SEMESTER - III							
S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PCS23301	VLSI for Wireless Communication	3	0	0	3
2	PC	PCS231**	Professional Elective IV	3	0	0	3
3	PC	PCS231**	Professional Elective V	3	0	0	3
4	OE	********	Open Elective I	3	0	0	3
Practical							
1	PC	PCS23302	Project Work (Phase I)	0	0	12	6
			TOTAL	**12**	**0**	**12**	**18**

SEMESTER - IV							
S.No	Category	Course Code	Course Title	L	T	P	C
Practical							
1	PC	PCS23401	Project Work (Phase II)	0	0	24	12
			TOTAL	**0**	**0**	**24**	**12**

LIST OF PROGRAMME ELECTIVES

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	PCS23151	Multimedia Compression Techniques	3	0	0	3
2	PE	PCS23152	Electromagnetic Interference and Compatibility in system design	3	0	0	3
3	PE	PCS23153	Advanced Digital Image Processing	3	0	0	3
4	PE	PCS23154	MEMS and NEMS	3	0	0	3
5	PE	PCS23155	Broadband Wireless Technology	3	0	0	3
6	PE	PCS23156	Millimeter Wave Communication	3	0	0	3
7	PE	PCS23157	Pattern Recognition and Computational Intelligence	3	0	0	3
8	PE	PCS23158	Communication Protocols for IoT	3	0	0	3
9	PE	PCS23159	Satellite Communication and Navigation Systems	3	0	0	3
10	PE	PCS23160	Optimization Techniques	3	0	0	3
11	PE	PCS23161	Digital Communication Receivers	3	0	0	3
12	PE	PCS23162	Soft Computing and Machine Learning	3	0	0	3
13	PE	PCS23163	Cognitive Radio Networks	3	0	0	3
14	PE	PCS23164	High Performance Communication Networks	3	0	0	3
15	PE	PCS23165	Advanced Antenna Design	3	0	0	3
16	PE	PCS23166	Ultra Wide Band Communications	3	0	0	3
17	PE	PCS23167	Real Time Embedded Systems	3	0	0	3
18	PE	PCS23168	Wavelets and Sub-band Coding	3	0	0	3
19	PE	PCS23169	Speech Processing	3	0	0	3
20	PE	PCS23170	Telecommunication System Modeling and Simulation	3	0	0	3

OPEN ELECTIVE

S.No	Category	Course Code	Course Title	L	T	P	C
1	OE	PED23901	Industrial Safety	3	0	0	3
2	OE	PSE23901	Climate change and Adaptation	3	0	0	3
3	OE	PPS23901	Alternate Energy Sources	3	0	0	3
4	OE	PCS23901	Design of Digital Elements	3	0	0	3
5	OE	PCE23901	Big Data Analytics	3	0	0	3

PCS23301	VLSI FOR WIRELESS COMMUNICATION	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the concepts of basic wireless communication concepts.
2.	study the parameters in receiver and low noise amplifier design.
3.	study the various types of mixers designed for wireless communication.
4.	study and design PLL and VCO.
5.	understand the concepts of transmitters and power amplifiers in wireless communication.

UNIT I	COMMUNICATION CONCEPTS	9
Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.		
UNIT II	**RECEIVER ARCHITECTURE AND LOW NOISE AMPLIFIERS**	**9**
Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.		
UNIT III	**MIXERS**	**9**
Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.		
UNIT IV	**FREQUENCY SYNTHESIZERS**	**9**
PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.		
UNIT V	**TRANSMITTER ARCHITECTURES AND POWER AMPLIFIERS**	**9**
Transmitter back end design – Quadrature LO generator – Power amplifier design.		
	TOTAL PERIODS	**45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	analyse basic wireless communication concepts.	Analyzing (K4)
CO2	understand the parameters in receiver and design a low noise amplifier.	Understanding (K2)
CO3	apply his knowledge on various types of mixers designed for wireless communication.	Applying (K3)

CO4	design PLL and VCO.	Applying (K3)
CO5	apply the concepts of transmitters and utilize the power amplifiers in wireless communication.	Applying (K3)

REFERENCES

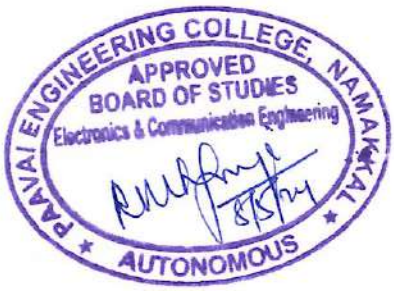
1. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.
2. B.Razavi ,"RF Microelectronics" , Prentice-Hall ,1998.
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 1999.
4. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design – Circuits & Systems", Kluwer Academic Publishers, 2000

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	2	2
CO2	2	1	2	1	2	2
CO3	2	1	2	1	2	2
CO4	2	1	2	1	2	2
CO5	2	1	2	1	2	2



PCS23302	PROJECT WORK (PHASE I)	0	0	12	6

COURSE OBJECTIVES

To enable the students to

1.	improve the skills in literature survey and to extract the relevant information by vast reading.
2.	obtain necessary exposure on the latest developments in the relevant field and to use the current field of work in the research work.
3.	develop the abilities for identifying and defining correct problem formulation in their chosen field.
4.	enhance the presentation and documentation skills in order to disseminate solution to the real world challenging problems.

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

The project should have the following

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

The student should complete the following for Phase I

- ✓ Literature survey and Problem Formulation
- ✓ Motivation for study and Objectives
- ✓ Preliminary design approaches
- ✓ Implementation and Verification
- ✓ Report and presentation
- ✓ Presenting the work in Reputed journals and International Conferences

TOTAL PERIODS	180

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	identify, analyze, interpret and formulate the problem and conceptualize the methodology of the project in research areas.	Applying (K3)
CO2	create a suitable method from different methodologies and forms of analysis to produce research design.	Applying (K3)
CO3	demonstrate the developed /implemented system in the form of hardware and/or software and complement to the society.	Applying (K3)
CO4	present the technical findings in written report/ product and be able to present the ideas in reputed journals and/or International Conferences.	Applying (K3)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2

PCS23401	PROJECT WORK (PHASE II)	0	0	24	12

COURSE OBJECTIVES	
To enable the students to	
1.	improve the skills in literature survey and to extract the relevant information by vast reading.
2.	obtain necessary exposure on the latest developments in the relevant field and to use the current field of work in the research work.
3.	develop the abilities for identifying and defining correct problem formulation in their chosen field.
4.	enhance the presentation and documentation skills in order to disseminate solution to the real world challenging problems.

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

The project should have the following

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

The student should complete the following for Phase II

- ✓ Literature survey and Problem Formulation
- ✓ Motivation for study and Objectives
- ✓ Preliminary design approaches
- ✓ Implementation and Verification
- ✓ Report and presentation
- ✓ Presenting the work in Reputed journals and International Conferences

TOTAL PERIODS	360

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	identify, analyze, interpret and formulate the problem and conceptualize the methodology of the project in research areas.	Applying (K3)
CO2	create a suitable method from different methodologies and forms of analysis to produce research design.	Applying (K3)
CO3	demonstrate the developed /implemented system in the form of hardware and/or software and complement to the society.	Applying (K3)
CO4	present the technical findings in written report/ product and be able to present the ideas in reputed journals and/or International Conferences.	Applying (K3)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2

PCS23151	MULTIMEDIA COMPRESSION TECHNIQUES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the concepts of multimedia techniques.
2.	get familiarized with text compression concepts.
3.	get acquainted with various compression techniques for audio sources.
4.	learn the basics of image compression
5.	know about video compression concepts.

UNIT I	MULTIMEDIA CONCEPTS	9

Special features of Multimedia; Graphics and Image Data Representations ; Fundamental Concepts in Video and Digital Audio; Storage requirements for multimedia applications; Need for Compression - Taxonomy of compression techniques ; Overview of source coding; source models; scalar and vector quantization theory; Evaluation techniques ; Error analysis and methodologies.

UNIT II	TEXT COMPRESSION	9

Compression principles - source encoders and destination encoders; Lossless and Lossy compression; Entropy encoding ; Source encoding, Text compression - Static Huffman Coding, Dynamic Huffman Coding ; Arithmetic coding; Lempel-Ziv (LZ)coding ; Lempel Ziv-Welsh Compression; Shannon Fano coding.

UNIT III	AUDIO COMPRESSION	9

Audio compression methods – ADPCM coding ; Linear predictive coding, Code excited LPC, Audio compression techniques - μ-Law and A-Law Companding, Frequency domain and filtering, Basic sub-band coding, Application to speech coding, Application to audio coding, MPEG audio, Speech compression techniques – LPC and CELP.

UNIT IV	IMAGE COMPRESSION	9

Predictive coding - Lossless predictive coding; Optimum predictors; JPEG lossless compression standard; Lossy predictive coding; DPCM coding ; Transform Coding, Sub-band coding algorithms, Wavelet based compression, EZW, SPIHT coders, JPEG 2000 standards, JBIG, JBIG2 standards.

UNIT V	VIDEO COMPRESSION	9

Video compression techniques and standards - MPEG Video Coding I; MPEG 1 and 2; MPEG Video Coding II; MPEG 4 and 7, Motion estimation and compensation techniques, H.261 Standard, DVI technology, DVI real time compression, Current Trends in compression standards.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	analyze the various multimedia techniques	Analyzing (K4)
CO2	ellaborate various text compression techniques.	Understanding (K2)
CO3	evaluate the performances of various algorithms employed for audio compression.	Analyzing (K4)
CO4	interpret various techniques involved in image compression.	Applying (K3)
CO5	analyze the different standards applicable for video compression.	Analyzing (K4)

REFERENCES

1. Fred Halshall "Multimedia Communication - Applications, Networks, Protocols and Standards", Pearson Education, 2007
2. Tay Vaughan, "Multimedia: Making It Work" McGraw-Hill Professional, 2006.
3. Peter Symes,"Digital Video Compression", McGraw Hill, FirstEdition,2003.
4. KR. Rao,Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems: Techniques, Standards, and Networks", Pearson Education 2007

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	1	1
CO2	2	-	-	-	1	1
CO3	2	-	-	-	1	1
CO4	2	-	-	-	1	1
CO5	2	-	-	-	1	1

PCS23152	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	identify the various types and mechanisms of electromagnetic interference
2.	find solution to EMI problems in PCB level / subsystem and system level design
3.	realize the different types of shielding, grounding methods and material used for the same
4.	be familiar with EMC design circuits.
5.	understand the different types of EMI/EMC measurement techniques and measuring equipments

UNIT I	EMI/EMC CONCEPTS	9
EMI-EMC definitions; Sources and Victims of EMI; Conducted and Radiated EMI Emission and Susceptibility; Units of Parameters; Sources of EMI; Case Histories, Radiation Hazards to humans.		

UNIT II	EMI COUPLING MECHANISMS	9
Classification of Coupling Mechanisms - Conductive coupling, Capacitive coupling, Inductive coupling and Radiated coupling; Conductive coupling - Common mode Conductive coupling, Differential-mode conduction; Near field cable to cable coupling; Field to cable coupling; Power mains and Power supply coupling.		

UNIT III	EMI CONTROL METHODS AND FIXES	9
Shielding; Grounding; Bonding ; EMI Filtering; EMI gasket; Isolation transformer; Transient suppressors; EMI Suppression Cables; Test beds for ESD and EFT.		

UNIT IV	EMC DESIGN FOR CIRCUITS AND PCB	9
Noise from Relays and Switches; Nonlinearities in Circuits; Cross talk in transmission line and cross talk control; Component selection and mounting; PCB design - PCB Trace Impedance Calculations, Controlled Routing; power Distribution decoupling; Zoning and grounding; precautions for PCB EMC design.		

UNIT V	EMI MEASUREMENTS	9
Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Line impedance stabilization networks; EMI Rx, Spectrum analyzer; Civilian standards -FCC, CISPR, IEC, EN; Military standards -MIL STD 461D/462.		

TOTAL PERIODS	45

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	diagnose and solve basic electromagnetic compatibility problems.	Applying (K3)

CO2	design coupling systems in EMIC.	Applying (K3)
CO3	evaluate the various EMI control methods	Analyzing (K4)
CO4	implement EMC circuit design for various applications.	Applying (K3)
CO5	explain the measurement concepts of EMIC.	Understanding (K2)

REFERENCES

1. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, New York, 2001.
2. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, New York, 2009
3. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002.
4. C.R.Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, Inc, 2006

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23153	ADVANCED DIGITAL IMAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the concepts of digital image processing
2.	understand the various models used in image processing.
3.	be familiar with the concepts of morphological image processing.
4.	possess knowledge on segmentation and its representation.
5.	learn about object recognition and its applications.

UNIT I	FUNDAMENTALS OF DIGITAL IMAGE PROCESSING	9
Elements of Visual Perception-Image acquisition; digitization; Histogram; Image enhancement, Spatial filters for smoothing and sharpening, Discrete2D transforms-DFT; DCT; Walsh- Hadamard, Slant, KL, Wavelet Transform, Haar wavelet.		
UNIT II	**COLOUR IMAGE PROCESSSING**	**9**
Colour Image Fundamentals, Colour Models - RGB;CMY;CMYK and HIS Colour Models, Pseudo Colour Image Processing, Intensity Slicing, Intensity to Colour transformations, Basics of Colour Image Processing, Colour Transformation, Colour Image Smoothing and Sharpening, Colour Segmentation -Noise in Colour Images.		
UNIT III	**MORPHOLOGICAL IMAGE PROCESSING**	**9**
Basic Concepts from Set Theory, Logic Operations Involving Binary Images, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Basic Morphological Algorithms, Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Gray-Scale Morphology		
UNIT IV	**SEGMENTATION, REPRESENTATION AND DESCRIPTION**	**9**
Edge Detection, Edge Linking and Boundary Detection, Thresholding, Segmentation by Morphological Watershed Segmentation Algorithm, Use of Markers, Representation and Boundary.		
UNIT V	**OBJECT RECOGNITION AND IMAGE PROCESSING APPLICATIONS**	**9**
Patterns and Pattern Classes ,Recognition Based on Decision, Theoretic Methods , Matching , Optimum Statistical Classifiers, Neural Networks, Fuzzy Systems , Image compression-, JPEG, JPEG2000, JBIG standards, Watermarking– Steganography		
	TOTAL PERIODS	**45**

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	demonstrate knowledge of image acquisition, digitization and spatial filters for enhancement	Understanding (K2)

CO2	explain the various models used in image processing.	Understanding (K2)
CO3	apply morphological image processing algorithms.	Applying (K3)
CO4	analyze and extract potential features of interest from the image.	Analyzing (K4)
CO5	implement the image processing for various applications.	Applying (K3)

REFERENCES

1. Rafael C. Gonzalez, "Digital Image Processing", Pearson Education, Inc.,3rdEdition, 2008.
2. Milman Sonka,VaclavHlavac, Roger Boyle, "Image Processing, Analysis and Machine Vision",
3. Khalid Sayood,"DataCompression",Morgan Kaufmann Publishers (Elsevier).,3rd Edition, 2006
4. Rafael C. Gonzalez, Richards E.Woods, Steven Eddins, "Digital Image Processing using MATLAB" ,Pearson Education,Inc.,2004.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23154	MEMS AND NEMS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the concepts of micro and nano electromechanical devices
2.	learn the fabrication process of Microsystems
3.	understand the design concepts of micro sensors and micro actuators
4.	be familiar about micro actuators
5.	acquire knowledge about the concepts of quantum mechanics and nano systems

UNIT I	INTRODUCTION TO MEMS AND NEMS	9
Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.		

UNIT II	MEMS FABRICATION TECHNOLOGIES	9
Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.		

UNIT III	MICRO SENSORS	9
MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester		

UNIT IV	MICRO ACTUATORS	9
Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch.		

UNIT V	NANO DEVICES	9
Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	interpret the basics of micro/nano electromechanical systems.	Understanding (K2)
CO2	elucidate the use of materials in micro fabrication process.	Understanding (K2)
CO3	design the key performance aspects of electromechanical transducers.	Applying (K3)
CO4	demonstrate the actuators and actuation using different forces.	Applying (K3)
CO5	comprehend the theoretical foundations of quantum mechanics and nano systems.	Understanding (K2)

REFERENCES

1. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997.
2. Stephen D. Senturia, "Micro system Design", Kluwer Academic Publishers,2001
3. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata Mcraw Hill, 2002.
4. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	-	-	1	1
CO2	2	-	-	-	1	1
CO3	2	-	-	-	1	1
CO4	2	-	-	-	1	1
CO5	2	-	-	-	1	1

PCS23155	BROADBAND WIRELESS TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know about MIMO channel model capacity
2.	understand concepts of MIMO diversity and spatial multiplexing
3.	learn about Massive MIMO system
4.	inculcate knowledge on millimeter wave communication
5.	be familiar with software defined radio and cognitive radio

UNIT I	INFORMATION THEORETIC ASPECTS OF MIMO	9

Review of SISO fading communication channels, MIMO Channel models, Classical id and extended channels, Frequency selective and correlated channels models, Capacity of MIMOchannels, Erogodic and outage capacity, capacity bounds and influence of channel properties on the capacity.

UNIT II	MIMO DIVERSITY AND SPATIAL MULTIPLEXING	9

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge; Alamouti space time code; MIMO spatial multiplexing - Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers, Diversity multiplexing trade - off.

UNIT III	MASSIVE MIMO SYSTEM	9

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

UNIT IV	MILLIMETER WAVE COMMUNICATION	9

Spectrum regulation, Channel propagation, Hardware technology for MMW systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

UNIT V	SOFTWARE DEFINED RADIO AND COGNITIVE RADIO	9

SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self- controlling system, Ontology based cognitive radio.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	analyse MIMO system and its capacity.	Analyzing (K4)
CO2	elucidate the concepts of spatial multiplexing.	Understanding (K2)

CO3	design massive MIMO systems.	Applying (K3)
CO4	implement the concepts of millimeter wave communication.	Applying (K3)
CO5	explain about software defined and cognitive radios	Understanding (K2)

REFERENCES

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2005.
2. Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press, 2005.
3. Mischa Dohler, Jose F. Monserrat Afif Osseiran "5G Mobile and Wireless Communication Technology", Cambridge University.
4. Mieczyslaw M Kokar, Lezek Lechowicz, "Cognitive Radio Interoperability through Waveform Reconfiguration" ARTECH House 2016.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23156	MILLIMETER WAVE COMMUNICATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	learn the fundamentals of millimeter wave devices and circuits.
2.	know about the millimeter devices and circuits
3.	understand the various components of millimeter wave communication systems.
4.	acquire knowledge about mm wave MIMO systems.
5.	explore about the antenna design at millimeter wave frequencies.

UNIT I	MILLIMETER WAVES	9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges; Radio wave propagation for mm wave; Large scale propagation channel effects; small scale channel effects; Outdoor and Indoor channel models; Emerging applications of millimeter wave communications

UNIT II	mm WAVE DEVICES AND CIRCUITS	9

S-Parameters, Z-Parameters, Y-Parameters, and ABCD-Parameters; Simulation, Layout, and CMOS Production of mmWave Circuits; Advanced Models for mmWave Transistors - BSIM Model, EKV Model Transistor Configurations; Analog mmWave Components ; Consumption Factor Theory

UNIT III	mm WAVE COMMUNICATION SYSTEMS	9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM; Millimeter wave link budget; Transceiver architecture; Transceiver without mixer; Receiver without Oscillator; Millimeter wave calibration; production and manufacture; Millimeter wave design considerations

UNIT IV	mm WAVE MIMO SYSTEMS	9

Massive MIMO Communications; Spatial diversity of Antenna Arrays - Multiple Antennas, MultipleTransceivers; Noise coupling in MIMO system; Potential benefits for mm wave systems ; Spatial, Temporal and Frequency diversity; Dynamic spatial, frequency and modulation allocation.

UNIT V	ANTENNAS FOR mm WAVE SYSTEMS	9

Antenna Topologies for mm Wave Communications - Antenna polarization; Beam Adaptation Protocols - 802.15.3c, IEEE 802.11ad, Backhaul, Channel Estimation Relaying for Coverage Extension; Characterization of On-Chip Antenna Performance; Device to Device communications over 5G systems; Design techniques of 5G mobile.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	comprehend various millimeter waves.	Understanding (K2)
CO2	explain the millimeter wave devices and circuits	Understanding (K2)

CO3	analyse the millimeter wave communication systems	Analyzing (K4)
CO4	identify the millimeter wave MIMO systems	Understanding (K2)
CO5	design antennas using millimeter wave technology.	Applying (K3)

REFERENCES

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
3. HemaniKaushal, V.K. Jain, SubratKar, "Free Space Optical Communication", Springer India, New Delhi, 2017.
4. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23157	PATTERN RECOGNITION AND COMPUTATIONAL INTELLIGENCE	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the fundamentals of pattern classifier.
2.	know about the various clustering concepts.
3.	understand the structural pattern recognition and feature extraction.
4.	acquire knowledge about concept learning and decision trees.
5.	be familiar with recent advances in pattern recognition techniques.

UNIT I	PATTERN CLASSIFIER	9

Overview of Pattern recognition ; Discriminant functions ;Supervised learning ; Decision Theory - Maximum Likelihood Estimation ; Bayesian inference for the Gaussian ; Problems with Bayes approach ; Pattern classification by distance functions ; Minimum distance pattern classifier.

UNIT II	CLUSTERING	9

Clustering for unsupervised learning and classification Image segmentation and compression ; An Alternative View of EM ; Hierarchical clustering procedures ; Bayesian Networks ; Markov Random Field; Inference in Graphical Models.

UNIT III	FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION	9

KL Transforms - Feature selection through functional approximation; Binary selection; Elements of formal grammars; Syntactic description; Stochastic grammars; Structural representation.

UNIT IV	CONCEPT LEARNING AND DECISION TREES	9

Learning Problems - Designing Learning systems, Perspectives and Issues, Concept Learning; Version Spaces, Candidate Elimination Algorithm; Inductive bias; Decision Tree learning - Representation , Algorithm , Heuristic Space Search.

UNIT V	RECENT ADVANCES IN PATTERN RECOGNITION	9

Neural network structures for pattern recognition; Neural network based pattern associators; Unsupervised learning in neural pattern recognition; Self organizing networks; Fuzzy logic - Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms.

TOTAL PERIODS	45

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	identify the patterns waves.	Understanding (K2)
CO2	explain about clustering and its validity.	Understanding (K2)

CO3	analyze the given data set to extract and select features for pattern recognition.	Analyzing (K4)
CO4	apply the decision tree and concept learning techniques.	Applying (K3)
CO5	use the concepts of recent advances in various applications.	Applying (K3)

REFERENCES

1. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Morton Nadier and Eric Smith P., "Pattern Recognition Engineering", John Wiley & Sons, New York, 1993.
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education, 2013.
4. Tou and Gonzalez, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23158	COMMUNICATION PROTOCOLS FOR IOT	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the IoT data link protocol.
2.	learn about the different concepts of network layer link protocol.
3.	understand the theory of session layer protocols.
4.	build the IoT solutions for various services.
5.	acquire knowledge about IoT in hardware and software.

UNIT I	IoT DATA LINK PROTOCOL	9
IEEE 802.15.4; IEEE 802,11;Wireless HART; Z-Wave; Bluetooth Low Energy; Zigbee Smart Energy; Long Term Evaluation A; LORAWAN.		

UNIT II	NETWORK LAYER LINK PROTOCOL	9
Routing Protocol for Low power Lossy Networks; CORPL; 6LoWPAN; Dynamic Host Configuration Protocol; IPV6.		

UNIT III	SESSION LAYER PROTOCOLS	9
Message Queuing Telemetry Transport; Advanced Message Queuing Protocol; Constrained Application Protocol Extensible Messaging and Presence Protocol; Security in IoT Protocols - MAC 802.15.4, 6LoWPAN , Application Layer		

UNIT IV	BUILDING IoT SOLUTIONS	9
Raspberry PI - Setting up web services; Publishing to web services; Case Studies - Smart Grid, Industrial Automation and Building automation, Connected Car, Connected Home, Digital Health, Smart City.		

UNIT V	IoT APPLICATIONS	9
Hardware for the IoT ; Classes of Constrained Devices; Hardware Platforms; TelosB; Zolertia Z1, Open Mote, Arduino; Intel Galileo; Raspberry Pi ; Software for the IoT - Open WSN , Tiny OS , Free RTOS, RIOT, Contiki OS		

TOTAL PERIODS	45

COURSE OUTCOMES	At the end of this course, the students will be able to	BT MAPPED (Highest Level)
CO1	summarize the protocols in IoT Data Link Layer.	Understanding (K2)
CO2	analyze the protocols used in network Layer.	Analyzing (K4)
CO3	illustrate session layer protocols and security in IoT protocols.	Understanding (K2)
CO4	implement IoT applications using the communication protocols.	Applying (K3)
CO5	design the concepts of IoT using hardware and software.	Applying (K3)

REFERENCES

1. Tsiatsis, Vlasios, Stamatis Karnouskos, Jan Holler, David Boyle, and Catherine Mulligan "Internet of Things: Technologies and applications for a new age of intelligence", Academic Press, 2019.
2. Lea, Perry," Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Packt Publishing Ltd, 2018.
3. Minoli, Daniel, " Building the internet of things with IPv6 and MIPv6: The evolving world of M2M communications", John Wiley and Sons, 2013
4. Peter Waher "Learning Internet of Things" Packt Publishing, 2015.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23159	SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the overview of the satellite communication.
2.	understand M2M developments and satellite applications.
3.	acquire knowledge about satellite communication in IPv6 environment.
4.	know the concepts of satellite navigation and global positioning system.
5.	understand deep space networks

UNIT I	OVERVIEW OF SATELLITE COMMUNICATION	9

Overview of satellite communication and orbital mechanics; Link budget Parameters; Link budget calculations; Auxiliary Equations; Performance Calculations.

UNIT II	M2M DEVELOPMENTS AND SATELLITE APPLICATIONS	9

Overview of the Internet of Things and M2M - M2M Applications, Examples and Satellite Support, Satellite Roles Context and Applications, Antennas for Satellite M2M Applications, M2M Market Opportunities for Satellite Operators; Ultra HD Video/TV and Satellite Implications; High Throughput Satellites and Ka/Ku Spot Beam Technologies; Aeronautical, Maritime, Mobility Services.

UNIT III	SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT	9

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence-- Implementation scenarios and support- Preparations for IPv6 in Satellite communication; Satellite specific Protocol issues in IPv6; Impact of IPv6 on Satellite Network architecture and services- Detailed transitional plan- IPv6 demonstration over satellites - Key results and recommendations.

UNIT IV	SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM	9

Overview of Radio and Satellite Navigation; GPS Principles; Signal model and Codes; Satellite Signal Acquisition; Mathematical model of GPS observables; Methods of processing GPS data; GPS Receiver Operation and Differential GPS; IRNSS, GAGAN, GLONASS.

UNIT V	DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS	9

Introduction, Functional description, Design procedure; performance criterion; Mars exploration; Rover Mission; Spacecraft summary; Telecommunication subsystem overview- Ground Subsystem; Telecom subsystem; Link performance Telecom subsystem Hardware and software; Chandrayaan-1 Mission - Mission, spacecraft summary; Telecommunication subsystem overview-Ground Subsystem - Telecom subsystem and Link performance; Mangalyaan Mission - Mission and spacecraft summary.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	elaborate concepts of satellite communication.	Understanding (K2)
CO2	design antenna for various applications.	Applying (K3)
CO3	analyse the IPv6 environment.	Analyzing (K4)
CO4	explain about satellite navigation and GPS.	Understanding (K2)
CO5	analyse the different case studies of satellite mission.	Analyzing (K4)

REFERENCES

1. Adimurthy.V," Concept design and planning of India's first interplanetary mission", Current Science, VoL. 109, No. 6, 1054 25, 2015.
2. Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
3. Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2015
4. Daniel Minoli, "Satellite Systems Engineering in an IPv6 Environment", CRC Press, First Edition, 2009.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23160	OPTIMIZATION TECHNIQUES	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	explain the theory of classical optimization techniques.
2.	learn about linear programing.
3.	understand the concepts in non-linear programing.
4.	acquire knowledge about dynamic programing process.
5.	be familiar with modern optimization methods.

UNIT I	CLASSICAL OPTIMIZATION TECHNIQUES	9

Single variable optimization; multivariable optimization with no constraints; multivariable optimization with equality constraints; multivariable optimization with inequality constraints; convex programming problem

UNIT II	LINEAR PROGRAMMING	9

Simplex method - Definitions and Theorems , Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations, Two Phases of the Simplex Method; Duality; Sensitivity , Post optimality Analysis; Karmarkar's Interior Method.

UNIT III	NON-LINEAR PROGRAMMING	9

Elimination methods; Interpolation methods; Unconstrained optimization techniques - Direct search methods- Indirect search methods; Constrained Optimization methods - Direct methods, Indirect methods.

UNIT IV	DYNAMIC PROGRAMMING	9

Multistage decision process; Concept of sub optimization and principle of optimality; computational procedure in dynamic programming; Linear Programming as a Case of Dynamic Programming; Continuous Dynamic Programming.

UNIT V	MODERN OPTIMIZATION METHODS	9

Genetic Algorithms; Simulated annealing; Particle Swarm optimization; Ant colony optimization; Practical Aspects of Optimization; Reduction of Size of an Optimization Problem, Fast Reanalysis Techniques, Derivatives of Eigenvalues and Eigenvectors.

TOTAL PERIODS	45

COURSE OUTCOMES	At the end of this course, the students will be able to	BT MAPPED (Highest Level)
CO1	elucidate classical optimization techniques.	Understanding (K2)
CO2	analyse linear programming.	Analyzing (K4)
CO3	explain nonlinear programming.	Understanding (K2)

CO4	apply the concepts of dynamic programming.	Applying (K3)
CO5	execute modern optimization methodologies.	Applying (K3)

REFERENCES

1. Singiresu S Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley and Sons, 2009
2. Xin-Sie Yang, "Nature Inspired Optimization Techniques", Elsevier, 2014.
3. Edwin K P Chong and Stanislaw S Zak, "An Introduction to Optimization", 4th Edition, John Wiley and Sons, 2013
4. Chander Mohan, Kusum Deep," Optimization Techniques" New Age Science, 2009

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23161	DIGITAL COMMUNICATION RECEIVERS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the baseband communication concepts.
2.	know about the pass band communication over time invariant channels.
3.	acquire knowledge about the synchronization algorithms.
4.	learn about the performance of synchronizers with feedback systems.
5.	explore about the characterization of selective fading channels.

UNIT I	BASEBAND COMMUNICATION	9

Introduction of Digital baseband communication-Baseband PAM; Clock Synchronizers; Clock recovery circuits; Error tracking and spectral - line generating synchronizers; Squaring and Mueller and Muller synchronizers.

UNIT II	PASSBAND COMMUNICATION OVER TIME INVARIANT CHANNELS	9

Passband Transmission-Transmission methods, Channel Transceiver model; Channel models; Receivers for PAM-Timing Recovery, Phase Recovery; Optimum ML receivers; Synchronized detection; Digital matched filter.

UNIT III	SYNTHESIS OF SYNCHRONIZATION ALGORITHMS	9

ML synchronization algorithms - NDA Timing Parameter Estimation -DD and NDA; Timing Error Feedback Systems - Phasor-Locked Loop; NDA Carrier Phasor Estimation.

UNIT IV	PERFORMANCE ANALYSIS OF SYNCHRONIZERS	9

Performance analysis of carrier and symbol synchronizers; Decision-Directed Symbol Synchronization, Tracking Performance Comparison; Feedback and feed forward synchronizers; Cycle slipping Acquisition of carrier phase and symbol timing.

UNIT V	PARAMETER SYNCHRONIZATION FOR SELECTIVE FADING CHANNELS	9

Fading channels; Statistical characterization; Flat and frequency selective fading channels; Optimal receivers for data detection and synchronization parameter estimation; Realizable receiver structures for synchronized detection.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	elucidate the generation and detection of digital baseband system.	Understanding (K2)
CO2	evaluate and determine the performance of pass band communication.	Analyzing (K4)

CO3	use the synchronization algorithms for various applications.	Applying (K3)
CO4	analyze the generation and detection of symbol synchronizers.	Analyzing (K4)
CO5	design the parameters of flat and frequency selective fading channels.	Applying (K3)

REFERENCES

1. H.Meyer , M. Moeneclaey, and S. A. Fechtel, "Digital Communication Receivers", Wiley, 1998.
2. U.Mengali, A.N.D.Andrea, "Synchronization Techniques for Digital Receivers", Kluwer, 1997.
3. H.Meyer, G.Ascheid, "Synchronization in Digital Communications", John Wiley, 1990.
4. N.Benuveruto, G.Cherubini, "Algorithms for Communication Systems and its Applications", Wiley, 2002.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	1	1	1
CO2	2	-	1	1	1	1
CO3	2	-	1	1	1	1
CO4	2	-	1	1	1	1
CO5	2	-	1	1	1	1

PCS23162	SOFT COMPUTING AND MACHINE LEARNING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the basics of artificial neural network.
2.	learn the concepts of modelling and control of neural and fuzzy control schemes.
3.	know about fuzzy set theory.
4.	be familiar with concepts of machine learning.
5.	acquire knowledge about linear methods for classification.

UNIT I	ARTIFICIAL NEURAL NETWORK	9

Review of fundamentals - Biological neuron, artificial neuron, activation function, and single layer perceptron Limitation; Multi-layer perceptron - Back Propagation Algorithm; Recurrent Neural Network; Adaptive Resonance Theory based network; Radial basis function network ; Online learning algorithms; BP through time; RTRL algorithms; Reinforcement learning.

UNIT II	NEURAL NETWORKS FOR MODELING AND CONTROL	9

Modelling of non-linear systems using ANN - Generation of training data; Optimal architecture; Model validation; Control of non-linear systems using ANN; Direct and indirect neuro control schemes; Adaptive Neuro controller; Familiarization with neural network toolbox.

UNIT III	FUZZY SET THEORY	9

Modelling of non-linear systems using fuzzy models; TSK model; Fuzzy logic controller; Fuzzification Knowledge base; Decision making logic; Defuzzification ; Adaptive fuzzy systems ; Familiarization with fuzzy logic toolbox.

UNIT IV	INTRODUCTION TO MACHINE LEARNING	9

Introduction to Machine Learning; Supervised Learning - Support Vector Machines - Kernel Methods - Instance based Methods - K-Nearest Neighbours ; Unsupervised Learning - Clustering Algorithms -K - Means Hierarchical Clustering, Cluster Validity; Reinforcement Learning - Elements, Model based Learning Temporal Difference Learning

UNIT V	LINEAR METHODS FOR CLASSIFICATION	9

Linear Regression of an Indicator Matrix; Linear Discriminant Analysis; Logistic Regression; Separating- Hyper planes; Wavelet Smoothing.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the basics of artificial neural network.	Understanding (K2)
CO2	analyse the different features of fuzzy logic and their modelling.	Analyzing (K4)

CO3	elaborate the modelling and control of neural networks.	Understanding (K2)
CO4	outline the concepts of machine learning.	Understanding (K2)
CO5	classify the different methods for linear models.	Analyzing (K4)

REFERENCES

1. Neural Networks and Learning Machines, 3rd edition, Simon Haykin, PHI Learning, 2011.
2. C. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill Inc., 2021.
3. T. Hastie, R. Tibshirani, J. Friedman. "The Elements of Statistical Learning", 2nd edition, 2017.
4. Christopher Bishop, "Pattern Recognition and Machine Learning", 2016.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	1	1
CO2	2	-	-	-	1	1
CO3	2	-	-	-	1	1
CO4	2	-	-	-	1	1
CO5	2	-	-	-	1	1

PCS23163	COGNITIVE RADIO NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamental concepts of cognitive radio networks.
2.	develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3.	understand the functions of MAC layer and Network layer and its various protocols.
4.	understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading.
5.	interpret the basics of security management and the various attacks & its countermeasures.

UNIT I	INTRODUCTION TO COGNITIVE RADIO	9

Cognitive Radio : Techniques and signal processing History and background, Communication policy and Spectrum Management, Cognitive radio cycle, Cognitive radio architecture, SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection, cyclo stationary and wavelet based sensing- problem formulation and performance analysis based on probability of detection Vs SNR. Cooperative sensing: different fusion rules, wideband spectrum

UNIT II	SPECTRUM SENSING AND TRADING	9

Introduction –Spectrum Sensing – Multiband Spectrum Sensing – Sensing Techniques – Other algorithms – Comparison – Performance Measure & Design Trade-Offs : Receiver operating characteristics – Throughput Performance measure –Fundamental limits and trade-off. Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential)

UNIT III	MAC PROTOCOLS AND NETWORK LAYER DESIGN	9

Functionality of MAC protocol in spectrum access –classification –Interframe spacing and MAC challenges – QOS – Spectrum sharing in CRAHN –CRAHN models – CSMA/CA based MAC protocols for CRAHN – Routing in CRN– Centralized and Distributed protocols – Geographical Protocol

UNIT IV	DYNAMIC SPECTRUM ACCESS AND MANAGEMENT	9

Spectrum broker, Dynamic spectrum access architecture- centralized dynamic spectrum access, distributed dynamic spectrum access, Inter- and intra-RAN dynamic spectrum allocation, Spectrum management, Spectrum sharing, Spectrum mobility issues

UNIT V	TRUSTED COGNITIVE RADIO NETWORKS AND RESEARCH CHALLENGES	9

Trust for CRN : Fundamentals – Models – Effects of Trust Management –Security properties in CRN

– Route Disruption attacks –Jamming attacks –PU Emulation attacks. Network layer and transport layer issues, cross layer design for cognitive radio networks.		
	TOTAL PERIODS	**45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	analyze the fundamental concepts of cognitive radio networks.	Analyzing (K4)
CO2	interpret the basics of various spectrum sensing techniques and algorithms.	Understanding (K2)
CO3	evaluate the functions of MAC layer and Network layer and its various protocols.	Analyzing (K4)
CO4	apply the concepts of cooperative spectrum sensing and handoff process.	Applying (K3)
CO5	understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.	Understanding (K2)

REFERENCES

1. Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Hüseyin Arslan, Springer, ISBN 978-1-4020-5541-6 (HB), 2007.
2. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.
3. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
4. Cognitive Radio Technology", by Bruce A. Fette, Elsevier, ISBN 10: 0-7506-7952-2, 2006.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	1	1	1	1	1	1
CO3	1	1	1	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1

PCS23164	HIGH PERFORMANCE COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the high speed computer network architectures.
2.	understand the concepts of multimedia networking.
3.	study the recent network concepts with reference to MPLS and VPN.
4.	study about the mathematical models related to network performance analysis.
5.	comprehend the current network management concept.

UNIT I	SWITCHING NETWORKS	9
Switching – Packet switching - Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched – SONET, DWDM, DSL, Intelligent Networks – CATV, ATM – Features, Addressing Signaling & Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.		
UNIT II	**MULTIMEDIA NETWORKING APPLICATIONS**	**9**
Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP differentiated services.		
UNIT III	**ADVANCED NETWORKS CONCEPTS**	**9**
VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networksP2P connections.-IPv4 vs. V6.		
UNIT IV	**PACKET QUEUES AND DELAY ANALYSIS**	**9**
Little's theorem, Birth and Death process, Queueing discipline- Control & stability -, Markovian FIFO Queueing system, Non-Markovian - Pollaczek-Khinchin Formula and M/G/1, M/D/1, self- similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.		
UNIT V	**NETWORK MANAGEMENT & SNMP**	**9**
Network Architecture, SNMP Basics, SNMP Naming and OIDs, MIBs, SNMPv1 Data Types, ASN.1 Syntax and SNMP, SNMP Tables, SNMP Operations, MIB Browsing, MIB-2 , SNMP and ASN.1 Encoding		
	TOTAL PERIODS	**45**

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	elucidate the switching networks	Applying (K3)

CO2	explain the applications of multimedia networks.	Applying (K3)
CO3	compare the various methods of providing connection-oriented services over an advanced network with reference to MPLS, VPN.	Understanding (K2)
CO4	analyze performance of packet queues and its related analysis	Analyzing (K4)
CO5	explore the concepts of network management.	Understanding (K2)

REFERENCES

1. J.F. Kurose & K.W. Ross, "Computer Networking- A Top Down Approach Featuring the Internet", Pearson, 6th Edition, 2012.
2. Nader F.Mir, "Computer and Communication Networks", Pearson Education, 2nd Edition 2015.
3. Peter Dordal , "An Introduction to Computer Networks" , Release 1.9.16, 2018.
4. Walrand .J. Varatya, "High Performance Communication Network", Morgan Kaufmann publishers, 2 nd Edition, 2000

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	1	1
CO2	2	1	1	1	1	1
CO3	2	1	1	1	1	1
CO4	2	1	1	1	1	1
CO5	2	1	1	1	1	1

PCS23165	ADVANCED ANTENNA DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the antenna radiation characteristics and arrays.
2.	enhance the student knowledge in the area of various antenna design.
3.	enhance the student knowledge in the area of antenna for practical applications.
4.	learn the concept of mutual coupling on antennas, applications and numerical techniques.
5.	understand about adaptive array concept.

UNIT I	FUNDAMENTAL CONCEPTS	9

Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

UNIT II	THIN LINEAR ANTENNAS AND ARRAYS	9

Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop, N-Element Linear Array, Antenna element spacing without grating lobes, Linear broadside array with non-uniform distributions, Gain of regularly spaced planar arrays with $d = \lambda/2$, Tchebyscheff Array antennas.

UNIT III	SECONDARY SOURCES AND APERTURE ANTENNAS	9

Magnetic currents, Duality, Images of electric and magnetic currents, electric and magnetic currents as sheet sources, Impressed and induced current sources, Induction and equivalence theorems, Field of a secondary or Huygens source, Radiation from open end of a coaxial line, Radiation through an aperture in conducting screen, slot antenna.

UNIT IV	EFFECT OF MUTUAL COUPLING ON ANTENNAS	9

Accounting for mutual effects for dipole array compensation using open-circuit voltages, compensation using the minimum norm formulation, Effect of mutual coupling- constant Jammers, Constant Signal, Compensation of mutual coupling- constant Jammers, Constant Signal, Result of different elevation angle.

UNIT V	ADAPTIVE ARRAY CONCEPT	9

Motivation of using Adaptive Arrays, Adaptive Array problem statement, Signal Environment, Array Element Spacing considerations, Array Performance, Concept of optimum Array Processing, Recursive Methods for Adaptive Error Processing.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	acquire the knowledge about basic antenna parameters.	Understanding (K2)
CO2	theoretically analyze wire antennas and arrays.	Understanding (K2)
CO3	identify secondary sources, aperture, broadband and frequency independent antennas.	Applying (K3)
CO4	apply the knowledge of mutual coupling on antennas, applications and numerical techniques.	Applying (K3)
CO5	acquire brief knowledge about adaptive array concept.	Understanding (K2)

REFERENCES

1. Balanis, C., Antennas, John Wiley and sons (2007) 3rd
2. Milligan, Thomas A., Modern Antenna Design 2nd edition, IEEE press, Wiley Interscience (2005).
3. David B. Davidson, Computational Electromagnetics for RF and Microwave Engineering, Cambridge University Press 2005.
4. Neelakanta, Perambur S., and Chatterjee, Rajeswari, Antennas for Information Super Skyways: An Exposition on Outdoor and Indoor Wireless Antennas, Research Studies Press Ltd. (2004).

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	2	2
CO2	2	2	1	1	2	2
CO3	2	2	1	1	2	2
CO4	2	2	1	1	2	2
CO5	2	2	1	1	2	2

PCS23166	ULTRA WIDE BAND COMMUNICATIONS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	learn fundamental concepts related to Ultra wide band.
2.	understand the channel model and signal processing for UWB.
3.	acquire knowledge about UWB antennas and regulations.
4.	understand UWB signal processing.
5.	learn UWB antenna applications.

UNIT I	INTRODUCTION TO UWB	9

History, Definition, FCC Mask, UWB features, Benefits and challenges, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services

UNIT II	UWB TECHNOLOGIES AND CHANNEL MODELS	9

Impulse Radio, Pulsed Multiband, Multiband OFDM, features: Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels Channel model: Impulse Response Modeling of UWB Wireless Channels, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling

UNIT III	UWB SIGNAL PROCESSING	9

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit-Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error , Locationing with OFDM

UNIT IV	UWB ANTENNAS	9

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT V	UWB APPLICATIONS AND REGULATIONS	9

Ultra wideband receiver architecture, Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries , UWB Regulation in ITU, IEEE Standardization

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the basic concepts of UWB.	understanding (K2)

CO2	understand the basic concepts of UWB technologies.	understanding (K2)
CO3	assess the performance of UWB channels.	Applying (K3)
CO4	apply the UWB signal processing.	Applying (K3)
CO5	design UWB antenna for various applications.	Applying (K3)

REFERENCES

1. Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications"1st Edition, Springer Science & Business Media B.V. 2010.
2. Thomas Kaiser, Feng Zheng "Ultra Wideband Systems with MIMO", 1st Edition, John Wiley & Sons Ltd, New York, 2010.
3. W. Pam Siriwongpairat and K. J. Ray Liu, "Ultra-Wideband Communications Systems: Multiband OFDM approach" John Wiley and IEEE press, New York 2008.
4. Huseyin Arslan,Zhi Ning Chen,Maria-Gabriella Di Benedetto "Ultra Wideband Wireless communication" Wiley-Interscience; 1st edition 2006.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	2	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	2	2
CO4	2	1	2	2	2	2
CO5	2	1	2	2	2	2

PCS23167	REAL TIME EMBEDDED SYSTEMS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the basics of embedded system and ARM architecture.
2.	understand the RTOS concepts like scheduling and memory management related to the embedded system.
3.	learn about the programming aspects of RTOS.
4.	learn the different protocols of embedded wireless application.
5.	study concepts involved in the design of hardware and software components for an embedded system.

UNIT I	INTRODUCTION	9

Real Time System – Embedded Systems – Architecture of Embedded System – Simple Programming for Embedded System – Process of Embedded System Development – Pervasive Computing – Information Access Devices – Smart Cards – Microcontrollers – ARM Processor -Real Time Microcontrollers.

UNIT II	EMBEDDED/REAL TIME OPERATING SYSTEM	9

Operating System Concepts: Processes, Threads, Interrupts, Events - Real Time Scheduling Algorithms - Memory Management – Overview of Operating Systems for Embedded, Real Time Handheld Devices – Target Image Creation – Programming In Linux, Rtlinux, Vxworks, Microcontroller Operating System Overview.

UNIT III	CONNECTIVITY	9

Wireless Connectivity - Bluetooth – Other Short Range Protocols – Wireless Application Environment – Service Discovery – Middleware.

UNIT IV	REAL TIME UML	9

The Rapid Object-Oriented Process for Embedded Systems (ROPES) Process. MDA and Platform-Independent Models- Scheduling Model-Based Projects- Model Organization Principles- Working with Model-Based Projects - Object Orientation with UML 2.0-Structural Aspects-Object Orientation with UML 2.0-Dynamic Aspects-UML Profile for Schedulability, Performance, and Time. Requirements Analysis – Object Identification Strategies – Object Behaviour – Real Time Design Patterns.

UNIT V	SOFTWARE DEVELOPMENT AND APPLICATION	9

Concurrency – Exceptions – Tools – Debugging Techniques – Optimization –Interfacing Digital Camera With USB Port. Interfacing of Sensors and Actuators for a Real Time Industrial Application.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	make a choice of suitable embedded processor for a given application.	Understanding (K2)
CO2	design the hardware and software for the embedded system.	Applying (K3)
CO3	design and develop the real time kernel/operating system functions, task control block structure and analyze different task states.	Analyzing (K4)
CO4	implement different types of inter task communication and synchronization techniques.	Applying (K3)
CO5	know about the aspects embedded connectivity in real time systems.	Understanding (K2)

REFERENCES

1. R.J.a.Buhr, D.L.Bailey, "An Introduction To Real-Time Systems", Prentice-Hall International,1999.
2. David E-Simon, "An Embedded Software Primer", Pearson Education, 2007.
3. C.M.Krishna, Kang G.Shin, "Real Time Systems", Mc-Graw Hill, 2010.
4. B.P.Douglass, "Real Time Uml - Advances In the UML for Real-Time Systems, 3rd Edition Addison-Wesley, 2004.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	2	2
CO2	2	1	1	1	2	2
CO3	2	1	1	1	2	2
CO4	2	1	1	1	2	2
CO5	2	1	1	1	2	2

PCS23168	WAVELETS AND SUB-BAND CODING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	introduce the fundamentals concepts of wavelet transforms.
2.	learn multiresolution concept and Discrete Wavelet Transform.
3.	study system design using Wavelets.
4.	learn the different wavelet families & their applications.
5.	study signal compression and sub-band coding.

UNIT I	INTRODUCTION TO WAVELETS	9

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II	MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM	9

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks- Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III	WAVELET SYSTEM DESIGN	9

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV	WAVELET FAMILIES	9

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V	SIGNAL COMPRESSION AND SUB-BAND CODING	9

Compression Systems Based on Linear Transforms - Speech and Audio Compression - Image Compression - Video Compression - Joint Source-Channel Coding

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the fundamental concepts of wavelet transforms.	Understanding (K2)
CO2	apprehend detailed knowledge about wavelet transform.	Understanding (K2)

CO3	understand system design using wavelets.	Understanding (K2)
CO4	compare different wavelet families.	Understanding (K2)
CO5	analyze signal compression and sub-band coding.	Analyzing (K4)

REFERENCES

1. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, "Introduction to wavelets and wavelet transform", Prentice Hall, 1998.
2. G.Strang and T.Nguyen, "Wavelet and filter banks", Wesley and Cambridge Press, 1996.
3. Metin Akay, "Time frequency and wavelets in biomedical signal processing", Wiley-IEEE Press, October 1997.
4. M.Vetterli and J. Kovacevic, "Wavelets and sub band coding", Prentice Hall, 1995.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	2	2	2
CO2	2	1	1	2	2	2
CO3	2	1	1	2	2	2
CO4	2	1	1	2	2	2
CO5	2	1	1	2	2	2

PCS23169	SPEECH PROCESSING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	introduce speech production and related parameters of speech.
2.	illustrate the concepts of speech signal representations and coding.
3.	understand different speech modeling procedures such Markov and their implementation issues.
4.	gain knowledge about text analysis.
5.	learn about speech synthesis.

UNIT I	FUNDAMENTALS OF SPEECH PROCESSING	9
Introduction - Spoken Language Structure - Phonetics and Phonology - Syllables and Words - Syntax and Semantics - Probability, Statistics and Information Theory - Probability Theory - Estimation Theory - Significance Testing - Information Theory.		

UNIT II	SPEECH SIGNAL REPRESENTATIONS AND CODING	9
Overview of Digital Signal Processing - Speech Signal Representations - Short time Fourier Analysis - Acoustic Model of Speech Production - Linear Predictive Coding - Cepstral Processing - Formant Frequencies - The Role of Pitch - Speech Coding - LPC Coder, CELP, Vocoders.		

UNIT III	SPEECH RECOGNITION	9
Hidden Markov Models - Definition - Continuous and Discontinuous HMMs - Practical Issues - Limitations. Acoustic Modeling - Variability in the Speech Signal - Extracting Features - Phonetic Modeling - Adaptive Techniques - Confidence Measures - Other Techniques.		

UNIT IV	TEXT ANALYSIS	9
Lexicon - Document Structure Detection - Text Normalization - Linguistic Analysis - Homograph Disambiguation - Morphological Analysis - Letter-to-sound Conversion - Prosody - Generation schematic - Speaking Style - Symbolic Prosody - Duration Assignment - Pitch Generation		

UNIT V	SPEECH SYNTHESIS	9
Attributes - Formant Speech Synthesis - Concatenative Speech Synthesis - Prosodic Modification of Speech - Source-filter Models for Prosody Modification - Evaluation of TTS Systems.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	model speech production system and describe the fundamentals of speech.	Remembering (K1)
CO2	extract and compare different speech parameters.	Understanding (K2)

CO3	choose an appropriate statistical speech model for a given application.	Understanding (K2)
CO4	design a speech recognition system.	Applying (K3)
CO5	use different text analysis and speech synthesis techniques.	Analyzing (K4)

REFERENCES

1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.
3. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2002.
4. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	1	2
CO2	2	1	2	2	1	2
CO3	2	1	2	2	1	2
CO4	2	1	2	2	1	2
CO5	2	1	2	2	1	2

PCS23170	TELECOMMUNICATION SYSTEM MODELING AND SIMULATION	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the various aspects of simulation methodology and performance.
2.	appreciate the significance of selecting sampling frequency and modeling different types of signals and processing them.
3.	learn the Monte Carlo Simulation.
4.	learn different simulation techniques, their pros and cons.
5.	understand and interpret results using case studies.

UNIT I	SIMULATION METHODOLOGY	9
Introduction, Aspects of methodology, Performance Estimation, Simulation sampling frequency, Low pass equivalent simulation models for bandpass signals, Multicarrier signals, Non-linear and time-varying systems, Post processing – Basic graphical techniques and estimations		

UNIT II	RANDOM SIGNAL GENERATION & PROCESSING	9
Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Correlated and Uncorrelated Gaussian random number generation, PN sequence generation, Random signal processing, Testing of random number generators.		

UNIT III	MONTE CARLO SIMULATION	9
Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi - analytic techniques, Case study: Performance estimation of a wireless system		

UNIT IV	ADVANCED MODELS & SIMULATION TECHNIQUES	9
Modeling and simulation of non-linearities : Types, Memoryless non-linearities, Non-linearities with memory, Modeling and simulation of Time varying systems : Random process models, Tapped delay line model, Modeling and simulation of waveform channels, Discrete memoryless channel models, Markov model for discrete channels with memory.		

UNIT V	EFFICIENT SIMULATION TECHNIQUES	9
Tail extrapolation, pdf estimators, Importance Sampling methods, Case study: Simulation of a Cellular Radio System.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the different signal generation and processing methods.	Understanding (K1)
CO2	mathematically model a physical phenomenon.	Applying (K3)

CO3	simulate a phenomena so as to depict the characteristics that may be observed in a real experiment.	Applying (K3)
CO4	apply knowledge of the different simulation techniques for designing a communication system or channel.	Applying (K3)
CO5	validate a simulated system performance so as to match a realistic scenario.	Applying (K3)

REFERENCES

1. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore) Pvt. Ltd, 2004.
2. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, Simulation of Communication Systems: Modeling, Methodology and Techniques, Plenum Press, New York, 2001.
3. Averill.M.Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill Inc., 2000.
4. Geoffrey Gorden, System Simulation, Prentice Hall of India, 2nd Edition, 1992.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	1	1	1	1	1	1
CO5	2	2	2	2	2	2

PCS23901	DESIGN OF DIGITAL ELEMENTS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	provide an understanding of Boolean algebra and logic functions.
2.	design and model the Verilog HDL and data path circuits for digital systems.
3.	develop the knowledge of combinational and sequential logic circuit design.
4.	enable the student to design and model of sequential logic circuit design.
5.	establish a strong understanding of programmable logic and design and model the logic circuits using Verilog HDL.

UNIT I	Boolean Algebra	9

Boolean Algebra: Basic definitions, Axiomatic definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Simplification of Boolean functions. Gate-Level Minimization: The Map Method (K-map up to 4 variable), Product of Sums and Sum of Products Simplification, NAND and NOR Implementation. Logic Families: Digital Logic Gates, TTL and CMOS logic families

UNIT II	Verilog HDL & Design of data path circuits	9

Verilog HDL: Introduction to Verilog HDL, Lexical Conventions, Ports and Modules, Operators, Dataflow Modelling, Gate Level Modelling, Behavioural Modeling, Test Bench. Design of data path circuits: N-bit Parallel Adder/Subtractor, Carry Look Ahead Adder, Unsigned Array Multiplier, Booth Multiplier, 4-Bit Magnitude comparator. Modeling of data path circuits using Verilog HDL.

UNIT III	Design of Combinational Logic Circuits	9

Design Procedure, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Decoders, Encoders, Multiplexers, De-multiplexers, Parity generator and checker, Applications of Decoder, Multiplexer and De-multiplexer. Modeling of Combinational logic circuits using Verilog HDL.

UNIT IV	Design of Sequential Logic Circuits	9

Latches, Flip-Flops - SR, D, JK & T, Buffer Registers, Shift Registers - SISO, SIPO, PISO, PIPO, Design of synchronous sequential circuits: state table and state diagrams, Design of counters: Modulo-n, Johnson, Ring, Up/Down, Asynchronous counter. Modeling of sequential logic circuits using Verilog HDL.

UNIT V	Design of FSM & Programmable Logic Devices	9

Design of FSM: Finite state Machine(FSM):Mealy FSM and Moore FSM , Design Example : Sequence detection, Modeling of FSM using Verilog HDL. Programmable Logic Devices : Types of Programmable Logic Devices: PLA, PAL, CPLD, FPGA Generic Architecture

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	optimize the logic functions using and Boolean principles and K-map.	Understanding (K1)
CO2	design the Verilog VHDL and data path circuits.	Applying (K3)
CO3	model and design the Combinational logic circuits using Verilog HDL.	Applying (K3)
CO4	analyze and apply the design aspects of sequential logic circuits.	Applying (K3)
CO5	explore the design aspects of Finite state machines and examine the basic architectures of programmable logic devices.	Applying (K3)

REFERENCES

1. M. Morris Mano and Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL and System Verilog, 2018,6th Edition, Pearson Pvt. Ltd.
2. Ming-Bo Lin, Digital Systems Design and Practice: Using Verilog HDL and FPGAs,2015, 2nd Edition, Create Space Independent Publishing Platform.
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2009, 2nd edition, Prentice Hall of India Pvt. Ltd.
4. Stephen Brown and ZvonkoVranesic," Fundamentals of Digital Logic with Verilog Design", 2013, 3rd Edition, McGraw-Hill Higher Education.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)

(1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	3	-	-	-
CO4	3	3	2	2	-	-
CO5	3	3	3	2	-	-