Dr.Mahalingam College of Engineering and Technology

(An Autonomous Institution)

Pollachi – 642 003

Curriculum and Syllabi

M.E.Communication Systems

SEMESTER I to IV

REGULATIONS 2019

Department of Electronics and Communication Engineering

Vision

To strive for excellence in Electronics and Communication Engineering education, research and technological services imparting quality training to students to make them competent and motivated engineers.

Mission

- Impart quality engineering education in the areas of Electronics, Signal Processing, Embedded Systems and Communication Networks.
- Equip the students with professionalism and technical expertise to provide appropriate solutions to societal industrial needs.
- Provide stimulating environment for continuously updated facilities to pursue research through creative thinking and team work.

OBE Coordinator | Programme Coordinator | Head of the Department

Head - OBE

Programme: M.E. Communication systems

Programme Educational Objectives (PEOs) - Regulations 2019

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Exhibit the sustained knowledge in the field of Communication Systems and possess leadership capability in their professional careers.

PEO2. Develop optimal solutions to the needs of industry and society in the area of RF Communication systems and networking.

PEO3. Carryout research in multidisciplinary areas allied with Communication Engineering through lifelong learning

Programme Outcomes (POs) - Regulations 2019

On successful completion of M.E. Communication System, graduating students/graduates will be able to:

PO1. Achieve widespread knowledge in Communication Systems with an ability to analyze and synthesize Communication Engineering and Networking

PO2. Write and present a substantial technical report/document for communicating the research findings.

PO3. Apply appropriate techniques and modern tools to analyze and test Communication systems

PO4. Practice professional ethics in multidisciplinary environment with a desire for life-long learning

Programme Specific Outcomes (PSOs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PSO1: Provide feasible solutions to the problem in the areas of Microwave, RF Communication, Networking and Signal processing

PSO2: Develop Communication subsystems using recent techniques

OBE Coordinator | Programme Coordinator | Head of the Department

Head - OBE

Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'
Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 www.mcet.in

Programme: M.E COMMUNICATION SYSTEMS
2019 REGULATIONS
Curriculum for Semester I to IV
Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COCN1101	Advanced Communication Networks	3	0	0	3	100	-
19COCN1102	Wireless and Mobile Communication	3	0	0	3	100	-
19COFG1101	Research Methodology and IPR	3	0	0	3	100	All
XXXXXXXXXX	Professional Elective – I	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – II	3	0	0	3	100	-
19COCN2101	Advanced Communication Networks Laboratory	0	0	4	2	100	-
19COCN2102	VLSI and Wireless Communication Laboratory	0	0	4	2	100	-
19SHAG1101	English for Research Paper Writing	2	0	0	-	100	All
TOTAL		**17**	**0**	**8**	**19**	**800**	

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COCN1201	Antennas and Radiating Systems	3	0	0	3	100	-
19COCC1001	Advanced Digital Signal Processing	3	0	0	3	100	CO & AE
19COCN1202	VLSI Signal Processing	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – III	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – IV	3	0	0	3	100	-
19COCN2201	RF System Design Laboratory	0	0	4	2	100	-

Passed in Board of Studies meeting held on 23.03.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener

BOS Chairman

Dr. R. SUDHAKAR, B.E., M.E., Ph.D.
Head, Electronics and Communication Engineering
Dr. Mahalingam College of Engineering and Technology

19COPN3201	Mini Project with Seminar	0	0	4	2	100	-
19SHAG1201	Teaching and Learning in Engineering	2	0	0	-	100	All
TOTAL		**17**	**0**	**8**	**19**	**800**	

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
XXXXXXXXXX	Professional Elective – V	3	0	0	3	100	-
XXXXXXXXXX	Open Elective	3	0	0	3	100	-
19COPN5301	Project – I	0	0	20	10	200	-
TOTAL		**6**	**0**	**20**	**16**	**400**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COPN5401	Project – II	0	0	32	16	400	-
TOTAL		**0**	**0**	**32**	**16**	**400**	

Total Credits: 70

Passed in Board of Studies meeting held on 23.03.19

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Approved in Academic Council meeting held on 27.07.19

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Professional Electives – I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COEN1101	Wireless Sensor and Optical Networks	3	0	0	3	100	-
19COEN1102	VLSI for Wireless Communication	3	0	0	3	100	-
19COEN1103	Statistical Information Processing	3	0	0	3	100	-

Professional Electives – II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COEN1104	Cognitive Radio	3	0	0	-	100	-
19COEN1105	RF and Microwave Circuit Design	3	0	0	-	100	-
19COEC1101	DSP Architecture	3	0	0	-	100	CO & AE

Professional Electives – III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COEN1201	Satellite Communication	3	0	0	-	100	-
19COEN1202	Internet of Things	3	0	0	-	100	-
19COEN1203	Voice and Data Networks	3	0	0	-	100	-

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Professional Electives – IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COEN1204	Markov Chain and Queuing System	3	0	0	3	100	-
19COEN1205	MIMO System	3	0	0	3	100	-
19COEN1206	Programmable Networks	3	0	0	3	100	-

Professional Electives – V

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19COEN1301	High Performance Networks	3	0	0	3	100	-
19COEN1302	Pattern Recognition and Machine learning	3	0	0	3	100	-
19COEN1303	Remote Sensing	3	0	0	3	100	-

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Open Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19COOC1301	Cryptography and Network Security	3	0	0	3	100
19COOC1302	Advanced Embedded System	3	0	0	3	100
19CPOC1301	Business Analytics	3	0	0	3	100
19CPOC1302	Cyber Security & Computer Forensics	3	0	0	3	100
19CCOC1301	Automation Systems	3	0	0	3	100
19CCOC1302	Enterprise Resource Planning	3	0	0	3	100
19STOC1301	Safety Engineering	3	0	0	3	100
19STOC1302	Waste to Energy	3	0	0	3	100

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2019 REGULATION -COURSE CODE GENERATIONPROCEDURE

1	2	3	4	5	6	7	8	9	10
1	9	A	E						

REGULATION

BOARD /DEPARTMENTS	
CHARCTERTYPE-ALPHABET	
AE	APPLIEDELECTRONICS
CC	CAD / CAM
CO	COMMUICATION SYSTEMS
CP	COMPUTER SCIENCE
ST	STRUCTURAL
CA	COMPUTER APPLICATIONS

SEMESTER No.	
CHARCTERTYPE-NUMBER	
1to4	SEMESTER
0	FLOATINGSEMESTER

MODEOFASSESSMENT	
CHARCTERTYPE-NUMBER	
1	THEORY
2	PRACTICAL
3	MINIPROJECT
4	SEMINAR
5	PROJECT

SEQUENCE NUMBER
CHARCTERTYPE-NUMBER
01,02,03….99

COURSETYPE	
CHARCTERTYPE – ALPHABET	
F	FUNDAMENTAL COURSE
C	PROFESSIONAL CORE
E	PROFESSIONAL ELECTIVE
O	OPEN ELECTIVE
A	AUDIT COURSES
P	EMPLOYABILITY ENHANCEMENT COURSES
V	OCC

COMMON TOANYBOARD/DEPARTMENTS	
CHARCTERTYPE-ALPHABET	
G	GENERIC (COMMON TOALL BRANCHES–ex COMMUNICATION SKILLS)
N	NON COMMON COURSE(INDIVIDUAL)
C	COMMON COURSE(ex COMMON TO AE,CO,CS)

Regulations 2019

Detailed Syllabi for Semesters I to IV

Semester I

Course Code:19COCN1101		Course Title: Advanced Communication Networks	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the need for the TCP congestion control mechanism
2. Differentiate the services in communication networks
3. Explain the mechanisms of Quality of Service in networking
4. Explain Packet classification algorithms
5. Explain Admission control in Internet

Unit I TCP/IP **9 Hours**

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

Unit II Real Time Communications Over Internet **9 Hours**

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

Unit III Packet Scheduling Algorithms **9 Hours**

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic. Active Queue Management - RED, WRED.

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Unit IV **Admission Control** **9 Hours**

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

Unit V **IP Switching and MPLS** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Analyze the TCP congestion control mechanism.	Analyze
CO2: Identify the services in Communication Networks.	Apply
CO3: Describe the mechanisms of Quality of Service in networking.	Understand
CO4: Explain Packet classification algorithms.	Understand
CO5: Explain Admission control in Internet.	Understand

Reference Book(s):

R1. Jean Wairand and PravinVaraiya, "High Performance Communications Networks", Morgan Kaufmann Publishers, 2nd edition, 2000

R2. Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queueing Systems for the Internet", Springer Verilag, 2001

R3. Zhang Wang, "Internet QoS", Morgan Kaufman Publishers, 2001.

R4. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" , Morgan Kaufman Publishers, 2004.

R5. George Kesidis, ATM Network Performance, Kluwer Academic, 2000.

R6. Research Papers

Web References:

1. http://kfall.net/ucbpage/EE122/lec26/sld001.htm
2. http://intronetworks.cs.luc.edu/current/uhtml/queuing.html

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Course Code:19COCN1102	Course Title: Wireless and Mobile Communication		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:	
1.	Describe the operation of various wireless communication systems
2.	Apply path loss and shadowing models for wireless communication and analyze their influences on system's performance
3.	Analyze the Capacity of Time varying and Time Invariant Channels
4.	Apply frequency-reuse concept in mobile communications
5.	Describe modern mobile communication techniques

Unit I Introduction **9 Hours**

History of wireless communication- wireless vision – Technical Issues- current wireless systems: Cellular Telephone Systems –Cordless Phones-Wireless LANs-Wide Area Wireless Data Services - Broadband Wireless Access-Paging Systems -Satellite Networks-Low-Cost Low-Power Radios: Bluetooth and Zigbee- Ultra wideband Radios-The Wireless Spectrum: Methods for Spectrum Allocation-Spectrum Allocations for Existing Systems.

Unit II Path Loss and Shadowing **10 Hours**

Radio wave propagation- transmit and receive signal models- free space path loss- two-ray model- simplified path loss model- Shadow Fading-Combined Path Loss and Shadowing -Outage Probability under Path Loss and Shadowing- Statistical Multipath Channel Models: Time-Varying Channel Impulse Response- Narrowband Fading Models: Autocorrelation, Cross Correlation, and Power Spectral Density - Envelope and Power Distributions-Level Crossing Rate and Average Fade Duration-Wideband Fading Models: Power Delay Profile-Coherence Bandwidth-Doppler Power Spectrum and Channel Coherence Time.

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Unit III **Capacity of Wireless Channel** **8 Hours**

Capacity in AWGN-Capacity of Flat-Fading Channels - Capacity of Frequency-Selective Fading Channels: Time-Invariant Channels -Time-Varying Channels

Unit IV **Cellular Systems and Infrastructure Based Wireless Networks** **9 Hours**

Cellular system design- Frequency Reuse in cellular systems- Frequency reuse in Code division systems- Frequency reuse in time and frequency division systems- dynamic resource allocation in cellular systems- Area spectral efficiency

Unit V Higher Generation Cellular Standards **9 Hours**

Review of 2G Standards,3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, Introduction to 5G

Course Outcomes:	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the operation of various wireless communication systems	Understand
CO2: Apply path loss and shadowing models for wireless communication and analyze their influences on system's performance.	Apply
CO3: Analyze the Capacity of Time varying and Time Invariant Channels for Flat Fading and Frequency Selective Fading.	Analyze
CO4: Apply frequency-reuse concept in mobile communications to explore its effects on interference, system capacity, handoff techniques	Apply
CO5: Describe modern mobile communication techniques like VoLTE and 5G.	Understand

Reference Book(s):

R1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.

R2. V.K.Garg, J.E.Wilkes, "Principle & Application of GSM", Pearson Education, 5th edition, 2008.

R3. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009

R4. T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002.

R5. William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 1995.

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Web References:

1. https://swayam.gov.in/nd1_noc19_ee48
2. https://www.igi-global.com/dictionary/communicame/34130
3. https://www.britannica.com/technology/wireless-communications

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Course Code: 19COFG1101	Course Title: Research Methodology and IPR (Common to PG Programmes)		
Course Category: Foundation Course		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the overview of research methodology.
2. Explain the attitude measurements, scales and sampling methods
3. Apply hypotheses testing in research problem
4. Elucidate the research report writing and presentation effectively
5. Apply patent and copyright for their innovative works.

Unit I Overview of Research Methodology **9 Hours**

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

UNITII Attitude Measurements, Scales and Measuring Methods **9 Hours**

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

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Unit III Hypotheses Testing **10 Hours**

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests)

Unit IV Report Writing and Presentation **8 Hours**

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation

Unit V Patenting **9 Hours**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1. Describe the overview of research methodology.	Understand
CO 2. Explain the attitude measurements, scales and sampling methods	Understand
CO 3. Apply hypotheses testing in research problem.	Apply
CO 4. Elucidate the research report writing and presentation effectively.	Understand
CO 5. Apply patent and copyright for their innovative works	Apply

Reference Books

R1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

R2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in NewTechnological Age", Clause 8 Publishing, 2016.

R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.

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Course Code:19COEN1101	Course Title: Wireless Sensor and Optical Networks		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Discuss the various applications of WSN
2. Explain the MAC and routing protocols for WSN
3. Explain the various components of optical networks
4. Design WDM networks
5. Explain the concept of access and packet switching networks

Unit I **Application of Wireless Sensor Networks** **9 Hours**

Basic Sensor Network Architectural Elements, Applications of WSN-Range, Examples of Category 1 and 2 WSN Applications, Sensor node technology-Overview- Hardware and Software- Sensor Taxonomy- WN Operating Environment.

Unit II **Protocols For Wireless Sensor Networks** **9 Hours**

Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC Case Study, Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Challenges and Design Issues in Wireless Sensor Networks.

Unit III **Optical Networks and Components** **9 Hours**

Second-Generation Optical Networks, The Optical Layer, Transparency and All-Optical Networks, Components-Coupler-Isolator and Circulator- Multiplexers and Filters- Mach-Zehnder interferometers, Optical Amplifier-EDFA, Electro-Optic Switch, Wavelength Convertors.

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Unit IV WDM Networks **9 Hours**

Optical Line Terminals, Optical Add/Drop Multiplexers, Optical Cross connects, OADM Architectures, Network Management Functions, Optical Layer Services and Interfacing, WDM Network Design- Cost Trade-Offs: A Detailed Ring Network Example- LTD and RWA Problems.

Unit V Access Networks and Photonic Packet Switching **9 Hours**

Access Networks -Network Architecture Overview, Enhanced HFC, Fiber to the Curb (FTTC),Photonic Packet Switching -Optical Time Division Multiplexing, Synchronization Header Processing, Buffering, Burst Switching, Test beds

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
1. Discuss the various applications of WSN	Understand
2. Explain the MAC and routing protocols for WSN	Understand
3. Explain the various components of optical networks	Understand
4. Design WDM network using WDM Elements	Apply
5. Explain the concept of access and packet switching networks.	Understand

Reference Book(s):

R1. Kazem Sohraby ,Daniel Minoli ,Taieb Znati , 'Wireless Sensor Networks: Technology, Protocols, and Applications' John Wiley & Sons Publishers, 2007.

R2.Rajiv Ramaswami,Kumar N. Sivarajan and Galen H. Sasaki, 'Optical Networks A Practical Perspective, 3rd edition, Morgan Kaufmann Publishers,2010.

R3. C. Siva Rama Murthy and Mohan Guruswamy, ' WDM Optical Networks: Concepts, Design and Algorithms' ,2nd Ed., 2003, PEI.

R4. Andreas Willig and Holger Karl, 'Protocols and Architectures for Wireless Sensor Networks', John Wiley & Sons Publishers, 2007.

R5. Biswanath Mukherjee, 'Optical Communication Networks', McGraw-Hill, 1997.

R6. Biswanath Mukherjee, 'Optical WDM Networks', McGraw-Hill, 1997.

R7. Waltenegus Dargie and Christian Poellabauer, 'Fundamentals of Wireless Sensor Networks Theory and Practice', A John Wiley and Sons, Ltd., Publication.2010

Web References:

1. http://hscc.cs.nthu.edu.tw/~sheujp/lecture_note/sensys-ch10902.pdf
2. http://www.eng.ucy.ac.cy/christos/courses/ECE654/Presentations/optical.pptx

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Course Code:19COEN1102	Course Title: VLSI for Wireless Communication		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives:

The course is intended to:

1. Explain the fundamental concepts of components and devices
2. Describe about mixers
3. Explain the design of frequency synthesizers
4. Discuss the principles of subsystems and their implementations
5. Explain the concepts and applications of VLSI for wireless communication

Unit I Components and Devices **9 Hours**

Integrated inductors, resistors, MOSFET AMPLIFIER DESIGN: Low Noise Amplifier -Wideband LNA-Narrowband LNA-Impedance Matching-Power Amplifiers

Unit II Mixers **9 Hours**

Balancing Mixer - Qualitative Description of the Gilbert Mixer-Conversion Gain–distortion-Low Frequency Case: Analysis of Gilbert Mixer–Distortion-High-Frequency Case–Noise-A Complete Active Mixer. Switching Mixer –Noise- Sampling Mixer- Noise.

Unit III Frequency Synthesizers **9 Hours**

Phase Locked Loops-Voltage Controlled Oscillators-Phase Detector–Analog Phase Detectors–Digital Phase Detectors-Frequency Dividers-LC Oscillators-Ring Oscillators-Phase Noise-A Complete Synthesizer Design Example (DECT Application).

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Unit IV **Sub Systems and Implementations** **9 Hours**

Data converters in communications, adaptive Filters, equalizers and transceivers VLSI architecture for Multitier Wireless System - Hardware Design Issues for a Next generation CDMA System.

Unit V **Instructional Activities** **9 Hours**

Survey minimum of four VLSI Circuit design for wireless communication networks and carry out simulation of those networks.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the fundamental concepts of components and devices	Understand
CO2. Describe about mixers	Understand
CO3. Explain the design of frequency synthesizers	Understand
CO4. Discuss the principles of subsystems and their implementations	Understand
CO5. Explain the concepts and applications of VLSI for wireless communication	Understand

Reference Books:

R1. B.Razavi,"RF Microelectronics", Prentice-Hall, 1998.
R2. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.
R3. Thomas H.Lee, "The Design of CMOS Radio Frequency Integrated Circuits', Cambridge University Press, 2003
R4. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI Wireless Design Circuits and Systems", Kluwer Academic Publishers, 2000.
R5. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw Hill, 1999.
R6. J. Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer AcademicPub., 1997.

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Course Code:19COE N1103	Course Title: Statistical Information Processing		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Apply Random process and Probability theory
2. Formulate random signal modeling
3. Design and analyse estimators based on CRLB, MLE, MAP and various criteria
4. Apply estimation algorithms for signal processing applications
5. Apply source coding and channel coding techniques

Unit I Review on Random Variables **9 Hours**

Probability distribution and density functions, Discrete &Continuous Random Variables, Vector-space representation of Random variables, Independent, Uncorrelated and Orthogonal random variables, Chebyshev's Inequality, Central Limit theorem, Expectations and Moments.

Unit II Random Processes **9 Hours**

Discrete-Time Random Processes Stationary process, Autocorrelation and Auto covariance functions, Wide-Sense Stationary, Spectral representation of random signals, Properties of power spectral density, Ergodicity, Gaussian Process and White noise process.

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Unit III **Decision Theory – Classical and Bayesian Approach** **9 Hours**

Hypothesis Testing, Principles of Estimation and its properties, Bayes' Criterion, Minmax Criterion, Neyman-Pearson Criterion, MVUE, CR Bound, MLE, EM, MAP,LSE, RLSE, Best Linear Unbiased estimator, Bayes estimation and MMSE.

Unit IV **Application of Estimation in Signal Processing** **9 Hours**

Range Estimation, Frequency, Estimation, Bearing Estimation, Autoregressive Parameter Estimation

Unit V **Information Coding and its Application** **9 Hours**

Source Coding Techniques - Huffman, Arithmetic, Adaptive, Run Length, LZW, LZ-77, LZ-78. Discrete Memory Less Channel, Mutual Information, Channel Capacity theorem, Channel Coding Theorem, Differential entropy and Mutual Information for continuous Ensembles. Group, Ring & Field, Vector, GF addition, multiplication rules. BCH codes and Decoder, Reed- Solomon codes & Decoder, Implementation of Reed Solomon encoders and decoders.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Apply Random process and probability theory for information processing and communication.	Apply
CO2.	Formulate random signal modeling to demonstrate a communication system.	Apply
CO3.	Design and analyze efficient algorithms for estimation.	Create
CO4.	Estimate the signal in real time applications of Communication systems.	Evaluate
CO5.	Apply source coding and channel coding techniques for effective information processing.	Apply

Reference Books:

R1. Peyton Z. Peebles, Probability, Random Variables and Random Signal Principles, 2nd Edition, 1980.

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R2. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing", McGraw-Hill, 2005.

R3. Mourad Barkat , "Signal Detection and Estimation", Artech House, 2 nd Edition, 2005.

R4. Steven M.Kay, " Fundamentals of Statistical Signal Processing", Vol I Estimation Theory, Prentice Hall Inc, 1998.

R5. F. J. MacWilliams and N. J. A. Sloane, "The Theory of Error-Correcting Codes", New York, North-Holland, 1977.

R6. R G. Gallager, "Information theory and reliable communication", Wiley, 1st edition, 1968.

R7. A. Papoulis and S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, Fourth Edition, Mc Graw Hill, 2002.

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Course Code: 19COEN1104	Course Title: Cognitive Radio		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the fundamental concepts of cognitive radio
2. Explain various spectrum sensing methods
3. Analyze different optimization programming algorithms
4. Explain fundamental issues of dynamic spectrum access and management
5. Explain the concept of spectrum trading

Unit I Introduction to Cognitive Radios **9 Hours**

Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Unit II Spectrum Sensing **9Hours**

Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market)-Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

Unit III Optimization Techniques of Dynamic Spectrum Allocation **9 Hours**

Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

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Unit IV **Dynamic Spectrum Access and Management** **9 Hours**

Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit V **Spectrum Trading** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Describe the fundamental concepts of cognitive radio networks.	Understand
CO2. Explain the various spectrum sensing methods and its research challenges in cognitive radio	Understand
CO3. Analyze the dynamic spectrum allocation concept using appropriate optimization programming technique.	Apply
CO4. Explain fundamental issues regarding dynamic spectrum access, the radio-resource management for spectrum exploitation.	Understand
CO5. Explain the various spectrum trading methods	Understand

Reference Book(s):

R1. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.

R2. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.

R3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.

R4. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009

R5. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Web References:

1. https://nptel.ac.in/courses/108107107/

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Course Code:19COEN1105	Course Title: RF and Microwave Circuit Design		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks: 100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Design Microwave Impedance matching networks
2. Examine the microwave passive devices
3. Use transformations in designing a filter network
4. Categorize the semiconductor devices and integrated circuits based on the design aspects
5. Construct amplifier by analyzing noise, gain and stability requirements

Unit I Microwave Network Analysis and Impedance Matching 9 Hours

Impedance, equivalent voltages and currents, Impedance and admittance matrices, The scattering matrix, transmission matrix, Impedance Matching: Matching with lumped elements, Stub matching-Single and double stub using Smith chart, The Quarter-wave Transformer.

Unit II Microwave Components 9Hours

Microwave Power dividers: T-junction type, Wilkinson type, directional couplers: 90 degree and 180 degree couplers, Coupled Line Directional Couplers, Lange Coupler, Ferromagnetic devices: Isolators, Phase shifters.

Unit III Microwave Filters 9 Hours

Filter Design by the Insertion Loss Method - Maximally Flat Low Pass Filter prototype, Filter Transformations, Filter Implementation, Stepped – Impedance Low-pass filters.

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Unit IV **Microwave Semiconductor Devices and Integrated Circuits** **9Hours**

PIN diode, Tunnel diodes, Varactor diode, Schottky diode, Microwave BJTs, GaAs FETs. Microwave Integrated Circuits: MIC materials, Types of MICs, Hybrid Vs Monolithic MICs.

Unit V **Noise, Stability, Gain Concepts and Amplifier Design** **9 Hours**

Noise in Active Networks: Sources of Noise, Noise Figure of Cascaded Networks, Constant Noise Figure Circles. Stability, Power gain equations, constant gain circles, Amplifier Design: Single-stage transistor amplifier, low noise amplifier and broadband amplifier.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Design Microwave Impedance matching networks using high frequency network parameters	Apply
CO2. Analyze the microwave passive components like dividers couplers to arrive at their Characteristics	Analyze
CO3. Design a microwave filter by adopting suitable transformations	Apply
CO4. Justify the choice of Microwave semiconductor devices and integrated circuits from the design aspects	Analyze
CO5. Design a single stage amplifier and a low noise amplifier analyzing the noise, gain and stability	Apply

Reference Book(s):

R1. Matthew M. Radmanesh Ph.D, "Advanced RF & Microwave Circuit Design: Ultimate Guide to Superior Design", Author House, 2009.

R2. David.M. Pozar, "Microwave Engineering," 4th Edition, John Wiley and Sons Inc., 2011.

R3. Samuel.Y. Liao, "Microwave Circuit Analysis and Amplifier Design", Prentice Hall, 1987.

R4. Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Prentice Hall PTR, 2001.

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Course Code:19COEC1101	Course Title: DSP Architecture (Common to CO & AE)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks: 100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the fundamentals of DSP hardware
2. Discuss the TMS family of processors
3. Develop programs for DSP applications
4. Explain multi-core DSPs and parallel processing
5. Discuss FPGA based DSP systems

Unit I Programmable DSP Hardware **9 Hours**

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

Unit II Structural and Architectural Considerations **9Hours**

Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System,

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Peripheral Devices, Illustrative Examples for assembly coding.

Unit III **VLIW Architecture** **9 Hours**

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

Unit IV **Multi-Core DSPS** **9 Hours**

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

Unit V **FPGA Based DSP Systems** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the fundamentals of DSP hardware architecture	Understand
CO2: Discuss the TMS family of fixed point and floating point processors	Understand
CO3: Develop programs for DSP applications using Code Composer Studio environment	Apply
CO4: Explain the concepts of multi-core DSPs and parallel processing	Understand
CO5: Discuss the implementation of DSP based applications in FPGA	Understand

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Reference Book(s):

R1. B. Venkataramani, M. Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2011

R2. M. Sasikumar, D. Shikhare, Ravi Prakash, "Introduction to Parallel Processing", 1st Edition, PHI, 2006.

R3. Fayez Gebali, "Algorithms and Parallel Computing",1st Edition, John Wiley & Sons, 2011

R4. Ann Melnichuk,Long Talk, "Multicore Embedded systems", 1st Edition, CRC Press,2010.

R5. Wayne Wolf, "High Performance Embedded Computing: Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.

R6. E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands,2007.

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Course Code:19COCN2101	Course Title: Advanced Communication Networks Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Practice configuring a network using basic Networking commands
2. Analyze the various TCP congestion control mechanisms
3. Select an appropriate scheduling algorithm for an application
4. Explain the configuration of DHCP & DNS
5. Compare different routing algorithms

List of Experiments

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
    1. Configuring NIC's IP Address
    2. Determining IP Address and MAC Address using if-config command
    3. Changing IP Address using if-config
    4. Static IP Address and Configuration by Editing
    5. Determining IP Address using DHCP
    6. Configuring Hostname in /etc/hosts file
3. Configuration of IP addressing for a given scenario for a given set of topologies.

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4. Performance Evaluation of TCP Congestion control Mechanisms.
5. Simulation of Resource reservation Protocol(RSVP).
6. Network design and testing using simulation tools.
7. Simulation of Queuing and Scheduling algorithms.
8. Configure DHCP server and DHCP clients.
9. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS.
10. Perform a case study about the different routing algorithms to select the network path with its optimum and economical during data transfer.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Experiment to Configure the network devices using commands	Analyze
CO2. Analyze the performance of the network	Analyze
CO3. Choose appropriate scheduling algorithm for an application	Analyze
CO4. Experiment to Configure a DHCP and DNS	Analyze
CO5. Compare different routing algorithms	Analyze

Reference Book(s):

R1. Lab Manual prepared by ECE department

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Course Code:19COCN2102	Course Title: VLSI and Wireless Communication Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0:4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Design Low Noise Amplifier and Mixer for a given specification
2. Demonstrate PLL and VCO design using SPICE simulation
3. Design Ring oscillator and analyse stage ratio
4. Integrate Layout design of Transreceiver Front end
5. Design data converters for communication application.

List of Experiments

1. Design a LNA for given specifications. Perform DC and transient analysis.
2. Design Gilbert mixer for given specifications. Perform DC and transient analysis using SPICE simulation
3. Design PLL for given specifications perform analysis using SPICE simulation
4. Design VCO for given specifications perform analysis using SPICE simulation
5. Design Ring oscillator and show the effect of stage variation on the output frequency
6. Design a transreceiver front end and perform impedance matching at layout level
7. Design a CMOS A/D converter for data communication application.

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8. Design a CMOS D/A converter for data communication application.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Design Low Noise Amplifier and Mixer for a given specification.	Analyze
CO2. Demonstrate PLL and VCO design using SPICE simulation.	Analyze
CO3. Design Ring oscillator and analyse stage ratio.	Apply
CO4. Integrate Layout design of Trans receiver Front end.	Analyze
CO5. Design data converters for communication application.	Analyze

Reference Book(s):

R1. Lab Manual prepared by ECE department

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Course Code:19SHAG1101	Course Title: English for Research Paper Writing (Common to PG Programmes)		
Course Category: Audit Course		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Credits:-	Total Contact Hours:30	Max Marks:100

Course Objectives

The course is intended to:

1.Describe how to improve the writing skills and level of readability

2.Apply research writing skills in each section

3.Explain the skills needed when writing titles

Unit I **Research Plan and Preparatory Tools** **10 Hours**

Plan - Word Order - Break up long sentences - Paragraph and Sentence Structures - Concise and Remove Redundancy - Avoid Ambiguity and Vagueness - Preparation

Unit II **Grammar for Research** **10 Hours**

Expand the vocabulary & phrases – Grammar & punctuation - Ensure the content - Review of the Literature - Conclusions

Unit III **Key Skills for Preparation** **10 Hours**

Clarify Who Did What – Highlight the Findings - Hedge and Criticise - Paraphrase - Check Plagiarism - Sections of a Paper - Abstracts –Introduction - Key skills needed when writing - a Title, an Abstract, an Introduction, a Review of the Literature, Methods, Results, Discussion, Conclusions

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe how to improve the writing skills and level of readability	Understand
CO 2: Apply research writing skills in each section	Apply
CO 3: Use the skills needed when writing titles	Apply

Reference Book(s):

R1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

R2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

R3. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

Web References:

1. https://writing.wisc.edu/handbook/assignments/planresearchpaper/
2. https://libguides.usc.edu/writingguide/grammar
3. https://grammar.yourdictionary.com/writing/how-to-write-a-research-paper.html
4. https://wordvice.com/seminar-how-to-write-an-effective-research-paper/

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Semester II

Course Code:19COCN1201	Course Title: Antennas and Radiating Systems		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

1. Explain the behavior of antenna in terms of its parameters
2. Apply beam forming methods to construct smart antenna
3. Analyze the radiation characteristics of Aperture antenna
4. Design a Microstrip patch antenna
5. Measure special antenna characteristics using a suitable instrument

Unit I Fundamentals of Antenna **9 Hours**

Antenna Radiation mechanism, Types of Antennas, Radiation pattern, near and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, Radiation from surface and line current distributions – dipole, monopole, loop antenna.

Unit II Linear Arrays **9 Hours**

Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, planar array, Design consideration, Smart antenna array- Benefits of Smart antennas, Types of Smart antenna - fixed beam, switched beam and adaptive antenna system.

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Unit III **Aperture Antennas** **9 Hours**

Field equivalence principle, Radiation Equations, Radiation from Rectangular and Circular apertures-Uniform aperture distribution on an infinite ground plane, Horn antenna, Reflector antennas- parabolic reflector

Unit IV **Microstrip Antenna** **9 Hours**

Radiation Mechanism, Basic Characteristics, Feeding mechanisms, Rectangular patch-Radiation analysis from cavity model, Circular patch, Input impedance, Microstrip array and feed network, Application of microstrip array antenna.

Unit V **Special Antenna and Measurements** **9 Hours**

Mobile phone antenna-base station, hand set antenna-PIFA, UWB antenna, EMI/EMC-Standards and Measurement, Antenna factors, Antenna measurement and instrumentation–Gain and Impedance measurement.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1. Explain the behavior of antenna in terms of its parameters	Understand
CO 2.Apply beam forming methods to construct smart antenna	Apply
CO 3. Analyze the radiation characteristics of Aperture antenna using suitable principles	Analyze
CO 4. Design a Microstrip patch antenna for given specifications	Create
CO 5.Select the antenna for the given application and suitable instrument to measure their characteristics	Apply

Reference Book(s):

R1.Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, NewYork, 1982.

R2. Krauss.J.D, "Antennas", 2nd Edition, John Wiley and sons, New York, 1997.

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R3. Bahl. I.J. and Bhartia.P., "Microstrip Antennas", Artech House,Inc.,1980

R4. Liberti, JR and Theodore Rappaport, "Smart Antennas for Wireless communication" Prentice Hall of India, 1999,

R5.Henry W.Ott, "Electromagnetic Compatibility Engineering" John Wiley & Sons, 2009.

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Course Code:19COCC1001	Course Title: Advanced Digital Signal Processing (Common to CO & AE)		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the fundamental concepts of stationary models
2. Describe the parametric and nonparametric methods of power spectrum estimation
3. Explain the design of filters for linear prediction
2. Discuss the principles and applications of adaptive filters
3. Explain the concepts and applications of multirate signal processing

Unit I Stationary Models **9 Hours**

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

Unit II Spectral Estimation **9 Hours**

Non parametric methods – Periodogram – Modified Periodogram – Bartlett, Welch & Blackman Tukey methods – Performance comparison – Parametric methods – Auto Regressive (AR) spectrum estimation – Moving Average and Auto Regressive Moving Average spectrum estimation.

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Unit III **Linear Prediction** **9 Hours**

Linear prediction and optimum linear filters – forward-backward linear prediction filters – solution of normal equations – AR Lattice and ARMA Lattice-Ladder filters – Wiener filters for filtering and prediction

Unit IV **Adaptive Filtering** **9Hours**

Introduction to adaptive filters – Applications – Gradient and Minimum mean square error criterion – Gradient search by the method of steepest descent – LMS algorithm – RLS algorithm- Introduction to Kalman filter and extended Kalman filter

Unit V **Multirate Signal Processing** **9 Hours**

Multi rate DSP – Decimators and Interpolators – Sampling rate conversion – multistage decimator & interpolator – poly phase filters – QMF filter banks – Applications in subband coding

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the fundamental concepts of stationary models	Understand
CO2. Describe the parametric and nonparametric methods of power spectrum estimation	Understand
CO3. Explain the design of filters for linear prediction	Apply
CO4. Discuss the principles and applications of adaptive filters	Understand
CO5. Explain the concepts and applications of multirate signal processing	understand

Reference Book(s):

R1. Hayes M H, "Statistical Digital Signal Processing and Modeling ", Wiley, New York, 2008.

R2. Simon Haykin "Adaptive Filter Theory", Fourth edition, Pearson education, 2010

R3. WidrowB and Stearns .S D, "Adaptive Signal Processing", Pearson education, 2009.

R4. Fliege N J, "Multirate Digital Signal Processing", John Wiley and sons, 2010.

R5. Vaidyanathan P P, "Multirate Systems and Filter banks", Prentice Hall, 2008.

R6. Ifeachor E C and Jervis B. W, "Digital Signal Processing: A Practical Approach", Prentice Hall, 2009.

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R7. Lawrence R. Rabiner, Ronald W. Schafer, "Theory and Applications of Digital Speech Processing", Pearson, 2011.

R8. Ristic, Arulampalam, Gordon, " Beyond the Kalman filter: Tracking applications of particle filters", Artech House, 2003.

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Course Code:19COCN1202	Course Title: VLSI Signal Processing		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Apply the concepts of pipelining and parallel processing
2. Apply algorithmic level transformation techniques in VLSI design of DSP sub-systems
3. Apply algorithmic level strength reduction techniques in Filters
4. Explain scaling, round-off noise and design bit level arithmetic architectures.
5. Design asynchronous and wave pipelined architectures.

Unit I **Pipelining and Parallel Processing Of Digital Filters** **9 Hours**

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters -Application in simple architectures, Pipelining and Parallel processing for low power

Unit II **Algorithmic Level Transformation Techniques** **9 Hours**

Retiming – definitions and properties, Techniques ; Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application; Folding-Folding Transformation, Register minimization technique, Folding of multirate systems.

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Unit III Algorithmic Level Strength Reduction fast Convolution **9 Hours**

Fast convolution – Cook-Toom algorithm, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters

Unit IV Scaling and Round off Noise and Bit-Level Arithmetic Architectures **9 Hours**

Scaling-Scaling and Round off noise, state variable description of digital filters, Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon"s bit-serial multipliers using Horner"s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement; Distributed arithmetic.

Unit V Numerical Strength Reduction, Wave and Asynchronous Pipelining **9 Hours**

Numerical strength reduction – sub Expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply the concepts of pipelining and parallel processing to design VLSI architectures for DSP algorithms.	Apply
CO2: Apply algorithmic level transformation techniques in VLSI design of DSP sub-systems .	Apply
CO3: Apply algorithmic level strength reduction techniques in Filters for efficient VLSI implementation..	Apply
CO4: Explain scaling, round-off noise, and design bit level arithmetic architectures.	Apply
CO5: Apply the concepts in numerical strength reduction and design asynchronous and wave pipelined architectures .	Apply

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Reference Book(s):

R1. Jose E. France, YannisTsividis, "Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994.

R2. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ",Wiley, Interscience, 2007.

R3. U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004.

R4. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singal processing, Prentice Hall, 1985.

R5. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1994.

Web References:

1. http://nptel.ac.in/courses/106103068/36
2. http://nptel.ac.in/courses/106104024

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Course Code:19COEN1201	Course Title: Satellite Communication		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain Satellite communication system.
2. Describe the effect of natural phenomenon on satellite system.
3. Describe the satellite subsystems.
4. Analyze link budget equations for a satellite system.
5. Analyze the principle of Satellite navigation and positioning system.

Unit I **Overview of Satellite Communication** **9 Hours**

Architecture of Satellite Communication System: Principles and architecture of satellite Communication, applications, and frequency bands used for satellite communication. Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite.

Unit II **Earth Segment** **9 Hours**

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

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Unit III **Satellite Subsystem** **9 Hours**

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

Unit IV **Satellite Link Design** **9 Hours**

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

Unit V **Satellite Navigation and Positioning System** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain Satellite communication system using Kepler's laws.	Understand
CO2. Describe the effects of natural phenomenon on satellite system.	Understand
CO3. Describe the satellite subsystems such as satellite segment and earth segment.	Understand
CO4. Analyze link budget equations for a satellite system.	Analyze
CO5. Analyze the principle of Satellite navigation and positioning system.	Analyze

Reference Book(s):

R1. Timothy Pratt, Charles Bostian, Jeremy Allnutt "Satellite Communications", Wiley India, 2nd edition,2010.

R2. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2nd edition, 2011.

R3. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2nd edition,2009.

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R4. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

R5. G.Maral, M. Bousquet, Satellite Communications systems, 2nd edition, John Wiley & Sons, 2002

Web References:

1. https://nptel.ac.in/courses/117105131/11
2. https://sites.google.com/a/ciit-attock.edu.pk/satcom/lecture-notes

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Course Code: 19COEN1202	Course Title: Internet of Things		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the concepts of Internet of Things(IoT)
2. Interpret basic protocols in wireless sensor network
3. Illustrate the challenges due to privacy and security in IoT
4. Design IoT applications in different domain and be able to analyze their performance
5. Implement the IoT on embedded platform with Python programming

Unit I **Introduction to IOT and M2M** **9 Hours**

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Machine to Machine, Difference between IoT and M2M, Software define Network

Unit II **Network and Communication Aspects** **9 Hours**

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

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Unit III **Privacy and Security in IOT** **9 Hours**

Design challenges, Development challenges, Security challenges, IoT Security tomography, layered attacker model, Security models, profiles and protocols.

Unit IV **Domain Specific Applications of IOT** **9Hours**

Home automation, Industry applications, Surveillance applications, Logistic applications, Agriculture applications

Unit V **IOT with Python** **9 Hours**

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the fundamental concepts of Internet of Things	Understand
CO2: Interpret basic protocols in wireless sensor network	Understand
CO3: Illustrate the challenges due to privacy and security in IoT	Understand
CO4: Design IoT applications in different domain and be able to analyze their performance	Understand
CO5: Implement the IoT on embedded platform with Python programming	Apply

Reference Book(s):

R1. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013..

R2. A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", VPT publisher, 2014.

R3. CunoPfister, "Getting started with Internet of Things", Maker Media, 1st edition, 2011.

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R4. Samuel Greenguard, "Internet of things", MIT Press, 2015

R5. Raj Kamal, Internet of Things, McGraw-Hill Education, 2017

Web References:

1. Introduction to Internet of Things - https://nptel.ac.in/courses/106105166/-

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Course Code:19COEN1203	Course Title: Voice and Data Networks		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Analyze the network performance and issues involved in designing voice and data networks
2. Illustrate the layered and layer less communication of Voice networks
3. Explain Link Layer Design and its associated protocols.
4. Analyze the performance of the data network based on queuing model
5. Discuss congestion control mechanisms in voice and data networks

Unit I Network Design Issues **9 Hours**

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

Unit II Layer Less Communication **9 Hours**

Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

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Unit III **Data Networks and their Design** **9 Hours**

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

Unit IV **Queuing Models of Networks** **9Hours**

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

Unit V **Inter-Networking and Congestion Avoidance** **9 Hours**

Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Analyze the network performance and issues involved in designing voice and data networks	Understand
CO2. Illustrate the layered and layer less communication of Voice networks	Understand
CO3. Explain Link Layer Design and its associated protocols.	Understand
CO4. Analyze the performance of the data network based on queuing model	Understand
CO5. Discuss congestion control mechanisms in voice and data networks.	Apply

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Reference Book(s):

R1. D. Bertsekas and R. Gallager, "Data Networks", 2nd Edition, Prentice Hall, 1992

R2. L. Peterson and B. S. Davie, "Computer Networks: A Systems Approach",5thEdition,Morgan Kaufman, 2011.

R3. Kumar, D. Manjunath and J. Kuri, "Communication Networking: An analytical approach",1st Edition, Morgan Kaufman, 2004.

R4. Walrand, "Communications Network: A First Course", 2nd Edition, McGraw Hill, 2002.

R5. Leonard Kleinrock, "Queueing Systems, Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.

R6. Aaron Kershenbaum, "Telecommunication Network Design Algorithms", McGraw Hill,

R7. Vijay Ahuja, "Design and Analysis of Computer Communication Networks", McGraw Hill, 1987

Web References:

1. ftp://im1.im.tku.edu.tw/Prof_Liang/DataComunication&ComputerNetwork/6th%20Edi/Instructor%20Manual/Chapter%2011.pdf
2. http://www.rhyshaden.com/voice.htm

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Course Code:19COEN1204	Course Title: Markov Chain and Queuing System		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Introduce the basic concepts of probability and random process
2. Teach the concepts of Renewal process
3. Explain the mathematical basis of Discrete-time Markov chains
4. Explain the mathematical basis of continuous-time Markov chains
5. Familiarize the fundamental queuing concepts

Unit I Introduction **9 Hours**

Review of basic probability, properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem

Unit II Renewal Processes **9 Hours**

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

Unit III Discrete Time Markov Chains **9 Hours**

Definitions and properties, matrix representation, Perron Frobenius theory.

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Unit IV **Continuous Time Markov Chains** **9 Hours**

Basic definitions, Q-matrix, birth-death processes, quasi birth death processes.; Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.

Unit V **Fundamental Queuing Results** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the basic concepts of probability and random process	Understand
CO2. Explain the concepts of renewal process	Understand
CO3. Demonstrate understanding of the mathematical basis of Discrete-time Markov chains	Apply
CO4. Demonstrate understanding of the mathematical basis of Continous-time Markov chains	Apply
CO5. Model a system as queuing system with some aspect of the queue governed by a random process.	Apply

Reference Book(s):

R1.Gunter Bolch, Stefan Greiner, Hermann de Meer, Kishor S. Trivedi, "Queueing Networks and Markov Chains: Modeling and Performance Evaluation", John Wiley & Sons, 2006.

R2. Cliffs, "Stochastic Modelling and the Theory Queues", Prentice Hall, 1989.

R3. P.Bremaud, "Markov Chains", Springer-Verlag, 1999.

R4. E.Seneta, "Non Negative Matrices and Markov Chains", Springer Series in Statistics, Springer,1981.

R5. R.Gallager, "Discrete Stochastic Processes", Kluwer Academic Press, 1996.

R6. L.Kleinrock, "Queuing Systems", vols I and II, John Wiley and Sons 1976.

R7. Bruno Sericola, "Markov Chains: Theory and Applications" John Wiley & Sons2013.

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Web References:

1. https://nptel.ac.in/courses/117103017/10
2. http://www.math.uchicago.edu/~may/VIGRE/VIGRE2011/REUPapers/Constantin.pdf

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Course Code:19COEN1205	Course Title: MIMO System		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the diversity concepts of MIMO
2. Perform mathematical analysis of MIMO systems
3. Design the MIMO antenna system for Narrow band, wideband and LTE applications
4. Perform channel modeling and analysis of MIMO systems
5. Explain cooperative and coordinated multi-cell MIMO in OFDM and LTE systems

Unit I **Concepts of Multi-Antenna Systems** **9 Hours**

Introduction to Multi-antenna Systems, Types of multi-antenna systems, Diversity, Multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, BER of Alamouti Coded System-SVD in MIMO- Capacity of MIMO Wireless Systems. Spectral efficiency and capacity, Receive diversity, The rake receiver

Unit II **MIMO Wireless Communications** **9 Hours**

The generic MIMO problem, Singular Value Decomposition, Eigen values and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Predistortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of precoding and combining.

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Unit III MIMO Diversity - Beam Forming **9 Hours**

Beam forming, Beam forming principles, increased spectrum efficiency, Interference cancellation, Switched beam former, Adaptive beam former, Narrowband beam former, Wideband beam former, Beam forming in LTE

Unit IV Spatial Multiplexing and Channel Modeling **9 Hours**

Propagation Channels, Combining techniques, Spatial Multiplexing, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

Unit V Channel Estimation **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the diversity concepts of MIMO	Understand
CO2. Perform mathematical analysis of MIMO systems	Understand
CO3. Design the MIMO antenna system for Narrow band, wideband and LTE applications	Apply
CO4. Perform channel modeling and analysis of MIMO systems.	Apply
CO5. Explain cooperative and coordinated multi-cell MIMO in OFDM and LTE systems	Apply

Reference Book(s):

R1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications : From Real-world Propagation to Space-time Code Design", Academic Press, 1st edition, 2010.

R2. Andreas.F.Molisch, "Wireless Communications", Second Edition, John Wiley-India, 2007.

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R3. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication". Cambridge University Press,2005

R4. Mohinder Janakiraman, "Space - Time Codes and MIMO Systems", Artech House Publishers, 2004.

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Course Code:19COEN1206	Course Title: Programmable Networks		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain advanced concepts in Programmable Networks
2. Describe the network virtualization concept and Mininet for SDN
3. Explain Software Defined Networking, an emerging Internet Architectural framework
4. Implement the main concepts, architectures, algorithms, protocols for SDN and NFV
4. Explain the application of SDN and NFV

Unit I **Introduction to Programmable Networks** **9 Hours**

Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.

Unit II **Network Virtualization Concepts** **9 Hours**

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

Unit III **Control Plane** **9 Hours**

Control Plane Overview, Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts.

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Unit IV **Programming SDNS** **9 Hours**

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

Unit V **Data Centre Networks** **9 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain advanced concepts in Programmable Networks	Understand
CO2. Describe the network virtualization concept and Mininet for SDN	Understand
CO3. Explain Software Defined Networking, an emerging Internet architectural framework.	Apply
CO4. Implement the main concepts, architectures, algorithms, protocols for SDN and NFV	Apply
CO5. Explain the application of SDN and NFV	Apply

Reference Book(s):

R1. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, August 2013.

R2. Paul Goransson, Chuck Black, Timothy Culver. "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publishers, 2016.

R3. Fei Hu, "Network Innovation through Open Flow and SDN: Principles and Design", CRC Press, 2014.

R4. Vivek Tiwari, "SDN and Open Flow for Beginners", Amazon Digital Services, Inc., ASIN: , 2013.

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R5. Nick Feamster, Jennifer Rexford and Ellen Zegura, "The Road to SDN: An Intellectual History of Programmable Networks" ACM CCR April 2014.

R6. B.P. Lathi, "Communication Systems", 3rd edition, Wiley Eastern Limited New Delhi, 1988

Web References:

1. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.

2. Open Flow standards, http://www.openflow.org, 2015

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Course Code:19COCN2201	Course Title: RF System Design Laboratory		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Design Impedance Matching Network for RF Circuits
2. Design Planar Antenna for given Specifications
3. Design and simulate passive RF subsystems
4. Design and Simulate active RF subsystems
5. Measure the Microwave components using Vector Network Analyzer

List of Experiments:

1. Simulation of Planar Transmission Lines and matching network
2. Design and Simulation of Microwave Filters
3. Design and Simulation of Microstrip Couplers
4. Design and Simulation of Power dividers using ADS
5. Design and Simulation of Patch antenna for ISM Band
6. Design and Simulation of Planar Antenna Array
7. Simulation of RF Mixer Circuit

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8. Design and Simulation Low noise amplifier
9. Simulation of RF Transceiver
10. Measurement of Coupler, Power Divider and Isolator using VNA.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design Impedance Matching Network for RF Circuits	Apply
CO2: Design Planar Antenna for given Specifications	Apply
CO3: Design and simulate passive RF subsystems	Apply
CO4: Design and Simulate active RF subsystems	Apply
CO5: Measure the Microwave components using Vector Network Analyzer	Analyze

Reference Book(s):

R1. RF System Design Laboratory Manual prepared by ECE department

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Course Code:19SHAG1201	Course Title: Teaching and Learning in Engineering (Common to PG Programmes)		
Course Category: Audit Course		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:0	Credits:-	Total Contact Hours:30	Max Marks:100

Course Objectives

The course is intended to:

1. Use Outcome based approach in teaching courses.
2. Conduct lecture/practical/tutorial sessions using active learning methods.
3. Conduct higher order assessments using rubrics.

Unit I **Outcome Based Approach** **10 Hours**

Outcome based Education- Need &Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy

Unit II **Active Learning Methods** **10 Hours**

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods- Active learning strategies- Benefits of Active learning Methods

Unit III **Assessments** **10 Hours**

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Use outcome based approach in teaching courses in engineering programmes.	Apply
CO2. Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO3. Conduct higher order assessments using rubrics.	Apply

Reference Book(s):

R1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.

R2. Dr. William G. Spady, Wajid Hussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.

R3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

Web References:

1. cid.buu.ac.th/information/Eric_Soulsby_Assessment_Notes.pdf
2. www4.ncsu.edu/unity/lockers/users/f/felder/public/.../Active/Active-learning.pdf
3. https://tomprof.stanford.edu/posting/1491-Common Active Learning Mistakes

Assessment pattern:

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation (Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

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- **Students will be finally awarded with three levels based on the score as follows:**

Marks Scored	Levels
70% & above	Good
30- 69%	Average
< 30%	Fair

Web References:

1. https://nptel.ac.in/courses/106106046/

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Semester III

Course Code:19COEN1301	Course Title: High Performance Networks		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the overview of various network architectures, physical media, channel access techniques and the related link-level protocols.
2. Explain the protocols for real-time applications and QoS Services
3. Explain the concept of virtual private networks.
4. Analyze packet queues and delay in a network using different network models.
5. Explain the concepts of security and network management.

UNIT I - INTRODUCTION **9 Hours**

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN,ATM.

UNIT II - MULTIMEDIA NETWORKING APPLICATIONS **9 Hours**

Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

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UNIT III - ADVANCED NETWORKS CONCEPTS **9 Hours**

Virtual private network-Remote access VPN, site-to-site VPN, tunneling and PPP, Security in VPNs, Multiprotocol Label Switching-MPLS operation, Routing in MPLS domains, Tunneling and use of FEC, Traffic engineering, MPLS based VPNs, overlay networks-peer-to-peer (P2P) connection.

UNIT IV - TRAFFIC MODELLING **9 Hours**

Little's theorem, Need for modeling, Poisson modeling and its failure, Non-Poisson modeling and network performance evaluation.

UNIT V - NETWORK SECURITY AND MANAGEMENT **9 Hours**

Network security, principles of network security, Authentication, Integrity, key distribution and certification, Access controls-firewalls, attacks and countermeasures, security in many layers, Infrastructure for network management-The internet standard management framework-SMI,MIB,SNMP, Security and administration-ASN.1

Course Outcomes

At the end of this course, students will be able to:	**Cognitive Level**
CO1: Explain the various network architectures, physical media, channel access techniques and the related link-level protocols.	Understand
CO2: Choose appropriate protocols and QoS Services for real-time applications	Apply
CO3: Explain the concepts of virtual private networks.	Understand
CO4: Analyze packet queues and delay in a network using different network models.	Analyze
CO5: Explain the concepts of security and network management.	Understand

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Reference Book(s):

1. J.F. Kurose & K.W. Ross,"Computer Networking- A top down approach featuring the internet", Pearson, 2 nd edition, 2003.
2. Walrand .J. Varatya, High performance communication network, Margan Kanffman – Harcourt Asia Pvt. Ltd. 2 nd Edition, 2000.
3. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
4. Aunuragkumar, D. MAnjunath, Joy kuri, "Communication Networking", Morgan Kaufmann Publishers, 1ed 2004.
5. HersentGurle& petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003.
6. Fred Halsall and Lingana Gouda Kulkarni,Computer Networking and the Internet, fifth edition, pearson education
7. Nader F.Mir ,Computer and Communication Networks, first edition.
8. Larry l.Peterson&BruceS.David, "Computer Networks: A System Approach"- 1996

Web References:

1. https://eng.uok.ac.ir/abdollahpouri/Network/A.LeonGarcia_Communication_Networks.pdf
2. https://www8.cs.umu.se/kurser/5DV013/HT13/utdelat/Chapter_9_V6.0.pdf

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Course Code:19COEN1302	Course Title: Pattern Recognition and Machine learning		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

This course is intended to:

1. Explain the basic concepts of pattern recognition methods
2. Describe the parametric and linear models
3. Explain neural network and SVM
4. Explain algorithm independent machine learning techniques
5. Explain the unsupervised learning techniques and clustering

UNIT I - INTRODUCTION TO PATTERN RECOGNITION **9 Hours**

Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis

UNIT II - LINEAR MODELS **9 Hours**

Linear Models for Regression, linear regression, logistic regression Linear Models for Classification

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UNIT III - NEURAL NETWORK **9 Hours**

Introduction to Neural Network - perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning, linear programming algorithms, Support vector machine

UNIT IV –ALGORITHM INDEPENDENT MACHINE LEARNING **9Hours**

Lack of inherent superiority of any classifier, bias, and variance, re-sampling for classifier design, combining classifiers

UNIT V –UNSUPERVISED LEARNING AND CLUSTERING **9 Hours**

Unsupervised Bayesian learning, k-means clustering, fuzzy k-means clustering, hierarchical clustering

Course Outcomes

	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the basic concepts of pattern recognition methods	Understand
CO2: Describe the parametric and linear models for classification	Understand
CO3: Explain neural network and SVM for classifying the data	Understand
CO4: Explain algorithm independent machine learning techniques	Understand
CO5: Explain the unsupervised learning techniques and clustering	understand

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Reference Book(s):

1. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John Wiley & Sons, 2001.
3. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.
4. Y. Anzai, Pattern Recognition and Machine Learning,Elsevier, 2012, Academic Press.
5. Murty M Narasimha, Susheela Devi V, Introduction to Pattern Recognition and Machine Learning, 2010, IISC lecture notes series

Web References:

1. https://nptel.ac.in/courses/106106046/

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Course Code:19COEN1303	Course Title: Remote Sensing		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

This course is intended to:

1. Explain the fundamental concepts of remote sensing
2. Explain different data acquisition systems for satellites
3. Discuss the various scattering techniques in remote sensing
4. Analyse the thermal and hyper spectral images
5. Discuss different data analysis techniques in remote sensing

UNIT I - PHYSICS OF REMOTE SENSING **9 Hours**

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

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UNIT II - DATA ACQUISITION **9 Hours**

Types of Platforms–different types of aircrafts-Manned and Unmanned spacecrafts–sun synchronous and geo synchronous satellites –Types and characteristics of different platforms – LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD.

UNIT III - SCATTERING SYSTEM **9 Hours**

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

UNIT IV - THERMAL AND HYPER SPECTRAL REMOTE SENSING **9Hours**

Sensors characteristics-principle of spectroscopy imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing –thermal sensors, principles, thermal data processing, applications.

UNIT V - DATA ANALYSIS **9 Hours**

Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics-visual and digital interpretation–Basic principles of data processing –Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping.

Course Outcomes

Cognitive Level

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

CO1.	Explain the fundamental concepts of remote sensing	Understand
CO2.	Explain different data acquisition systems for satellites	Understand

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CO3.	Discuss the various scattering techniques in remote sensing	Understand
CO4.	Analyse the thermal and hyper spectral images	Understand
CO5.	Discuss different data analysis techniques in remote sensing	understand

Reference Book(s):

1. Richards, John A., Jia, Xiuping, "Remote Sensing Digital Image Analysis",5th Edition, Springer-Verlag Berlin Heidelberg, 2013.
2. John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", 2nd Edition, Prentice Hall,1995.
3. Lillesand.T.M. and Kiefer.R.W,"Remote Sensing and Image interpretation", 6th Edition,John Wiley & Sons, 2000.
4. Paul Curran P.J. Principles of Remote Sensing, 1st Edition, Longman Publishing Group, 1984.
5. Charles Elachi, Jakob J. van Zyl, "Introduction to The Physics and Techniques of Remote Sensing", 2nd Edition, Wiley Series, 2006
6. Sabins, F.F.Jr, "Remote Sensing Principles and Image Interpretation", 3rd Edition, W.H.Freeman& Co, 1978

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OPEN ELECTIVES

Course Code: 19COOC1301	Course Title: Cryptography and Network Security		
Course Category: Open Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the need for cryptography and Network security
2. Explain mathematical concepts involved in cryptography.
3. Explain the concepts of public key cryptosystem with key exchange algorithms
4. Choose an appropriate authentication algorithm for a given application.
5. Distinguish among different types of threats to the system and handle them.

UNIT I - SECURITY **9 Hours**

Need, security services, Attacks, OSI Security Architecture, one time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques, Hands on practice.

UNIT II - NUMBER THEORY AND PRIVATE-KEY CRYPTOGRAPHY **9 Hours**

Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic. Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES),Advanced Encryption Standard (AES), Triple DES

UNIT III - PUBLIC-KEY CRYPTOGRAPHY **9 Hours**

RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC

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UNIT IV - AUTHENTICATION **9 Hours**

IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction.

UNIT V - SYSTEM SECURITY **9 Hours**

Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Firewall Design Principles, Trusted Systems.

Course Outcomes

		Cognitive Level
At the end of this course, students will be able to:		
CO 1.	Identify and utilize different forms of cryptography techniques.	Apply
CO 2.	Analyze the mathematics behind cryptography	Analyze
CO 3.	Explain the concepts of public key cryptosystem	Understand
CO 4.	Choose an appropriate authentication algorithm for a given application.	Apply
CO 5.	Analyze various intrusion detection techniques	Analyze

Reference Book(s):

1. William Stallings, "Cryptography and Network Security", 8th Edition, Pearson Education, 2009.
2. Behrouz Forouzan, "Cryptography & Network Security", Tata McGraw Hill, 2008.
3. AtulKahate, " Cryptography and Network Security", Tata McGraw Hill, 2006
4. Charlie Kaufman , Network Security: Private Communication in Public World, 2nd Edition, Prentice Hall of India, New Delhi, 2004.
5. William Stallings, Network Security Essentials, 2nd Edition, Prentice Hall of India, New Delhi, 2004.

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Web References:

1. https://nptel.ac.in/courses/106105031/
2. https://www.tutorialspoint.com/cryptography/

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Course Code: 19COOC1302	Course Title: Advanced Embedded System		
Course Category: Open Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the overview of Embedded System.
2. Explain the hardware software Co-design concepts
3. Apply the design steps of embedded system for multi-tasking activities
4. Explain the integrated development environment.
5. Apply embedded operating system trends in industry.

UNIT I - TYPICAL EMBEDDED SYSTEM **9 Hours**

Core of the embedded system, Memory, Sensors and Actuators, Commutation interface, Embedded firmware, Other system components. Characteristics and quality attribution of Embedded Systems.

UNIT II - HARDWARE SOFTWARE CO-DESIGN AND PROGRAM MODELLING **9 Hours**

Fundamental issues in hardware software co-design, Computational models in embedded design, Introduction to Unified modelling language, Hardware software trade-off.

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UNIT III - EMBEDDED FIRMWARE DESIGN AND DEVELOPMENT **9 Hours**

Embedded firmware design approaches, Embedded firmware development language. Real time operating system (RTOS) based embedded system design: Operating system basics, Types of OS, Tasks, Process and threads, Multiprocessing and multitasking, Task scheduling, Threads, Processing and scheduling: Putting them altogether, Task communication, task synchronization, Device drivers, How to choose an RTOS

UNIT IV - THE EMBEDDED SYSTEM DEVELOPMENT ENVIRONMENT **9 Hours**

The Integrated development environment (IDE), Types of files generated on cross compilation, Disassembler/Decompilers, Emulators and debugging, Target hardware debugging, Boundary scan

UNIT V - TRENDS IN THE EMBEDDED INDUSTRY **9 Hours**

Processor trends in embedded system, Embedded OS trends, development language trends Open standards, Frameworks and alliances, Bottlenecks

Course Outcomes

	Cognitive Level
At the end of this course, students will be able to:	
CO 1. Describe the overview of Embedded System.	Understand
CO 2. Explain the hardware software Co-design concepts.	Understand
CO 3. Apply the design steps of embedded system for multi-tasking activities.	Apply
CO 4. Explain the integrated development environment.	Understand
CO 5: Apply embedded operating system trends in industry	Apply

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Reference Book(s):

1. K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009..
2. James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley,

2008.Proakis, and Manolakis, "Digital signal processing", 3rd edition, Prentice Hall, 1996

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