2	1	2	1
CO5	3	3	2	2	1	2

Program Articulation Matrix for the Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2		2	2

1 – Slight (Low); 2 – Moderate (Medium); 3 – Substantial (High); '-' : No correlation