KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Electronics and Communication Engineering for the Nation and beyond

MISSION

Department of Electronics and Communication Engineering is committed to:

MS1: To impart industry and research based quality education for developing value based electronics and communication engineers

MS2: To enrich the academic activities by continual improvement in the teaching learning process

MS3: To infuse confidence in the minds of students to develop as entrepreneurs

MS4: To develop expertise for consultancy activities by providing thrust for Industry Institute Interaction

MS5: To endeavour for constant upgradation of technical expertise for producing competent professionals to cater to the needs of the society and to meet the global challenges

2018 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of **M.E –Communication Systems** will

PEO1: Design , analyze and Develop communication systems with strong fundamentals and advanced concepts acquired during the programme

PEO2: Attain successful professional carriers, exhibit leadership to meet challenges in industry and academia with continuous updates of technical and managerial skills.

PEO3: Embark on a lifelong learning to professional development and pursue research for academic and entrepreneurial pursuits.

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	2
MS2	2	3	3
MS3	2	1	3
MS4	3	3	3
MS5	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)

M.E (Communication Systems) Graduates will be able to:

PO1 Independently carry out research/investigation and development work to solve practical problems.

PO2 Write and present a substantial technical report /document.

PO3 Demonstrate a degree of maturity and mastery in the science of RF systems design, antenna system and microwave integrated circuits with respect to their applications

PO4 Integrate the learning experience accrued to provide system solutions in the domains of wireless systems and their applications.

PO5 Bring together their programme outcome expertise to create innovative products/systems to solve real world problems in communication systems domain.

PO6 Apply appropriate managerial and technical skills in the domain of communication systems incorporating safety and sustainability to become a successful professional /entrepreneur through lifelong learning.

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	2	3	1
PEO2	3	2	3	2	3	3
PEO3	2	1	3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2018

Curriculum Breakdown Structure(CBS)	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Program Core(PC)	41.67	450	30
Program Electives(PE)	25	270	18
Humanities and Social Sciences and Management Studies(HSMS)	5.56	60	4
Project(s)/Internships(PR)/Others	27.7	300	20
Total			**72**

KEC R2018: SCHEDULING OF COURSES – ME (Communication Systems)

Semester	Theory/ Theory cum Practical / Practical							Internship & Projects	Online/ VACs	Special Courses	Credits
	1	2	3	4	5	6	7	8	10	11	
I	Applied Mathematics for Electronic Engineers HSMS-1 (3-1-0-4)	Optical Networks PC-1 (3-0-0-3)	Wireless Communication Networks PC-2 (3-0-2-4)	Antenna System Design PC-3 (3-0-2-4)	Digital Communication Techniques PC-4 (3-0-2-4)	Statistical Signal Processing PC-5 (3-1-0-4)					23
II	Information Theory & Coding PC-6 (3-0-0-3)	Digital Communication Receivers PC-7 (3-0-2-4)	Wireless Sensor Networks PC-8 (3-1-0-4)	Professional Elective I PE-1 (3-0-0-3)	Professional Elective II PE-2 (3-0-0-3)	Professional Elective III PE-3 (3-0-0-3)		Mini Project PR-1 (0-0-4-2)			22
III	Professional Elective I PE-4 (3-0-0-3)	Professional Elective II PE-5 (3-0-0-3)	Professional Elective III PE-6 (3-0-0-3)					Project work Phase – I PR-2 (0-0-12-6)		Audit Course (2-0-0-0)	15
IV								Project work Phase – II PR-2 (0-0-24-12)			12

Total Credits: 72

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M.E. DEGREE IN COMMUNICATION SYSTEMS

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18AMT13	Applied Mathematics for Electronics Engineers	3	1	0	4	50	50	100	PC
18COT11	Optical Networks	3	0	0	3	50	50	100	PC
18COC11	Wireless Communication Networks	3	0	2	4	50	50	100	PC
18COC12	Antenna System Design	3	0	2	4	50	50	100	PC
18COC13	Digital Communication Techniques	3	0	2	4	50	50	100	PC
18COT12	Statistical Signal Processing	3	1	0	4	50	50	100	PC
	Total				**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN COMMUNICATION SYSTEMS

CURRICULUM
(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18MWE02	Information Theory and Coding	3	0	0	3	50	50	100	PC
18COC21	Digital Communication Receivers	3	0	2	4	50	50	100	PC
18COT21	Wireless Sensor Networks	3	1	0	4	50	50	100	PC
	Elective - I	3	0	0	3	50	50	100	PE
	Elective - II	3	0	0	3	50	50	100	PE
	Elective - III	3	0	0	3	50	50	100	PE
	Practical								
18COP21	Mini Project	0	0	4	2	100	0	100	PR
	Total				**22**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN COMMUNICATION SYSTEMS

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Elective - IV	3	0	0	3	50	50	100	PE
	Elective - V	3	0	0	3	50	50	100	PE
	Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
18COP31	Project Work Phase I	0	0	12	6	50	50	100	PR
	Total				**15**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN COMMUNICATION SYSTEMS

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical								
18COP41	Project Work Phase II	0	0	24	12	50	50	100	PR
	Total				**12**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	Course Title	Hours/Week			Credit	CBS
		L	T	P		
SEMESTER II						
18MWE03	Multimedia Compression Techniques	3	0	0	3	PE
18MWC22	Network Security Essentials	3	0	2	4	PE
18COE01	CDMA Engineering	3	0	0	3	PE
18COE02	Statistical Detection Theory	3	0	0	3	PE
18COE03	TCP/IP Networks	3	0	0	3	PE
18COE04	Electromagnetic Interference and Compatibility	3	0	0	3	PE
18COE05	Satellite Communication Systems	3	0	0	3	PE
18COE06	Mobile Ad-Hoc Networks	3	0	0	3	PE
18COE07	Multicarrier Communications	3	0	0	3	PE
18COE08	Spread Spectrum Communication	3	0	0	3	PE
18COE09	DSP Processor Architecture and Programming	2	0	2	3	PE
SEMESTER III						
18VLE12	Nature Inspired Optimization Techniques	3	0	0	3	PE
18COE10	Statistical Estimation Theory	3	0	0	3	PE
18COE11	Microwave Integrated Circuits	3	0	0	3	PE
18COE12	RF System Design	3	0	0	3	PE
18COE13	Digital Image Processing and Multi Resolution Analysis	3	0	0	3	PE
18COE14	Industrial Data Communication	3	0	0	3	PE
18COE15	Wireless Systems and Standards	3	0	0	3	PE
18COE16	Satellite Navigational System	3	0	0	3	PE
18COE17	Speech and Audio Signal Processing	2	0	2	3	PE

18AMT13 APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS

(Common to VLSI Design, Communication Systems and Embedded Systems Branches)

L	T	P	Credit
3	1	0	4

Preamble	This course will demonstrate various analytical skills in applied mathematics and use extensive mathematical tools such as linear programming, graph and queuing theory with the tactics of problem solving and logical thinking applicable in electronics engineering.
Prerequisites	Vectors and Probability

UNIT – I **9**

Vector Spaces: Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.

UNIT – II **9**

Linear Programming: Mathematical Formulation of LPP – Basic definitions – Solutions of LPP: Graphical method – Simplex method – Transportation Model – Mathematical Formulation - Initial Basic Feasible Solution: North west corner rule – Vogel's approximation method – Optimum solution by MODI method – Assignment Model – Mathematical Formulation – Hungarian algorithm.

UNIT – III **9**

Non-Linear Programming: Formulation of non–linear programming problem – Constrained optimization with equality constraints – Constrained optimization with inequality constraints – Graphical method of non–linear programming problem involving only two variables.

UNIT – IV **9**

Graph Theory: Introduction of graphs – Isomorphism – Subgraphs – Walks, paths and circuits – Connected graphs – Eulerian Graphs – Hamiltonian Paths and circuits – Digraph – Adjacency matrix and incidence matrix of graphs – Applications: Shortest path algorithms – Dijkstra's algorithm – Warshall's algorithm – Trees – Properties of trees – Spanning trees – Applications of trees: Minimal spanning trees – Prim's Algorithm – Kruskal's algorithm.

UNIT – V **9**

Queuing Theory: Markovian queues – Single and Multi-server Models – Little's formula – Non- Markovian Queues – Pollaczek Khintchine Formula.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Howard Anton, "Elementary Linear Algebra", 10^{th} Edition, John Wiley & Sons, 2010.
2. Kanti Swarup, Gupta P.K. and Man Mohan, "Operations Research", S. Chand & Co., 1997.
3. Bondy J.A. and Murthy, USR, "Graph Theory and Applications", Mc Millan Press Ltd., 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate accurate and efficient use of advanced algebraic techniques	Understanding (K2)
CO2:	formulate and solve linear programming problems that appear in electronics engineering	Evaluating (K5)
CO3:	use non-linear programming concepts in real life situations	Applying (K3)
CO4:	apply graph theoretic algorithms in design of systems	Applying (K3)
CO5:	analyze the characteristics of various queuing models	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2	3				2	2
CO3	3				3	
CO4	3		2	2	2	
CO5	3					

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18COT11 OPTICAL NETWORKS

L	T	P	Credit
3	0	0	3

Preamble	To provide the essential knowledge about optical information processing. Optical networks covers the basics and advanced topics for an in depth knowledge in this technology.
Prerequisites	Optical Communication

UNIT – I **9**

Optical System Components: Optical System Components - Couplers - Isolators - Circulators - Multiplexers - Filters: Bragg Gratings - Fabry perot - Mach Zehnder Interferometer - Optical Amplifiers - Transmitters - Detectors - Switches - Wavelength converters

UNIT – II **9**

Network Design and Management & Control and Management: Network Design and Management: Transmission System Engineering - System Model - Power Penalty - Transmitter - Receiver - Optical amplifiers - Crosstalk - Dispersion - Fiber Non-linearity - Wavelength Stabilization. Control and Management: Network Management Functions - Configuration Management - Performance and Fault management - Optical safety.

UNIT – III **9**

Optical Network Architecture and Survivability: Introduction to Optical Networks: SONET / SDH - Layered Architecture - Broadcast and Select Networks - IP, MAC Protocols and Test beds. Network Survivability - Protection in SONET / SDH and IP Networks - Optical Layer Protection - Internetworking between layers.

UNIT – IV **9**

Wavelength Routing: WDM Network Elements: WDM Network Design - Cost trade-offs - LTD and RWA - Dimensioning Wavelength - Routing Network - Statistical Dimensioning Models.

UNIT – V **9**

Packet Switching: Photonic Packet Switching - OTDM – Synchronization - Header Processing – Buffering - Burst Switching - Access Networks.

Total: 45

REFERENCES:

1. Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", 2nd Edition, Harcourt Asia Pvt. Ltd., 2006.
2. Siva Rama Moorthy C., and Mohan Gurusamy, "WDM Optical Networks: Concept Design and Algorithms", 1st Edition, PHI, 2002.
3. Biswanath Mukherjee, "Optical WDM Networks", Springer, 2006.
4. Keiser Gerd, "Optical Fiber Communication", 4th Edition, Tata McGraw-Hill, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	analyze different Optical components constituting a communication System	Analyzing (K4)
CO2:	apply the network management concepts of an optical network	Applying(K3)
CO3:	demonstrate knowledge in modern optical systems and their implementation	Applying (K3)
CO4:	design WDM networks based on network requirements	Creating (K6)
CO5:	analyze Photonic Packet Switching systems	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1				
CO2	1				3	
CO3	3				1	
CO4	3				1	
CO5	3					

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18COC11 WIRELESS COMMUNICATION NETWORKS

L	T	P	Credit
3	0	2	4

Preamble	To introduce students to 802.11 based wireless networks. This course will cover the most recent research topics in the MAC layer, PHY layer and Mobility management. Furthermore, separate unit is dedicated for 802.11 a/b/g/ac simulation and analysis using NS-3.
Prerequisites	Cellular and Mobile Communication, Wireless Networks

UNIT – I **9**

802.11 Networks Overview: Frequency band - Nomenclature and design – Architecture - Mobility support and non-standard devices.

UNIT – II **9**

802.11 MAC Fundamentals: CSMA/CA - MAC access modes (PCF and DCF) - Hidden terminal problem - Frame fragmentation - Encapsulation of higher-layer protocols within 802.11 - Contention-based data service - 802.11 Framing.

UNIT – III **9**

802.11 PHY Fundamentals: Physical-Layer Architecture, 802.11 FH PHY, HR-DSSS: PLCP and PMD. OFDM: PLCP and PMD.802.11 b/g flavors. Simulation of 802.11 b/g radios.

UNIT – IV **9**

Mobility: Mobility - Roaming and Mobile IP - Simulation of mobility model: indoor and outdoor. Demonstration of Mobile IP.

UNIT – V **9**

QoS for 802.11 Wireless LAN: QoS Challenges in wireless environment - QoS Mechanism Overview - Deployment Planning - WLAN Design Considerations.

List of Exercises / Experiments:

1. Routing Protocol Implementation in Multi-hop Networks
2. Congestion Control Algorithm in Multi-hop Networks
3. Mobility Analysis in V2V Networks
4. Traffic model analysis in Multi-hop Wireless Network
5. Simulation of 802.11 wireless networks

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Matthew Gast, “802.11 Wireless Networks: The Definitive Guide”, O'Reilly Press, April 2002, ISBN: 0-596-00183-5.
2. Pejman Roshan and Jonathan Leary, “802.11 Wireless LAN Fundamentals”, Cisco Press, December 2003, ISBN: 9781587050770.
3. Vijay K. Garg., “Wireless Communications and Networking”, 1st Edition, Elsevier-Morgan Kaufmann Series, 2007, ISBN: 978-0-12-373580-5.
4. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, 2nd Edition, PHI, 2010, ISBN: 10-8131731863.
5. Andrea Goldsmith, “Wireless Communication”, 1st Edition, Cambridge University Press, New Delhi, 2005, ISBN: 10- 0521704162.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	examine the functionalities of 802.11based wireless networks	Understanding (K2)
CO2:	analyze 802.11 MAC and PHY layer functionalities	Analyzing (K4)
CO3:	analyze performance of wireless devices on different mobility models environment	Analyzing (K4)
CO4:	validate routing protocol performance on different wireless	Evaluating (K5)
CO5:	validate congestion control algorithm performance under wireless environment	Evaluating (K5)
CO6:	analyse different congestion control approach	Analyzing(K4), Manipulation(S2),
CO7:	analyse the 802.11 network	Analyzing(K4), Manipulation(S2),
CO8:	simulate and analyse different routing mechanism for wireless network	Analyzing(K4), Manipulation(S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2	3	3				
CO3	3	3				
CO4					3	
CO5					3	
CO6	3	2		2	3	2
CO7	3	2		2	3	2
CO8	3	2		2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18COC12 ANTENNA SYSTEM DESIGN

L	T	P	Credit
3	0	2	4

Preamble	To understand the theory and fundamentals of antenna design and to learn the key aspects of practical antenna design
Prerequisites	Antennas and Wave Propagation

UNIT – I **9**

Antenna Fundamentals: Antenna fundamental parameters - The Vector Potential A for an Electric Current Source - The Vector Potential F for a Magnetic Current Source M - Half wave length dipole - Broadband antennas.

UNIT – II **9**

Radiation from Aperture: E-plane and H-plane horn antenna - Parabolic reflector antenna - Slot antenna.

UNIT – III **9**

Antenna Arrays and Microstrip antennas: N element - Linear and planar array antennas - Rectangular and circular patch antenna - Circularly polarized microstrip antenna array.

UNIT – IV **9**

Antenna Measurements and Instrumentation: Gain - Impedance and antenna factor measurement - Antenna test range Design - Concept of EMC measuring antenna - Antenna radiation hazards.

UNIT – V **9**

Special Antennas and Advanced Antennas: Multiband antennas - Phased array antenna - Mobile antenna - Smart antennas - Fractal antenna.

List of Exercises / Experiments :

1. Design of half wave dipole
2. Design of horn antenna
3. Design of slot antenna
4. Design of patch antenna
5. Transmission line parameters and antenna Measurement using Network Analyzer
6. Design and simulation of dual band antennas
7. Design and simulation of multiband antennas

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Constantine A. Balanis, “Antenna Theory”, 4th Edition, Wiley-Inderscience, 2016.
2. John D. Kraus and Ronald J. Marhefka, “Antenna for All Applications”, Tata McGraw Hill, 2001.
3. Warren L. Stutzman and Gary A. Theile, “Antenna Theory and Design”, 3rd Edition, Wiley, 2012.
4. Bahl J. and Bhartia P., “Microstrip Antennas”, Artech House, Inc., 1997.
5. Prasad K.D., “Antennas and Wave Propagation”, Tech India Publications, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concept of vector potential to derive the radiated field from antenna	Applying (K3)
CO2:	analyze the radiation cahracteristics of aperture antennas	Analyzing (K4)
CO3:	deisgn arrays of linear and microstrip antenna	Creating (K6)
CO4:	measure the antenna parameters and analyze for radiation hazards	Evaluating (K5)
CO5:	design the multiband antennas and smart antennas for wearable devices	Creating (K6)
CO6:	design linear antennas and analyze the radiation pattern	Analyzing (K4), Precision (S3)
CO7:	design and analyze the radiation characteristics of aperture antennas	Analyzing (K4), Precision (S3)
CO8:	analyze the radiation characteristics of multiband patch antennas	Evaluating(K5), Precision(S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2		
CO2		3	3			
CO3	3	2	3			
CO4			3	3		2
CO5			3	3		
CO6	3	1	3	2		2
CO7	3	2	2	2		2
CO8	2	2		2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18COC13 DIGITAL COMMUNICATION TECHNIQUES

L	T	P	Credit
3	0	2	4

Preamble	To provide the essential knowledge in the digital modulation techniques like trellis code, viterbi coding and turbo coding for efficient transmission and better implementation
Prerequisites	Communication Engineering

UNIT – I **9**

Coherent and Non Coherent Communication: Coherent receivers - Optimum receivers in WGN - IQ Modulation and Demodulation - Non coherent receivers in random phase channels - MFSK receivers - Rayleigh and Rician channels - Partially coherent receivers - DPSK - M PSK - BER Performance Analysis.

UNIT – II **9**

Trellis Coded Modulation: Coded modulation for bandwidth constrained channels - Trellis coded Modulation - Set Partitioning Four state Trellis coded modulation with 8 PSK signal constellation.

UNIT – III **9**

OFDM Modulation: Generation of sub carriers using the IFFT Guard time and Cyclic Extension - Windowing.

UNIT – IV **9**

Turbo Coding: Introduction - Turbo Encoder - Turbo Decoder - Iterative Turbo Decoding Principles Modifications Of The MAP Algorithm - The Soft Output Viterbi Algorithm (SOVA).

UNIT – V **9**

Time Coding: Maximum ratio combining - Space time Block Codes - Space time Trellis codes.

List of Exercises / Experiments :

1. Baseband communication using raised cosine spectrum pulse – roll off rate – characteristics of RC pulse – behaviour of timing acquisition algorithm
2. To study a robust timing acquisition algorithm for OFDM – Fractional frequency offset – estimate integer part of frequency offset
3. To simulate the QPSK transmitter and receiver – Phase and Frequency offset

Lecture:45, Practical:30, Total: 75

REFERENCES/ MANUALS/ SOFTWARES:

1. Bernard Sklar, “Digital Communications”, 2nd Edition, Pearson Education, 2001.
2. John G. Proakis, “Digital Communication”, 4th Edition, Mc Graw Hill Publication, 2001.
3. Richard Van Nee and Ramjee Prasad, “OFDM for Multimedia Communications”, Artech House Publication, 2001.
4. Theodore S. Rappaport, “Wireless Communications”, 2nd Edition, Pearson Education, 2002.
5. Stephen G. Wilson, “Digital Modulation and Coding”, 1st Indian Reprint, Pearson Education, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	learn different communication schemes in digital communication	Understanding (K2)
CO2:	comprehend the Trellis coded modulation techniques	Understanding (K2)
CO3:	demonstrate knowledge in OFDM modulation scheme	Applying (K3)
CO4:	implement Turbo and Viterbi encoder techniques	Applying (K3)
CO5:	analyze block codes in communication systems	Analyzing (K4)
CO6:	evaluate the temporal behaviour of baseband signals through simulation	Evaluating (K5), Precision (S3)
CO7:	analyse the performance of OFDM against frequency offset	Analyzing (K4), Precision (S3)
CO8:	introduce phase and frequency offset in QPSK and analyse the BER performance	Analyzing(K4), Precision(S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			2	3	
CO2	2			3		
CO3	3			3	1	
CO4	3				3	
CO5	3		3		3	
CO6		2	3		3	
CO7		2	3	3	3	
CO8		3	3	2	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18COT12 STATISTICAL SIGNAL PROCESSING

L	T	P	Credit
3	1	0	4

Preamble	To appraise the advanced topics in digital signal processing such as Wiener filters, power spectrum estimation, signal modeling and adaptive filtering.
Prerequisites	Digital Signal Processing

UNIT – I **9**

Discrete Random Signal Processing: Discrete time random process - Random process: Ensemble averages - Gaussian process - Stationary process - The autocovariance and autocorrelation matrices - ergodicity - white noise the power spectrum. Filtering random process - Spectral factorization. Parseval's Theorem - Wiener Khintchine relation.

UNIT – II **9**

Non Parametric Methods: Periodogram - Performance of periodogram - Modified periodogram - Bartlett's Method - Welch's Method. **Parametric Methods:** AR model - Yule-Walker Method - Levinson-Durbin Algorithms - MA Model - ARMA Model.

UNIT – III **9**

Wiener Filters: The FIR Wiener filter - Least mean squared error criterion - IIR Wiener filters - Non causal IIR Wiener filter - The causal IIR Wiener filter. **Adaptive Filter:** Concepts of adaptive filter - FIR adaptive filters - LMS algorithm - Adaptive recursive filters.

UNIT – IV **9**

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 linear prediction - Error Filter - AR Lattice and ARMA Lattice - Ladder Filters.

UNIT – V **9**

Multirate Digital Signal Processing: Introduction - Decimation by a Factor D - Interpolation by a Factor I - Sampling Rate Conversion by a Rational Factor I/D - Implementation for sampling rate Conversion - Poly phase filter structures - Multistage Implementation of Sampling Rate Conversion - Sampling Rate Conversion of Bandpass Signals - Applications of Multirate Signal Processing.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Hayes, Monson H., "Statistical Digital Signal processing and Modeling", John Wiley and Sons, Inc., 1996.
2. Proakis John G. and Manolakis Dimitris G., "Digital Signal Processing: Principles Algorithms and Applications", PHI, 2006.
3. Petre Stoica and Randolph L. Moses, "Spectral Analysis of Signals. Prentice Hall", 1st Edition, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	infer the concepts of discrete random signal processing	Understanding (K2)
CO2:	estimate and analyze the power spectrum using parametric and non - parametric approach	Analyzing (K4)
CO3:	design FIR and IIR wiener filter and comprehend the design procedure of adaptive LMS and RLS filters	Applying (K3)
CO4:	compute the filter coefficients for lattice structure	Applying (K3)
CO5:	interpret the concepts of multirate signal processing	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2	3				2	
CO3	3					
CO4	3	2				
CO5	3				2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18MWE02 INFORMATION THEORY AND CODING (Common to Information Technology (Information Cyber Warfare), Information Technology & Communication Systems branches)					
		L	**T**	**P**	**Credit**
		3	**0**	**0**	**3**
Preamble	Information Theory and Coding deals with concept of information and its efficient, error-free and secure delivery of information using binary data streams. It also provides a complete understanding of error-control coding techniques over noisy communication channel.				
Prerequisites	Communication Networks/Systems				
UNIT – I					**9**
Source Coding: Introduction to Information theory – Uncertainty and Information – Entropy and Average Mutual Information – Information Measure for Continuous Random Variables – Source coding theorem – Huffman Coding – Shannon-Fano-Elias Coding – Arithmetic Coding – Lempel – Ziv Algorithm – Run Length Encoding and the PCX Format – Rate Distortion Function					
UNIT – II					**9**
Channel Capacity and Coding: Introduction – Channel Model – Channel Capacity – Channel Coding – Information Capacity Theorem – Error control coding: Introduction to Error Correction Codes – Basic Definitions – Matrix Description of Linear Block Codes – Equivalent Codes – Parity Check Matrix – Decoding of Linear Block Code – Syndrome Decoding – Error Probability after Coding – Perfect Codes – Hamming Codes – Low Density Parity Check (LDPC) Codes – Optimal Linear Codes – Maximum Distance Separable (MDS) Codes					
UNIT – III					**9**
Cyclic Codes: Introduction to the Cyclic Codes – Polynomials – Division Algorithm for Polynomials – A Method for Generating Cyclic Codes – Matrix Description of Cyclic Codes – Burst Error Correction – Fire Codes – Golay Codes – Cyclic Redundancy Check (CRC) Codes – Circuit Implementation of Cyclic Codes					
UNIT – IV					**9**
Bose-Chaudhuri Hocquenghem (BCH) Codes: Introduction to BCH Code – Primitive Elements – Minimal Polynomials – Generator Polynomials in Terms of Minimal Polynomials – Some Examples of BCH Codes – Decoding of BCH codes – Reed-Solomon Codes – Implementation of Reed –Solomon Encoders and Decoders – Performance of RS Codes Over Real Channels – Nested Codes					
UNIT – V					**9**
Convolutional Codes: Introduction to Convolutional Codes – Tree Codes and Trellis Codes – Polynomial Description of Convolution Codes – Distance Notions for Convolutional Codes – The Generating Function – Matrix Description of Convolutional Codes – Viterbi Decoding and Convolutional Codes – Distance Bounds for Convolutional Codes – Turbo Codes					
					Total: 45

REFERENCES:

1.	Ranjan Bose, "Information Theory, Coding and Cryptography", 2nd Edition, Tata McGraw Hill, 2008.
2.	Andrew J. Viterbi, Jim K. Omura, "Principles of Digital Communication and Coding", 4th Edition, Courier Corporation, 2018.
3.	John G. Proakis, Masoud Salehi, "Digital Communications", 5th Edition, McGraw Hill, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the principles behind an efficient, correct and secure transmission of digital data stream	Understanding (K2)
CO2:	recognize the basics of error-coding techniques	Analyzing (K4)
CO3:	construct the knowledge about the encoding and decoding of digital data streams	Applying (K3)
CO4:	examine the performance requirements of various coding techniques	Analyzing (K4)
CO5:	take part in to conduct research in information theory by the professionals	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3			3		
CO2	3			3		
CO3	3		2	2		
CO4	2				3	
CO5	3				2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18COC21 DIGITAL COMMUNICATION RECEIVERS

L	T	P	Credit
3	0	2	4

Preamble	To design Digital communication receiver systems that is used for the transmission of information from source to destination. A detailed quantitative framework for digital receiver techniques is addressed.
Prerequisites	Analog and Digital Communication

UNIT – I **9**

Digital Modulation Schemes: Representation of digitally modulated signals; Memory less modulation methods – PAM, Phase Modulation, QAM; Multidimensional signaling – orthogonal signaling, Hadamard signals; Signaling schemes with memory-Continuous Phase FSK, Continuous Phase Modulation – Minimum Shift Keying, Offset QPSK.

UNIT – II **9**

Baseband Signal Processing – Synchronization: Carrier and signal synchronization: Carrier Phase estimation – PLL, Decision directed loops; Symbol Timing estimation – Maximum likelihood and Non-Decision directed timing estimation; Joint estimation.

UNIT – III **9**

Baseband Signal Processing – Equalization: Adaptive Equalization: Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, Blind equalizers and Stochastic gradient algorithm.

UNIT – IV **9**

Optimum Receivers in AWGN: Optimum detection for AWGN channel – Correlation demodulator, matched filter, Maximum likelihood sequence detector, Optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for M-ary and correlated binary signals.

UNIT – V **9**

Optimum Receivers for Fading Channel: Optimum detection for fading channel – Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, The RAKE demodulator, Receiver structure for channel with ISI.

List of Exercises / Experiments :

1. Power spectrum of memory less modulation – simulation
2. Power spectrum of signaling with memory – simulation
3. Simulation of LMS, zero forcing equalizers
4. Simulation of decision feedback equalizers
5. BER analysis with optimum detectors in AWGN and fading channel
6. Simulation of Diversity techniques

Lecture:45, Practical:30, Total: 75

REFERENCES / MANUALS / SOFTWARES:

1. John G. Proakis, “Digital Communication”, 5th Edition, McGraw-Hill, New York, 2008.
2. Simon M.K., Hinedi S.M. and Lindsey Acirc W.C., “Digital Communication Techniques”, Prentice Hall of India, 1998.
3. Simon Marvin, “Digital communication over fading channel: An unified approach to performance Analysis”, 2nd Edition, John Wiley, New York, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the memory and memoryless digital modulation schemes	Analyzing (K4)
CO2:	evaluate the power spectrum of the memory and memoryless digital modulation techniques	Applying (K3)
CO3:	estimate the timing information in the received signals for synchronisation	Remembering (K1)
CO4:	analyze the algorithms for equalisation techniques in the receivers	Analyzing (K4)
CO5:	implement the optimum receivers in the presence of AWGN and fading channels	Creating (K6)
CO6:	analyze the power requirement in various digital modulation schemes	Analyzing (K4), Manipulation (S2)
CO7:	analyze the performance of the receiver with various equalizer under noisy and fading conditions	Analyzing (K4), Manipulation (S2)
CO8:	analyze the BER performance for digital modulation schemes under various fading conditions	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3			2		
CO2		2		3		
CO3	3					
CO4				3		
CO5					3	
CO6		2		3		
CO7				3		
CO8					3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COT21 WIRELESS SENSOR NETWORKS

(Common to Communication Systems, Control and Instrumentation Engineering, Computer Science and Engineering & Information Technology branches)

L	T	P	Credit
3	1	0	4

Preamble	This course will cover the most recent research topics in wireless sensor networks and IPV6 transition. Topics such as MAC layer and PHY layer functionalities, 6LoWPAN fundamentals, routing, mobility and other advanced topics are precisely covered.
Prerequisites	Wireless Networks

UNIT – I **9**

IEEE 802.15.4 PHY Layer: WSN Introduction, WPAN, network topologies, superframe structure, data transfer model, frame structure, slotted CSMA, IEEE 802.15.4 PHY: frequency range, channel assignments, minimum LIFS and SIFS periods, O-QPSK PPDU format, modulation and spreading. Simulation of data transfer model using Cooja simulator.

UNIT – II **9**

IEEE 802.15.4 MAC Layer: MAC functional description, MAC frame formats and MAC command frames, Simulation of WSN traffic model using Cooja simulator.

UNIT – III **9**

6LoWPAN Fundamentals: 6LoWPAN-Introduction, protocol stack, addressing, L2 forwarding, L3 routing, Header Compression, Fragmentation and Reassembly, Commissioning, Neighbor Discovery. Analyzing of sensor data exchange using Wireshark.

UNIT – IV **9**

6LoWPAN Mobility and Routing: Mobility: types, Mobile IPv6, Proxy MIPv6, NEMO, Routing: Overview, ROLL, border routing, RPL, MRPL, Edge Router Integration (Cooja simulation).

UNIT – V **9**

IPv6 Transition and Application Protocols: IPv4 Interconnectivity: IPv6 transition, IPv6-in-IPv4 tunneling, application protocols: design issues, MQTT-S, ZigBee CAP.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. "IEEE Standard for Local and metropolitan area networks, Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs)", IEEE Computer Society, New York, 5 September 2011.
2. Shelby and Zach, "6LoWPAN : The Wireless Embedded Internet", 1st Edition, John Wiley & Sons Inc., Hoboken, New Jersey, 2009, ISBN 978-0-470-74799-5.
3. Holger Karl and Andreas Willig, "Protocols and architectures for wireless sensor networks", John Wiley & Sons Inc., Hoboken, New Jersey, 2005, ISBN 978-0-470-09510-2.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the physical layer functionalities of IEEE 802.15.4 sensor devices	Understanding (K2)
CO2:	analyze MAC frame modeling of IEEE 802.15.4 sensor devices	Analyzing (K4)
CO3:	analyze 6LoWPAN architecture	Analyzing (K4)
CO4:	validate the routing protocol performance of 6LoWPAN devices	Evaluating (K5)
CO5:	apply IPV6 protocols for IoT applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2	3	3				
CO3	3	3			3	
CO4		3				
CO5					3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MWE03 MULTIMEDIA COMPRESSION TECHNIQUES

(Common to Information Technology (Information and Cyber Warfare), Information Technology & Communication Systems branches)

L	T	P	Credit
3	0	0	3

Preamble	The aims of this course are to study methods for handling and compressing various kinds of data, such as text, images, audio and video data and understand data compression techniques for multimedia and other applications, in particular to the Internet.
Prerequisite	Computer Networks

UNIT – I **9**

Introduction: Special features of Multimedia – Graphics and Image Data Representations – Popular File formats – Fundamental Concepts in Video – Digital Audio – Storage requirements for multimedia applications –Need for Compression – Lossy & Lossless compression techniques– Overview of Source Models – Source coding – Scalar and Vector quantization

UNIT – II **9**

Text Compression: Compression techniques: Shannon- Fano coding –Huffman coding – Adaptive Huffman Coding – Arithmetic coding – Dictionary techniques: LZW algorithm

UNIT – III **9**

Audio Compression: Audio compression techniques – μ- Law and A-Law companding- Differential Encoding –DPCM- ADPCM – DM – Optimal Predictors and Optimal Quantization –Application to speech coding: G.722 – Application to audio coding : MPEG audio, Speech compression techniques : Formants and CELP Vocoders

UNIT – IV **9**

Image Compression : Transform Coding: JPEG Standard – Sub band coding algorithms – Design of Filter banks – Implementation using filters- Wavelet based compression: EZW- SPIHT coders – JPEG 2000 standards- JBIG- JBIG2 standards

UNIT – V **9**

Video Compression: Video compression Based on Motion Compensation – Search for Motion Vectors – H.261 – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4: Object Based Visual Coding –Synthetic Object Coding –Object types-Profiles and Levels – MPEG 7.

Total: 45

REFERENCES:

1. Morgan Kauffman, Khalid Sayood, “Introduction to Data Compression”, 2nd Edition, Harcourt India, 2000.
2. David Salomon, “Data Compression – The Complete Reference”, 2nd Edition, Springer Verlag New York Inc., 2001.
3. Mark S. Drew, Ze-Nian Li, “Fundamentals of Multimedia”, 2nd Edition, PHI, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize scalar and vector quantization theory and also to represent the multimedia data in different formats for various applications	Understanding (K2)
CO2:	make use of different coding techniques and apply various algorithms for text compression	Applying (K3)
CO3:	identify the various audio and speech compression techniques for practical applications	Applying (K3)
CO4:	take part in image compression techniques and also to implement the compression techniques in MATLAB	Analyzing (K4)
CO5:	compare various video compression algorithms for practical applications	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2	3	2		2		
CO3	3				3	
CO4	3					
CO5	3					

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18MWC22 NETWORK SECURITY ESSENTIALS

(Common to Information Technology (Information Cyber Warfare), Communication Systems & Embedded Systems branches)

L	T	P	Credit
3	0	2	4

Preamble	To introduce the security problems associated with malicious software and intruders and familiarize the network security controls that help to protect the usability, integrity, reliability and safety of the network infrastructure and the data that travels through it.
Prerequisites	Computer Networks

UNIT – I **9**

Introduction: Characteristics of Networks, Need for network security, Intruders, Malicious Software, Reconnaissance, Eavesdropping, wiretapping, impersonation, traffic analysis, website defacement, DOS, active code or mobile code attacks, OSI Security Architecture, Security Services, Model for Network Security.

UNIT – II **9**

Cryptography and Key Distribution: Classical Encryption Techniques, Symmetric Encryption Principles, Symmetric Encryption Algorithms, DES, AES, Stream Ciphers, Block Cipher Modes of Operation, Public Key Cryptography Principles, Public Key Cryptographic Algorithms, RSA,ECC, Key Distribution using Symmetric and Asymmetric Encryption, Kerberos, X.509, Public Key Infrastructure, trust models, revocation, directories.

UNIT – III **9**

Message Authentication and Digital Signatures: Requirement of Authentication Functions, Message Authentication Codes, Hash and MAC Algorithms, MD2, MD4,MD5, SHA, HMAC, CMAC, Whirlpool, Address bases authentication, password based authentication, trusted intermediaries, digital Signatures, Digital Signature Standard.

UNIT – IV **9**

IP Security, Transport Layer Security: IP Sec, Authentication header, Encapsulating Security Payload, IKE, ISAKMP/IKE Encoding, Web Security Issues, Secure Sockets Layer, Transport Layer Security, Negotiating cipher suites, compression methods , encoding, HTTPS, Secure Shell.

UNIT – V **9**

Network Security Applications: Electronic Mail Security, Privacy enhanced mail, PGP, SMIME, Authorization and Access control, Firewalls, Intrusion Detection and Prevention Systems, Honeypots, honetnets, scanning and analysis tools, Antivirus Software, Virtual Private Network.

List of Exercises / Experiments :

1. Implement the following substitution and transposition techniques concepts
   a. Playfair Cipher
   b. Column Transformation
2. Implement Hill Cipher Technique
3. Implement the RSA Asymmetric key algorithm
4. Implement the Diffie Hellman Asymmetric key algorithm
5. Implement the Digital Signature standard algorithm
6. Setup a honey pot and monitor the honey pot on network (KF Sensor)
7. Demonstrate Intrusion Detection System (IDS) using any tool (snort or any other s/w)

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUALS / SOFTWARES:	
1.	William Stallings, "Cryptography and Network Security Principles and Practices", 6th Edition, Prentice Hall, 2013.
2.	Behrouz A. Fourouzan, "Cryptography and Network Security", 2nd Edition, Tata McGraw-Hill, 2012.
3.	Charlie Kaufman, RadiaPeralman, Mike Speciner, "Network Security: Private communication in public world", 2nd Edition, Prentice Hall, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the attacks against network infrastructure and the sources of attacks	Understanding (K2)
CO2:	evaluate the design principles of conventional encryption and public key encryption	Applying (K3)
CO3:	narrate the MAC and hashing techniques needed for authentication	Understanding (K2)
CO4:	identify the various types of security controls available to protect the network infrastructure	Understanding (K2)
CO5:	implement appropriate security controls to safeguard the network infrastructure	Applying (K3)
CO6:	practice the different types of symmetric key cryptographic algorithms	Applying (K3), Precision (S3)
CO7:	implement the various types asymmetric key cryptographic algorithms	Applying (K3), Precision (S3)
CO8:	demonstrate the different types of firewalls and intrusion detection system	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3		3	3	
CO2	3		3	3	
CO3	3		3	3	
CO4	3		3	3	
CO5	3		3	3	
CO6	3	2	3	3	1
CO7	3	2	3	3	1
CO8	3	2	3	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE01 CDMA ENGINEERING

L	T	P	Credit
3	0	0	3

Preamble	To inculcate the knowledge of spread spectrum applications in CDMA engineering.
Prerequisites	Digital Communication

UNIT – I **9**

Principles of Code Division Multiple Access: Spread spectrum technique – Direct sequence and frequency hopping spread spectrum communication system – PN codes and Walsh codes – Rake receiver – Capacity – Effects of loading, sectorization and voice activity – Power control – Hand off – Link structure – Forward link – Pilot, synchronization, paging and traffic channels – Reverse Link – access and traffic channel

UNIT – II **9**

Call Processing and Traffic: Call processing states – Initialization, idle, access and traffic states – Forward link and Reverse link analysis - Calculation of Ec/Io and Eb/No – Traffic intensity – Grade of Service – Erlang-B and C models

UNIT – III **9**

WCDMA Basics: Protocol architecture, principles of physical layer, Spreading codes and modulation-Introduction- channelization codes- Scrambling codes-modulation- uplink , downlink spreading and modulation

UNIT – IV **9**

OFDMA and MC-CDMA: OFDM principles , Frequency hopping in OFDMA - OFDMA system description – Channel coding, modulation, time and frequency synchronization, Combination of OFDM and CDMA - MC-CDMA, MT-CDMA and MC-DS CDMA systems - Difference between OFDMA and MC-CDMA

UNIT – V **9**

Optical CDMA: Families of Prime Codes- Prime code, Generalized and Extended Prime Codes, Experimental demonstration of Optical CDMA, Synchronization of Optical CDMA networks-Cross-correlation properties, Application, Temporal-Spatial CDMA Optical Network, Multiwavelength Optical CDMA networks

Total: 45

REFERENCES:

1. Samuel C. Yang, “CDMA RF System Engineering”, 1st Edition, Artech House, 1998.
2. Richard Van Nee and Ramjee Prasad, “OFDM for Wireless Multimedia Communication”, 1st Edition, Artech House, 2004.
3. Khaled Fazal and Stephen Kaiser, “Multicarrier and Spread Spectrum Systems”, 2nd Edition, Wiley, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate basic spread spectrum techniques and different CDMA techniques	Applying (K3)
CO2:	apply basic principles behind radio resource management techniques such as power control, channel allocation and handoffs in different CDMA techniques	Applying (K3)
CO3:	implement the concepts of WCDMA techniques	Applying (K3)
CO4:	analyze the concepts of WCDMA, OFDMA and MC-CDMA in wireless communication	Analyzing (K4)
CO5:	analyze the prime codes temporal and spatial CDMA optical networks	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				3	
CO2		3	2			
CO3	3			2		
CO4	3					
CO5	3				2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE02 STATISTICAL DETECTION THEORY

L	T	P	Credit
3	0	0	3

Preamble	To understand Statistical Information Processing in particular Detection Theory as fundamental to many branches of communications like Radar & Pattern Recognition.
Prerequisites	Random Process Applications and Theory

UNIT – I **9**

Introduction and Statistical Detection Theory: Introduction – Detection theory in Signal Processing – The Mathematical Detection Problem – Neyman Pearson (NP) Theorem and Proof – Receiver operating characteristics – Minimum probability of Error – Bayes Risk – Multiple Hypothesis Testing.

UNIT – II **9**

Decision Theory for Deterministic Signals: Decision theory – Matched filters – Development of Detector – Performance of Matched filter – Generalized Matched filters – Performance of Generalized Matched filter – Multiple signals – Binary case – Performance for Binary case – M ary case – Signal processing examples

UNIT – III **9**

Random Signal Detection: Introduction – Estimator correlator – Linear model – Estimator correlator for large data records – General Gaussian detection – Signal processing example – Tapped delay line channel model.

UNIT – IV **9**

Decision Theory – Unknown PDF: Introduction – Composite hypothesis testing – Bayesian approach and Generalized likelihood ratio test – Multiple hypothesis testing – Aymptotic PDF of GLRT

UNIT – V **9**

Deterministic Signals with Unknown Parameters: Signal modeling and detection performance – Unknown amplitude – GLRT & Bayesian approach – Sinusoidal detection – Amplitude – Amplitude and Phase – Amplitude, Phase and Frequency – Classical linear model.

Total: 45

REFERENCES:

1. Steven M. Kay, “Fundamentals of Statistical Signal Processing: Detection Theory”, 1st Edition, Prentice Hall Signal Processing Series, Upper Saddle River, NJ 2001.
2. Harry L. Van Trees, “Detection, Estimation, and Modulation Theory”, 2nd Edition, John Wiley & Sons, 2001.
3. Arthur Giordano, “Detection and Estimation Theory and its Applications”, 1st Edition, Prentice Hall, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the basics of the mathematical detection problem	Applying (K3)
CO2:	demonstrate the role of matched filters in decision theory	Applying (K3)
CO3:	demonstrate knowledge in random signal detection techniques	Applying (K3)
CO4:	design & implement Bayesian & GRLT techniques	Applying (K3)
CO5:	analyze unknown parameter detection techniques	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3			2		
CO2	3					
CO3				2	3	
CO4					3	
CO5	3					

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE03 TCP/IP NETWORKS

L	T	P	Credit
3	0	0	3

Preamble	To comprehend the layered protocol architecture defining IP networks. Emphasis is based on next generation systems and traffic management.
Prerequisites	Data Communication Networks

UNIT – I **9**

Introduction: Internet history and architecture, OSI layering, MAC and LLC Issues: Techniques for multiple access, Adaptive LLC mechanisms for wireless links, Internet Routing Architecture: Internet Service Providers and Peering.

UNIT – II **9**

Flow/Congestion Control: Implementation, modeling, fairness, stability, open-loop vs closed-loop vs hybrid, traffic specification (LBAP, leaky-bucket), window vs rate, hop-by-hop vs end-to-end,implicit vs explicit feedback, aggregate flow control, reliable multicast. TCP variants (Tahoe, Reno,Vegas, New-Reno, SACK)

UNIT – III **9**

Routing: Implementation, stability/convergence, link-state vs distance-vector vs link-vector,conventional routing, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Multicast OSPF (MOSPF), Distance Vector Multicast Routing Protocol (DVMRP), BGP instability, Fair queuing, TCP congestion control, TCP variants, Random Early Detect, TCP RTT estimation, Fast retransmit, Fast recovery.

UNIT – IV **9**

IP Next Generation: IP Next Layer (IPNL), IPV6 features, including transition, Mobile IPV6 operation, Models to support(WLAN) network roaming, IPV6 transition methods, Advanced IP routing and multihoming, IP Multicast. Traffic Management: Utility function, traffic models (for Internet), self-similarity, traffic classes (BE, GS), service models (DiffServ, IntServ), class-based allocation, controls at different time scales, renegotiation (RCBR), signaling (RSVP, ATM signaling), resource translation/mapping, admission control (worst-case, statistical, measurement-based), pricing, Capacity planning.

UNIT – V **9**

Traffic Management: Integrated Services, Resource Reservation Protocol (RSVP), Differentiated Services, Wireless TCP, Mobile IP, Multicast routing, Scalable Multicast routing: Core Based Trees (CBT), Protocol Independent Multicast (PIM), Pragmatic General Multicast (PGM), Scalable Reliable Multicast, Overlay Networks, Peer-to-Peer Networks.

Total: 45

REFERENCES:

1. Larry Peterson and Bruce Davie, “Computer Networks: A Systems Approach”, 5th Edition, Morgan Kaufmann, 2014.
2. Jim Kurose and Keith Ross, “Computer Networking: A Top-Down Approach Featuring the Internet”, 6th Edition, Addison-Wesley, 2012.
3. Keshav S., “An Engineering Approach to Computer Networking”, 5th Edition, Pearson Education, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze TCP/IP model in internet architectures	Analyzing (K4)
CO2:	implement the Congestion Control techniques for next generation technology	Applying (K3)
CO3:	analyze various routing techniques used in communication networks	Analyzing (K4)
CO4:	compare the multi-hop and multicast for next generation IP network	Understanding (K2)
CO5:	analyze traffic management in networks	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				2	1
CO2	3			2	2	2
CO3	3				2	2
CO4	3	1		2		2
CO5		1			3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18COE04 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

(Common to Communication Systems,VLSI Design, Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	To expose the basics and fundamentals of Electromagnetic Interference and Compatibility in Communication System Design and to know the concepts of EMI Coupling Principles, EMI Measurements and Control techniques and the methodologies of EMI based PCB design.
Prerequisites	Electromagnetic Principles

UNIT – I **9**

EMI Environment: EMI/EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Emission and immunity concepts, ESD.

UNIT – II **9**

EMI Coupling Principles: Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply coupling.

UNIT – III **9**

EMI/EMC Standards and Measurements: Civilian standards - FCC, CISPR,I EC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/Injectors/Couplers, Test beds for ESD and EFT, Military Test Method and Procedures (462).

UNIT – IV **9**

EMI Control Techniques: EMI Control Techniques : Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting

UNIT – V **9**

EMC Design of PCBs: PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models.

Total: 45

REFERENCES:

1. Ott W. Henry, “Noise Reduction Techniques in Electronic Systems”, 2nd Edition, John Wiley & Sons, New York, 2008.
2. Kodali V.P., “Engineering EMC Principles, Measurements and Technologies”, 2nd Edition, IEEE Press, London, 2006.
3. Keiser Bernhard, “Principles of Electromagnetic Compatibility”, 3rd Edition, Artech House, Dedham, 1987.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	estimate the EMI and analyze in time domain and frequency domain	Analyzing (K4)
CO2:	compare the various EMI coupling methods	Evaluating (K5)
CO3:	conduct the EMI measurement for civilian and military appliances	Analyzing (K4)
CO4:	device the EMI control techniques	Applying (K3)
CO5:	evaluate the PCB'S and motherboards EMI performance and design the EMC circuits	Creating (K6)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2		1	
CO2	1	2	3			
CO3	2	3	2	2	3	
CO4	2		3	2		
CO5			2	1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE05 SATELLITE COMMUNICATION SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	To provide an insight into the basic of orbital mechanics, various subsystems in a satellite communication system and current applications based on access techniques
Prerequisites	Communication Systems

UNIT – I **9**

Orbital Mechanics: Growth of Satellite Communication - Kepler's laws of motion, Frequency coordination and regulatory services, Orbit Equations, Orbit Description, Locating the Satellite in the Orbit and with Respect to Earth, Orbital Elements-Look Angle Determination and Visibility - Orbital Perturbations, Orbit Determination, Launch Vehicles, Orbital Effects in Communication System - Performance Attitude control,Satellite launch vehicles and propulsion mechanisms - spectrum allocations for satellite systems, Energy Dispersal, propagation characteristics of fixed and mobile satellite links.

UNIT – II **9**

Spacecraft Sub Systems: Spacecraft Subsystems, station keeping- Altitude and Orbit Control, stabilization techniques – Telemetry and Tracking, Power, Systems, Communication Subsystems, Transponders, Antennas, Equipment Reliability, atmospheric losses Earth Stations, antennas, tracking system, terrestrial interface, different types of interference, interference specification and protection ratio.

UNIT – III **9**

Earth Station: The Space Link: Satellite Link Design: Satellite uplink - down link power Budget, Basic Transmission Theory, System Noise Temp, G/T Ratio, Noise Figure; Downlink Design - Design of Satellite Links for Specified C/N - Microwave Propagation on Satellite to Earth.

UNIT – IV **9**

Satellite Access Techniques: Single access vs. multiple access (MA). Classical MA techniques: FDMA, TDMA. Single channel per carrier (SCPC) access - Code division multiple access (CDMA) Demand assignment techniques.

UNIT – V **9**

Applications of Satellite Access Techniques: ATM via satellite. TCP/IP via satellite - INTELSAT series - INSAT, VSAT Systems, LEO and Non Geostationary satellite systems.

Total: 45

REFERENCES:

1. Timothy Pratt and Charles W. Bostian, "Satellite Communications", 2^{nd} Edition, John Wiley & Sons, 2003.
2. Wilbur L. Pritchard, Hendri G. Suyderhood, Robert A. Nelson, "Satellite Communication Systems Engineering", 2^{nd} Edition, Prentice Hall, New Jersey, 1993.
3. Dennis Roddy, "Satellite Communications", 4^{th} Edition, Mc Graw Hill International Editions, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	comprehend the knowledge obtained in orbital mechanics for satellite communication	Applying (K3)
CO2:	identify the subsystems involved in spacecraft and techniques in tracking of the satellites	Applying (K3)
CO3:	elucidate the design procedure for an Earth station	Applying (K3)
CO4:	compare the satellite access techniques	Analyzing (K4)
CO5:	apply the multiple access techniques for the satellite systems	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				
CO2		2	2		3	
CO3	2		2		3	2
CO4	3				2	
CO5			3	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE06 MOBILE AD-HOC NETWORKS

L	T	P	Credit
3	0	0	3

Preamble	This course will cover the most recent research topics in multi-hop networks. Topics such as MAC layer fundamentals, routing protocols, Congestion control algorithm and QoS framework are precisely covered.
Prerequisites	Wireless Networks

UNIT – I **9**

Overview: Introduction to Ad Hoc Networks: Introduction – Issues in Adhoc wireless networks; Definition, characteristics - features, applications. Adhoc Mobility Models: - entity and group models

UNIT – II **9**

MAC Protocols: Design issues, goals and classification. Contention based protocols and reservation based protocols

UNIT – III **9**

Routing Protocols: Table driven routing- OLSR, on demand routing- AODV, Hybrid routing: ZRP, Geographic routing: LAR, Secure routing and power aware routing.

UNIT – IV **9**

Transport Layer: Issues and goals in designing, Adhoc transport protocols, TCP over Adhoc wireless networks, other transport layer protocol for Adhoc Wireless networks. Independent congestion control approach- Vegas Plus, W-Vegas and WFCC.

UNIT – V **9**

Quality of Service: Introduction, issues and challenges, classification, QoS framework for Adhoc wireless networks. Integration of Multi-hop ad hoc network with other wired and wireless networks.

Total: 45

REFERENCES:

1. Siva Ram Murthy C. and Manoj B.S., “Adhoc Wireless Networks Architectures and Protocols”, 3rd Impression, Pearson Education, 2008.
2. Charles E. Perkins, “Ad hoc Networking”, 1st Impression, Pearson Education, 2008.
3. Stefano Basagni J., Marco Conti, Silvia Giordano and Ivan Stojmenovic, “Mobile Adhoc Networking”, 1st Edition, Wiley - IEEE Press, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the multi-hop wireless devices performances under diverse mobile conditions	Analyzing (K4)
CO2:	analyze the MAC layer functionalities of multi-hop devices	Analyzing (K4)
CO3:	analyze the routing algorithms performance on multi-hop wireless networks	Analyzing (K4)
CO4:	develop a congestion control algorithm for heavily tailed multi-hop wireless networks	Applying (K3)
CO5:	apply a suitable QoS framework for the given channel model	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3				
CO2		3				
CO3		3				
CO4				3		
CO5					3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE07 MULTICARRIER COMMUNICATIONS

L	T	P	Credit
3	0	0	3

Preamble	To appraise the transceiver architectures, impairments of wireless channel and the methodologies to overcome the issues.
Prerequisites	Digital Communication, Wireless Communication, Signals and Systems

UNIT – I **9**

Introduction to Multicarrier Systems: Linear Algebra: Vector Spaces, Linear independence, Subspaces, Projections, Orthogonality, Eigen Decomposition, Quadratic forms, Digital Communication Review: Linear stream modulation, Optimal Detection, ISI channels, Equalization

UNIT – II **9**

Multicarrier Fundamentals: Motivation, OFDM, Subcarrier notion, Role of FFT, Parallel channel decomposition and detection, OFDM Transmitter Optimization: Adaptive Modulation, Waterfilling

UNIT – III **9**

Multicarrier Receivers: SNR gap analysis, Bit loading algorithms, Linear precoding, Coded OFDM, OFDM Receiver Algorithms: Synchronization, Sensitivity to timing and frequency errors

UNIT – IV **9**

Channel Estimation and Equalization: Zero forcing and MMSE algorithms, Training sequence design, Multiuser Systems: OFDMA, SCFDMA, Distributed and localized mapping.

UNIT – V **9**

Multicarrier Diversity: Multiuser diversity, Resource allocation algorithms, Applications to cellular systems, MIMO-OFDM: Fundamental MIMO concepts, Spatial diversity, Spatial Multiplexing, Space Frequency coding

Total: 45

REFERENCES:

1. Strang G., “Linear Algebra and Applications”, 4th Edition, New York Academic, 2006.
2. Tse D. and Vishwanath P., “Fundamentals of Wireless Communications”, 7th Reprint, Cambridge Press, 2013.
3. Chiueh T.D. and Tsai P.Y., “OFDM Baseband Receiver Design for Wireless Communications”, 1st Edition, Wiley, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of linear algebra to multicarrier communication	Applying (K3)
CO2:	use FFT to design OFDM for high data rate and low data rate requirement	Creating (K6)
CO3:	analyze the multicarrier receiver performance for different amount of bit loading and encoding and handle the timing error issue with suitable synchronization	Evaluating (K5)
CO4:	perform the channel estimation and equalization for multi-user systems	Evaluating (K5)
CO5:	analyze the diversity schemes propsed for multiuser scenario	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2	3	2	3			
CO3		3	3	3		
CO4	2	2	3	3		
CO5	2	2		3	3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE08 SPREAD SPECTRUM COMMUNICATION

L	T	P	Credit
3	0	0	3

Preamble	To invoke the types of spread spectrum technologies used in narrow band and broad band wireless systems and to analyze the spread spectrum system in the noisy channel.
Prerequisites	Digital Communication, Cellular and Mobile Communication

UNIT – I **9**

Performance Characterization of Digital Data Transmission: Detection of binary signals in AWGN - Quadrature multiplexed signaling schemes - Equalization of digital data transmission system - Communication in the presence of pulse noise jamming - Low probability detection scheme.

UNIT – II **9**

Spread Spectrum Systems: Direct sequence spread spectrum methods employing BPSK, QPSK and MSK - Frequency Hop spread spectrum methods - Coherent slow frequency Hop technique - Non coherent slow and fast frequency Hop spread spectrum techniques - Hybrid DS/FH spread spectrum.

UNIT – III **9**

Binary Shift Register Sequences for Spread Spectrum Systems: Definition - PN sequence generator fundamentals - Maximal length sequences - Properties, Power spectrum and Polynomial tables for maximal length sequences - Gold codes - Rapid Acquisition systems - Non-linear code generators.

UNIT – IV **9**

Synchronization of Spread Spectrum Systems: Optimal tracking of wideband signals - Code tracking loops for FHSS - Optimum synchronization techniques - Synchronization using a matched filter - Synchronization by estimating the received spreading code.

UNIT – V **9**

Performance of Spread Spectrum System: SS Systems communications models - Performance without coding under AWGN - spread spectrum systems performances with forward error correction - Block coding - Convolutional coding and specific error correcting codes - Interleaving - Random coding bounds

Total: 45

REFERENCES:

1. Ziemer R.E., Peterson R.L. and David E. Borth, "Introduction to Spread Spectrum Communications", 1st Edition, Published by Pearson Education Pvt. Ltd., 2005.
2. Dr. Kamilo Feher, "Wireless Digital Communications – Modulation and Spread Spectrum Applications", 1st Edition, Prentice Hall of India, 2009.
3. Mosa Ali Abu-Rgheff, "Introduction to CDMA Wireless Communications", 1st Edition, Elsevier Ltd., 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	examine the performance of data transmission over AWGN channel	Evaluating (K5)
CO2:	analyze the characteristics of spread spectrum systems	Analyzing (K4)
CO3:	generate the spreading codes suitable for spread spectrum communication systems	Creating (K6)
CO4:	analyze the synchronization techniques used for spread spectrum systems	Analyzing (K4)
CO5:	analyze the performance of spread spectrum system with and without channel coding	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2		3		
CO2	3	2		2		
CO3	3				3	
CO4	3		2	2		
CO5	3		2	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18COE09 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING

(Common to Communication Systems,VLSI Design & Embedded Systems branches)

L	T	P	Credit
2	0	2	3

Preamble	To design the parameters of filters and implement it in real time DSP hardware.
Prerequisites	Digital Signal Processing

UNIT – I **6**

Fundamentals of Programmable DSPs: Multiplier and Multiplier accumulator (MAC) – Modified Bus Structures and Memory access in Programmable DSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals

UNIT – II **6**

TMS320C54XX: Fundamentals of Programmable DSPs - Architecture of TMS320C54X-54X Buses- Memory organization-Computational Units-Pipeline operation-On-chip peripherals – Address Generation Units- Addressing modes and instruction set- assembly language instructions -Introduction to Code Composer studio

UNIT – III **6**

TMS320C6X: Architecture of TMS320C6X – Computational units-Addressing modes –Memory architecture- pipeline operation- instruction set- assembly language instructions

UNIT – IV **6**

Blackfin Processor(BF537): Architecture of BF537- Computational units - Internal Memory organization- System interrupts – Direct Memory Access- on-chip peripherals-ALU-MAC-DAG Units-Addressing modes- Assembly language instructions- Timers –Interrupts-Serial ports-UART-Simple programs

UNIT – V **6**

Applications Using TMS320C54X/C6X/BF537: Program development - Software Development Tools- The Assembler and the Assembly Source File Filter design- Linker and Memory Allocation -DSP Software Development Steps- Speech Digitization-Encoding and Decoding-Image compression-Restoration-Adaptive Echo cancellation-Modulation

List of Experiments:

1. Basic Signal operations using 54x.
2. Convolution using c54x and c6713x
3. FIR and IIR filter using C6713
4. Basic operations and convolution using BF 537
5. Speech and Audio application development using BF537

Lecture:30, Practical:30, Total: 60

REFERENCES / MANUALS / SOFTWARES:

1. Sen M. Kuo, Woon–Seng S. Gan, “Digital Signal Processors: Architecture, Implementation and Applications”, 1st Edition, Prentice Hall, 2009.
2. Woon-Seng Gan, Sen M. Kuo, “Embedded Signal Processing with the Microsignal Architecture”, John Wiley & Sons Inc. Publications, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	infer the basic concepts of DSP processor	Understanding (K2)
CO2:	apply programming concepts to develop simple and real time applications programs using c54x processor	Applying (K3)
CO3:	apply programming concepts to develop simple and real time applications using c6x processor	Applying (K3)
CO4:	apply programming concepts to develop simple and real time applications using BF 537 processor	Applying (K3)
CO5:	analyze the performance of DSP processors like TMS320C54X/C6X/BF537	Analyzing (K4)
CO6:	demonstrate the concepts of DSP using DSP processor	Applying (K3), Manipulation (S2)
CO7:	design digital filters using DSP processors	Applying (K3), Manipulation (S2)
CO8:	demonstrate speech/audio applications using DSP processor	Applying (K3), Manipulation (S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				2	
CO2	3				3	
CO3	3				3	
CO4	3				3	
CO5	3	3			3	
CO6	3				3	
CO7	3				3	
CO8	3				3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18VLE12 NATURE INSPIRED OPTIMIZATION TECHNIQUES

(Common to VLSI Design , Communication Systems, Embedded Systems, Computer Science and Engineering & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	To acquaint and familiarize with different types of optimization techniques, solving optimization problems, implementing computational techniques, abstracting mathematical results and proofs etc.
Prerequisites	Linear algebra and Calculus

UNIT – I — 9

Introduction to Algorithms: Newton's Method – Optimization - Search for Optimality - No-Free-Lunch Theorems - Nature-Inspired Metaheuristics - Brief History of Metaheuristics. **Analysis of Algorithms:** Introduction - Analysis of Optimization Algorithms - Nature-Inspired Algorithms - Parameter Tuning and Parameter Control.

UNIT – II — 9

Simulated Annealing: Annealing and Boltzmann Distribution - Parameters - SA Algorithm - Unconstrained Optimization - Basic Convergence Properties - SA Behavior in Practice - Stochastic Tunneling. **Genetic Algorithms** : Introduction - Genetic Algorithms - Role of Genetic Operators - Choice of Parameters - GA Variants - Schema Theorem - Convergence Analysis

UNIT – III — 9

Particle Swarm Optimization: Swarm Intelligence - PSO Algorithm - Accelerated PSO – Implementation - Convergence Analysis - Binary PSO – Problems. **Cat Swarm Optimization:** Natural Process of the Cat Swarm - Optimization Algorithm – Flowchart - Performance of the CSO Algorithm.

UNIT – IV — 9

TLBO Algorithm: Introduction - Mapping a Classroom into the Teaching-Learning-Based optimization – Flowchart- Problems. **Cuckoo Search:** Cuckoo Life Style - Details of COA – flowchart - Cuckoos' Initial Residence Locations - Cuckoos' Egg Laying Approach - Cuckoos Immigration - Capabilities of COA. **Bat Algorithms:** Echolocation of Bats - Bat Algorithms – Implementation - Binary Bat Algorithms - Variants of the Bat Algorithm - Convergence Analysis.

UNIT – V — 9

Other Algorithms: Ant Algorithms - Bee-Inspired Algorithms - Harmony Search - Hybrid Algorithms.

Total: 45

REFERENCES:

1. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 1st Edition, Elsevier, 2014.
2. Omid Bozorg-Haddad, "Advanced Optimization by Nature-Inspired Algorithms" Springer Volume 720, 2018.
3. Srikanta Patnaik, Xin-She Yang, Kazumi Nakamatsu, "Nature-Inspired Computing and Optimization Theory and Applications", Springer Series, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	infer the basic concepts of optimization techniques	Understanding (K2)
CO2:	identify the parameter which is to be optimized for an application	Analyzing (K4)
CO3:	analyze and develop mathematical model of different optimization algorithms	Analyzing (K4)
CO4:	select suitable optimization algorithm for a real time application	Applying (K3)
CO5:	recommend solutions, analyses, and limitations of models	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	3
CO2			2	3	2	
CO3			2	3	2	
CO4			3	3	3	
CO5			2	3	2	

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18COE10 STATISTICAL ESTIMATION THEORY

L	T	P	Credit
3	0	0	3

Preamble	To demonstrate knowledge in basics of estimation and advanced topics like BLUE and maximum likelihood estimation techniques are covered.
Prerequisites	Random Process Applications & Theory.

UNIT – I **9**

Introduction and Minimum Variance Unbiased Estimation: Introduction – Estimation in Signal Processing – The mathematical estimation problem – Assessing estimator performance – Unbiased estimators – Minimum variance criterion – Existence of the minimum variance unbiased estimator – Extension to a vector parameter.

UNIT – II **9**

Estimation – Cramer Rao Lower Bound: Introduction – Estimator accuracy considerations – Cramer Rao lower bound – General CRLB for signals in White Gaussian Noise – Transformation of Parameters – Extension to a vector parameter – CRLB for the general Gaussian case – Signal Processing examples.

UNIT – III **9**

Linear Models and General Minimum Variance Unbiased Estimation: Introduction – Definition and properties – Linear model examples – Extensions to the Linear Model. Sufficient statistics – finding sufficient statistics – using sufficiency to find the MVU estimator.

UNIT – IV **9**

Best Linear Unbiased Estimators (BLUE): Introduction – definition of the BLUE – Finding the BLUE – Extension to a vector parameter – Signal Processing examples.

UNIT – V **9**

Maximum Likelihood Estimation (MLE): Introduction – Example illustration – finding the MLE – Properties of the MLE – MLE for Transformed Parameters – Numerical determination of the MLE – Extension to a vector parameter – Signal Processing examples.

Total: 45

REFERENCES:

1. Steven M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", 1st Edition, Prentice Hall Signal Processing Series, Upper Saddle River, NJ 1998.
2. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory", 2nd Edition, John Wiley & Sons, 2013.
3. Vincent Poor H., "An Introduction to Signal Detection and Estimation", 2nd Edition, Springer, 1994.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	analyze minimum variance unbiased approach to estimation	Analyzing (K4)
CO2:	analyze the role of Cramer Rao lower bound in estimation	Analyzing (K4)
CO3:	demonstrate knowledge in linear models for estimation	Applying (K3)
CO4:	analyze best linear unbiased estimators (BLUE)	Analyzing (K4)
CO5:	implement Maximum Likelihood Estimation techniques for signal processing applications	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2	3					
CO3					3	
CO4					3	
CO5	3					

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE11 MICROWAVE INTEGRATED CIRCUITS

L	T	P	Credit
3	0	0	3

Preamble	To design and fabricate microstrip components in the field of wireless communication like satellite communications and mobile applications.
Prerequisites	Microwave Engineering

UNIT – I **9**

Microstrip Components: Introduction, Fabrication process of MMIC, Hybrid MICs, Propagating modes, Directional couplers, branch line couplers, Microstrip circulators, Phase shifters, Isolators. Introduction to slot line and coplanar wave guide, Introduction to coupled Microstrip.

UNIT – II **9**

Microstrip Line Analysis: Analysis of MIC by conformal transformation, Hybrid mode analysis, losses in Microstrip, Introduction to slot line and coplanar wave guide., Even and odd mode analysis, Design and Fabrication of Lumped elements for MICs, Comparison with distributed circuits Ferromagnetic substrates and inserts.

UNIT – III **9**

Amplifiers: Stability and gain analysis, matching techniques, reactively matched amplifier design, Power amplifier, LNA.

UNIT – IV **9**

Oscillators and Mixers: Oscillators: Design principles, active device CAD techniques for large signal oscillators design, phase noise, MMIC_VCO, mixers-Analysis of mixer circuits-Diode mixers-Active FET Mixers.

UNIT – V **9**

Integrated Antennas and Microwave Measurement Techniques: Integrated antenna selection, photonic band gap antennas, micro machined antenna, micro electro mechanical system antennas, microwave measurements test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

Total: 45

REFERENCES:

1. Ravender Goyal, “Monolithic MIC; Technology and Design”, Artech House, 1989.
2. Robertson I.D. and Lucyszyn S., “RFIC and MMIC Design and Technology”, Institution of Electrical Engineers, 2001.
3. Gupta K.C. and Amarjit Singh, “Microwave Integrated Circuits”, John Wiley, New York, 1975.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the passive components for MIC	Applying(K3)
CO2:	analyze the different modes in MIC	Analyzing (K4)
CO3:	analyze the stability, gain and impedance matching techniques of amplifiers	Analyzing (K4)
CO4:	analyze the diode mixer and active FET mixer circuits	Analyzing (K4)
CO5:	evaluate the radiation characteristics of integrated antennas in MIC	Evaluating(K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		3			2
CO2	2		3			2
CO3	3			3	1	3
CO4	3		3			3
CO5	3		3		3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE12 RF SYSTEM DESIGN

L	T	P	Credit
3	0	0	3

Preamble	To provide strong fundamentals in the area of RF passive circuit design for wireless systems. Both circuit and system level perspective will be addressed, supported by impedance matching techniques, modeling of passive components and resonant circuits.
Prerequisites	Analog and Digital Communication and Linear Integrated Circuits

UNIT – I **9**

CMOS Physics, Transceiver Specifications and Architectures: CMOS: Introduction to MOSFET Physics – Noise: Thermal, shot, flicker, popcorn noise transceviver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3,Sensitivity, SFDR, Phase noise - Specification distribution over a communication link Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures –Transmitter: Direct upconversion, Two step up conversion.

UNIT – II **9**

Impedance Matching and Amplifiers: S- parameters with Smith chart, Passive IC components - Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers – OC Time constants in bandwidth estimation and enhancement – High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match – Single ended and Differential LNAs – Terminated with Resistors and Source Degeneration LNAs.

UNIT – III **9**

Feedback Systems and Power Amplifiers: Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques – Time and Frequency domain considerations Compensation Techniques- Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers – ACPR metric.

UNIT – IV **9**

PLL and Frequency Synthesizers: PLL: Linearised Model – Noise properties – Phase detectors –Loop filters and Charge pumps Frequency Synthesizers: Integer-N frequency synthesizers – Direct Digital Frequency synthesizers.

UNIT – V **9**

Mixer: Characteristics – Non-linear based mixers: Quadratic mixers – Multiplier based mixers: Single balanced and double balanced mixers – subsampling mixers, Oscillators: Describing Functions, Colpitts oscillators – Resonators – Tuned Oscillators – Negative resistance oscillators – Phase noise.

Total: 45

REFERENCES:

1. Lee T.H., “Design of CMOS RF Integrated Circuits”, 2nd Edition, Cambridge University Press, 2004.
2. Jan Crols and Michiel Steyaert, “CMOS Wireless Transceiver Design”, 1st Edition, Kluwer Academic Publishers, 2003.
3. Razavi B., “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	compare the performance of homodyne and heterodyne transceiver	Evaluating (K5)
CO2:	design input and output materials microwave and analyze the performance of single ended and double ended LNF	Creating (K6)
CO3:	analyze the stability performance of feedback systems and power amplifiers	Analyzing (K4)
CO4:	model the PLL and design the frequency synthesizer	Creating (K6)
CO5:	analyze the characteristics of mixers and design the RF carrier oscillations	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3		3		
CO2	3		3	3		
CO3				3		
CO4	3		3	2		
CO5	3		3	3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE13 DIGITAL IMAGE PROCESSING AND MULTI RESOLUTION ANALYSIS

(Common to Communication Systems, Mechatronics, Information Technology & Applied Electronics branches)

L	T	P	Credit
3	0	0	3

Preamble	To analyze the images in frequency domain and to perform various operations like enhancement, Restoration, Compression, Registration and Multi resolution analysis.
Prerequisites	Digital Signal Processing

UNIT – I **9**

Image Transforms: Orthogonal transforms – FT, DST, DCT, Hartley, Walsh hadamard, Haar, Radon, Slant Wavelet, KL, SVD and their properties.

UNIT – II **9**

Image Enhancement and Restoration: Image enhancement - Point operations - contrast stretching - clipping and thresholding - digital negative intensity level slicing - bit extraction. Histogram processing - histogram equalisation -modification. Spatial operations – smoothing spatial filters, sharpening spatial filters. Transform operations. Color image enhancement. Image Restoration – degradation model, Noise models, Unconstrained and Constrained restoration, Inverse filtering – removal of blur caused by uniform linear motion, Wiener filtering, Restoration by SVD and Homomorphic filtering

UNIT – III **9**

Image Compression: Image Compression – Need for data compression – Run length encoding – Huffman coding – Arithmetic coding – predictive coding- transform based compression, - vector quantization – block truncation coding. Image Segmentation: Point, Edge and line detection -thresholding-Region based approach Image Representation: boundary based – region based and intensity based description

UNIT – IV **9**

Registration and Multivalued Image Processing: Registration – geometric transformation – registration by mutual information Mutivalued image processing – colour image processing – colour image enhancement-satellite image processing- radiometric correction – other errors- multi spectral image enhancement- medical image processing – image fusion.

UNIT – V **9**

Wavelets and Multiresolution Processing: Image Pyramids – Subband coding – The Haar Transform – Multiresolution Expansion – Series Expansion – Scaling Function – Wavelet Function – Wavelet Transform in One Dimension- The Wavelet Series Expansion – The Discrete Wavelet Transform – The Continuous Wavelet Transform – The Fast Wavelet Transform – Wavelet transform in two dimensions– Applications in image denoising and compression.

Total: 45

REFERENCES:

1. Gonzalez Rafel C. and Woods Richard E., “Digital Image Processing”, 4th Edition, Prentice Hall, New York, 2017.
2. Chanda B., Dutta Majumder D., “Digital Image Processing and Analysis”, 2nd Edition, PHI Learning, 2011.
3. Abdeljalil Ouahabi, “Signal and Image Multiresolution Analysis”, John Wiley & Sons, 2012.
4. Rosenfield Azriel and Kak Avinash C., “Digital Picture Processing”, 2nd Edition, Academic Press Inc., New York, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	implement the image enhancement and image restoration techniques	Applying (K3)
CO2:	model the systems to enhance and restore the image optimally	Applying (K3)
CO3:	apply the coding technique to perform compression of images	Applying (K3
CO4:	apply the concepts of registration to fuse images of various modalities	Applying (K3)
CO5:	analyze the images in one dimension and two dimension simultaneously	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1				
CO2	3	2			2	
CO3	3	2			2	
CO4	3	2			2	1
CO5	3	2			2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE14 INDUSTRIAL DATA COMMUNICATION

(Common to Communication Systems & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	To appreciate industrial control protocol and layers involved in it and use suitable protocol for various conditioning methods
Prerequisites	Computer Communication Networks, Wireless Networks

UNIT – I **9**

Modbus: Modbus-Overview, protocol structure, Modbus troubleshooting – common problems-detailed troubleshooting: Modbus plus-protocol overview, common problems/faults-detailed troubleshooting. Modbus II-protocol architecture.

UNIT – II **9**

DNP 3 and IEC 60870-5: DNP 3-Overview, physical layer, data link layer, transport layer, application layer; IEC 60870-5 – standard-protocol architecture, physical layer, data link layer, application layer

UNIT – III **9**

Industrial Ethernet: 10Mbps Ethernet - Medium-access-control – signalling - Frame-format, transmission - reception. 802.2LLC- 100Mbps - Media-access – Autonegotiation – Industrial - Ethernet troubleshooting.

UNIT – IV **9**

AS-Interface and Devicenet: As-interface-overview, physical layer, data link layer-Device Net-physical layer, data link layer, application layer.

UNIT – V **9**

Data Highway Plus and HART: Data highway plus (DH 485)-overview; HART-protocol overview, physical layer, data link layer and application layer

Total: 45

REFERENCES:

1. Deon Reynders, Steve Mackay and Edvin Wright, "Practical Industrial Data Communication: Best Practice Technique", 1st Edition, Elsevier, 2005.
2. Deon Reynders, Steve Mackay and Edvin, "Practical Industrial Data Network Design and Installation", 1st Edition, Elsevier, 2004.
3. https://www.moxa.com/doc/man/Industrial_Protocols_Users_Guide_6e.pdf

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of Modbus used in modern data communication	Applying (K3)
CO2:	apply industry standard communication protocol for various conditioning methods	Applying (K3)
CO3:	analyze different Ethernet standards used in Industry	Analyzing (K4)
CO4:	examine need for AS-interface and its various layers	Analyzing (K4)
CO5:	implement Data Highway plus and HART protocol in industry	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3				2
CO2			3	3	3	3
CO3		3				
CO4		3				
CO5		3		3		

1 – Slight, 2 – Moderate, 3 – Substantial BT – Blooms Taxonomy

18COE15 WIRELESS SYSTEMS AND STANDARDS

L	T	P	Credit
3	0	0	3

Preamble	To focus on various wireless standards and systems applicable to random access techniques.
Prerequisites	Wireless Networks

UNIT – I **9**

Wireless Systems: Global System for Mobile Communication – Frequency Bands and Channels – Frames – Identity Numbers – Layers, Planes and Interfaces of GSM – International Mobile Telecommunications (IMT-2000) – Spectrum Allocation – Services provided by 3G Cellular Systems – Harmonized 3G Systems.

UNIT – II **9**

The IEEE 802.11 Standard: Introduction to IEEE 802.11 – General Description – Medium Access Control (MAC) for the IEEE 802.11 Wireless LANs – Physical Layer for IEEE 802.11 Wireless LANs; Radio systems – Physical Layer for IEEE 802.11 Wireless LANs – IR Systems – Conclusions and Applications.

UNIT – III **9**

The HIPERLAN Standard: Introduction - Terminology – Physical Layer -HIPERLAN Channel access Control (CAC) – HIPERLAN Medium Access Control (MAC) – Conclusions on HIPERLAN Type 1 – Future Brand Standards.

UNIT – IV **9**

Future Standard and Trends: The Evolution of HIPERLAN – The Evolution of IEEE 802.11 – Forthcoming IR Standards – Other RF Standards: Digital Enhanced Cordless Technology (DECT) –Bluetooth – Wireless ATM (WATM) – Home RF.

UNIT – V **9**

Recent Advances: Introduction – Ultra Wide Band (UWB) Technology – Characteristics – Signal Propagation – Current Status and Applications – Advantages – Disadvantages – Challenges and Future Directions.

Total: 45

REFERENCES:

1. Assuncion Santamaria, Francisco Lopez-Hernandez, "Wireless LAN Standards and Applications", Artech House, 2001.
2. Dharma Prakash Agarwal and Qing-Anzeng, "Introduction to Wireless and Mobile Systems", 3rd Edition,
Vikas Publishing House, New Delhi, 2010.
3. Neeli Prasad and Anand Prasad, "WLAN System and Wireless IP for Next Generation Communications", 1st Edition, Artec House, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	interpret the physical layer functionalities of baseband signaling schemes for global system for mobile communication	Applying (K3)
CO2:	analyze the physical layer functionalities of IEEE 802.11 sensor devices	Analyzing (K4)
CO3:	analyze MAC frame modeling of HIPERLAN standard	Analyzing (K4)
CO4:	analyze the DECT, Bluetooth, WATM and Home RF	Analyzing (K4)
CO5:	apply the recent advances in UWB technology	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			3	2	2
CO2	3	2		2	3	2
CO3	3	1		2	1	2
CO4	2		3		1	
CO5	3		2		2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE16 SATELLITE NAVIGATIONAL SYSTEM

L	T	P	Credit
3	0	0	3

Preamble	This course will cover the most recent research topics in satellite navigational systems. Topics such as receiver processing, propagation impact, GLONASS, GALILEO, BEIDOU, QZSS and IRNSS satellite systems are precisely covered.
Prerequisites	Satellite Communication

UNIT – I **9**

Introduction and Satellite Signals: Satellite revolution, principle of satellite navigation, Effects of Doppler and of Ionospheric Propagation, Satnav Signal Characteristics, Satellite Navigation Signal Structure

UNIT – II **9**

Receiver Processing, Error Sources and Characterization: Correlator Output SNR, Effective C/N0, And I/S, Error Sources and Error Characterization

UNIT – III **9**

Satellite Navigation Systems: GPS History and Plans, GPS Description, Satellite-Based Augmentation Systems, GLONASS, GALILEO, BEIDOU SYSTEM, QZSS, IRNSS

UNIT – IV **9**

Receiver Processing: Receiver front end architecture and frequency plans, Code tracking, position, velocity and time calculation

UNIT – V **9**

Specialized Topics: Interference, multipath, augmentations using differential satellite navigation, assisted satellite navigation, integrated receiver processing

Total: 45

REFERENCES:

1. John W. Betz, "Engineering Satellite-Based Navigation and Timing," 1st Edition, John Wiley & Sons Publisher, 2015.
2. Kaplan E.D. and Hegarty C., "Understanding GPS: Principles and Applications", 2nd Edition, Artech House, 2006.
3. Van Diggelen F., "A-GPS: Assisted GPS, GNSS, and SBAS", 1st Edition, Artech House, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	apply the knowledge obtained in the satellite navigation signal characteristics and the effects of Doppler and of Ionospheric Propagation	Applying (K3)
CO2:	analyze the error sources and noise characteristics in receivers	Analyzing (K4)
CO3:	compare the current Satellite Navigation Systems	Understanding (K2)
CO4:	analyze the satellite navigation signal processing in the receivers in terms of time, velocity and position calculation	Analyzing (K4)
CO5:	analyze the effect of interference and multipath to implement the processing techniques in the receiver	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					
CO2		3				
CO3	3					
CO4		3			3	
CO5					3	

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy

18COE17 SPEECH AND AUDIO SIGNAL PROCESSING

L	T	P	Credit
2	0	2	3

Preamble	To learn about speech and language sciences, such as linguistics, phonetics and psychoacoustics and also deal with different algorithms for analysis of speech signals.
Prerequisites	Digital Signal Processing

UNIT – I **6**

Mechanism of Speech: Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system – Psycho acoustics

UNIT – II **6**

Feature Extraction: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual – Log–Spectral Distance, Cepstral analysis, LPC, PLP and MFCC Coefficients

UNIT – III **6**

Time and Frequency Domain Methods for Speech Processing: Time domain parameters of Speech signal - Methods for extracting the parameters: Energy, Average Magnitude - Zero crossing Rate (ZCR)- Silence Discrimination using ZCR and energy.

UNIT – IV **6**

Speech Modeling and Synthesis: Hidden Markov Model (HMM)for speech recognition, Viterbi algorithm, Training and testing using HMMs, Adapting to variability in speech (DTW), Language models

UNIT – V **6**

Speaker Recognition: Issues in speaker recognition and speech synthesis of different speakers. Text to speech conversion, Calculating acoustic parameters, synthesized speech output performance and characteristics of text to speech, Voice processing hardware and software architecture

List of Experiments:

1. Recording a speech signal and analyzing its characteristics and its frequency components
2. Extracting features from the recorded speech signal using LPC, PLP, MFCC
3. Time and Frequency Domain analysis of a signal using MATLAB
4. Modeling a speech signal using Hidden Markov Model
5. Developing an application (Speaker Recognition, Speech Identification)

Lecture: 30, Practical: 30, Total: 60

REFERENCES:

1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
2. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006.
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.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	qualitatively describe the mechanisms of human speech production and how the articulation mode of different classes of speech sounds determines their acoustic characteristics	Understanding (K2)
CO2:	identify and apply the suitable algorithm and extract the speech signal features for further processing	Applying (K3)
CO3:	analyse the speech signals by extracting time and frequency domain parameters	Analyzing (K4)
CO4:	model a speech signal using Hidden Markov model	Analyzing (K4)
CO5:	develop algorithms to recognize and synthesize different types of speakers	Creating (K6)
CO6:	analyze the frequency components of a speech signal	Analyzing (K4), Manipulation (S2)
CO7:	extract the features and develop a model for a speech signal	Applying (K3), Manipulation (S2)
CO8:	develop a speech application	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				2	
CO2	3	2			3	
CO3	3	2			3	
CO4	3	2			3	3
CO5	3	3			3	3
CO6	3	3			3	3
CO7	3	3			3	3
CO8	3	3			3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Blooms Taxonomy