ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. COMMUNICATION AND NETWORKING

CHOICE BASED CREDIT SYSTEM

REGULATIONS 2019

VISION OF DEPARTMENT OF ELECTRONICS ENGINEERING:

The Department of Electronics Engineering is committed to produce globally competitive and socially sensitized graduates in Electronics & Communication Engineering. We seek to instill the spirit of creativity and leadership skills enabling the students to make a global impact towards the availability of technology to mankind from all walks of life.

MISSION OF DEPARTMENT OF ELECTRONICS ENGINEERING

- To impart high quality technical education to students from socially and economically diverse backgrounds
- Give solid foundation on Mathematical skills and allied fields of Electronics & Communication
- To produce students with technical competence to design sophisticated systems in Electronics & Communication
- To make high quality research contribution in the field of Electronics, Communication, Networking , VLSI & Signal Processing
- To collaborate with industries in Electronics & Communication in the indigenous product development
- To inculcate qualities of leadership and entrepreneurship in students
- To facilitate adequate exposure to the faculty enabling them to be synchronized with the Cutting edge technology

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UNIVERSITY DEPARTMENTS
M.E. COMMUNICATION AND NETWORKING
REGULATIONS 2019

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. Acquire core competence and excel in communication and networking based industries.
II. Serve in research establishments and contribute towards the development of sophisticated signal processing systems.
III. Provide consultancy and offer networking solutions for establishments.
IV. Work towards doctoral and post-doctoral degrees in the area of communication, signal processing and networking.
V. Become entrepreneurs and contribute towards indigenous product development which could compete in global market.

2. PROGRAMME OUTCOMES (POs):

PO#	GRADUATE ATTRIBUTE	PROGRAMME OUTCOME
1.	Research aptitude	An ability to independently carry out research /investigation and development work to solve practical problems
2.	Technical documentation	An ability to write and present a substantial technical report/document
3.	Technical competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4.	Engineering Design	Ability to design and conduct experiments, perform analysis, signal processing and networking systems by applying the knowledge of computing, mathematics, science and electronic engineering.
5.	Conduct investigations of complex problems	Interpret the problems of communication and investigate solutions and work towards improved solutions.
6.	Life-long Learning	Continuously update knowledge with modern tools and technical developments and ensure professional development.

7. PROGRAMME SPECIFIC OUTCOMES (PSOs):

By the completion of Communication and Networking programme, students will have the following programme specific outcomes.

I. Foundation of communication and signal processing systems: Ability to understand the basics principles of communication, signal processing and understand their implementation issues.
II. Foundation of networking systems: Ability to understand the various technologies behind the recent communication standards and work towards improved solutions.
III. Foundations of Mathematical concepts: Ability to apply mathematical knowledge to solve complex signal processing algorithms and networking issues.
IV. Applications of Communication and networking and Research ability: Ability to use knowledge in various Domains to identify research gaps and provide innovative solutions.

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8. PEO/PO Mapping:

PEOs	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I.			✓	✓	✓	
II.	✓					
III.		✓	✓	✓	✓	✓
IV.	✓	✓	✓		✓	✓
V.		✓	✓	✓	✓	

L- Low, M-Medium, H-High

SEM	SUBJECTS	PROGRAM OUTCOMES (PO)					
		PO1	PO2	PO3	PO4	PO5	PO6
I	Applied Mathematics for Network Engineers	L		H	H	L	L
	Digital Communication Techniques	H	M	H	H	H	H
	Advanced Optical Communication	H	M	H	H	H	H
	High Performance Computer Networks	H	M	H	H	H	H
	RF Engineering	H	M	H	H	H	H
	Research Methodology and IPR	H	H				H
	Audit Course- I						
	Communication and signal processing Lab	H	H	H	H	H	H
	RF System Design Laboratory	H	H	H	H	H	H
II	Adaptive Signal Processing Techniques	H	M	H	H	H	H
	Network Security	H	M	H	H	H	H
	Wireless Mobile communication	H	M	H	H	H	H
	Program Elective I						
	Program Elective -II						
	Audit Course- II						
	Networking Laboratory	H	H	H	H	H	H
	Wireless Technology Laboratory	H	H	H	H	H	H
	Mini Project with Seminar	H	H	H	H	H	H
III	Program Elective III						
	Program Elective IV						
	Program Elective V						
	Open Elective						
	Dissertation - I	H	H	H	H	H	H
IV	Dissertation - II	H	H	H	H	H	H

PROFESSIONAL ELECTIVES (PEC)							
1.	Electromagnetic Interference and Electromagnetic Compatibility	H	M	H	H	H	H
2.	Analysis and Design of CMOS Analog Integrated Circuits	H	M	H	H	H	H
3.	Electromagnetic for Communications	H	M	H	H	H	H
4.	Information Theory and Coding	H	M	H	H	H	H
5.	Parallel Processing	H	M	H	H	H	H
6.	RF Integrated Circuits Design	H	M	H	H	H	H
7.	Speech Recognition and Synthesis	H	M	H	H	H	H
8.	VLSI Design Automation	H	M	H	H	H	H
9.	IoT Fundamentals	H	M	H	H	H	H
10.	Detection and Estimation Theory	H	M	H	H	H	H
11.	Pattern Recognition and machine learning	H	M	H	H	H	H
12.	Computational Electromagnetics	H	M	H	H	H	H
13.	Digital Audio and Video Broadcasting Technology	H	M	H	H	H	H
14.	Fundamentals of Cloud Computing	H	M	H	H	H	H
15.	Game theory for Wireless Communication and Networking	H	M	H	H	H	H
16.	Microwave Photonics	H	M	H	H	H	H
17.	Optical Networks	H	M	H	H	H	H

18.	Reconfigurable Architectures And Applications	H	M	H	H	H	H
19.	Satellite Communication	H	M	H	H	H	H
20.	Space time wireless Communication	H	M	H	H	H	H
21.	Spread Spectrum Techniques and Applications	H	M	H	H	H	H
22.	Wireless Sensor Network Design	H	M	H	H	H	H
23.	Microwaves and Radar	H	M	H	H	H	H
24.	Real Time Embedded System	H	M	H	H	H	H
25.	VLSI Signal Processing Techniques	H	M	H	H	H	H
26.	Advanced Operating Systems	H	M	H	H	H	H
27.	VLSI Design Techniques	H	M	H	H	H	H
28.	ASIC Design	H	M	H	H	H	H
29.	Image Analysis and Computer Vision	H	M	H	H	H	H
30.	Computational Intelligence	H	M	H	H	H	H
31.	Cognitive Radio Networks	H	M	H	H	H	H

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M.E. COMMUNICATION AND NETWORKING
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM
I – IV SEMESTER CURRICULUM AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5155	Applied Mathematics for Network Engineers	PCC	3	1	0	4	4
2.	NE5101	Digital Communication Techniques	PCC	3	0	0	3	3
3.	NE5102	Advanced Optical Communication	PCC	3	0	0	3	3
4.	NE5103	High Performance Computer Networks	PCC	3	0	0	3	3
5.	NE5151	RF Engineering	PCC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course- I*	AC	2	0	0	0	0
PRACTICALS								
8.	NE5111	Communication and Signal Processing Laboratory	PCC	0	0	4	4	2
9.	NE5161	RF System Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**26**	**22**

*Audit course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	NE5251	Adaptive Signal Processing Techniques	PC	3	0	0	3	3
2.	NE5201	Network Security	PC	3	0	0	3	3
3.	NE5202	Wireless Mobile communication	PC	3	0	0	3	3
4.		Program Elective I	PEC	3	0	0	3	3
5.		Program Elective -II	PEC	3	0	0	3	3
6.		Audit Course- II*	AC	2	0	0	2	0
PRACTICALS								
7.	NE5211	Networking Laboratory	PCC	0	0	4	4	2
8.	WT5261	Wireless Technology Laboratory	PCC	0	0	4	4	2
9.	NE5212	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**21**

*Audit course is optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective III	PEC	3	0	0	3	3
2.		Program Elective IV	PEC	3	0	0	3	3
3.		Program Elective V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	NE5311	Dissertation-I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	NE5411	Dissertation- II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

Attested

TOTAL NUMBER OF CREDITS = 73

FOUNDATIONAL COURSE (FC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MA5155	Applied Mathematics for Network Engineers	FCC	3	1	0	4	4

PROGRAM CORE COURSE (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	NE5101	Digital Communication Techniques	PCC	3	0	0	3	3
2.	NE5102	Advanced Optical Communication	PCC	3	0	0	3	3
3.	NE5103	High Performance Computer Networks	PCC	3	0	0	3	3
4.	NE5251	Adaptive Signal Processing Techniques	PCC	3	0	0	3	3
5.	NE5201	Network Security	PCC	3	0	0	3	3
6.	NE5202	Wireless Mobile Communication	PCC	3	0	0	3	3
7.	NE5111	Communication and Signal Processing Laboratory	PCC	0	0	4	4	2
8.	NE5161	RF System Design Laboratory	PCC	0	0	4	4	2
9.	NE5211	Networking Laboratory	PCC	0	0	4	4	2
10	WT5261	Wireless Technology Laboratory	PCC	0	0	4	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NE5311	Dissertation - I	EEC	0	0	12	12	6
2.	NE5411	Dissertation - II	EEC	0	0	24	24	12
3.	NE5212	Mini Project with Seminar	EEC	0	0	4	4	2

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RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S.NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2

OPEN ELECTIVE COURSES (OEC)

S.NO.	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0
					TOTAL CREDITS	0

PROGRAM ELECTIVE COURSES (PEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	NE5072	Electromagnetic Interference and Electromagnetic Compatibility	PEC	3	0	0	3	3
2.	NE5001	Analysis and Design of CMOS Analog Integrated Circuits	PEC	3	0	0	3	3
3.	NE5002	Electromagnetic for Communications	PEC	3	0	0	3	3
4.	NE5075	Information Theory and Coding	PEC	3	0	0	3	3
5.	NE5003	Parallel Processing	PEC	3	0	0	3	3
6.	NE5004	RF Integrated Circuits Design	PEC	3	0	0	3	3
7.	NE5005	Speech Recognition and Synthesis	PEC	3	0	0	3	3
8.	NE5006	VLSI Design Automation	PEC	3	0	0	3	3
9.	NE5076	IoT Fundamentals	PEC	3	0	0	3	3
10.	NE5007	Detection and Estimation Theory	PEC	3	0	0	3	3
11.	NE5078	Pattern Recognition and machine learning	PEC	3	0	0	3	3
12.	NE5009	Computational Electromagnetics	PEC	3	0	0	3	3
13.	NE5010	Digital Audio and Video Broadcasting Technology	PEC	3	0	0	3	3
14.	NE5011	Fundamentals of Cloud Computing	PEC	3	0	0	3	3
15.	NE5073	Game theory for Wireless Communication and Networking	PEC	3	0	0	3	3
16.	NE5012	Microwave Photonics	PEC	3	0	0	3	3
17.	NE5013	Optical Networks	PEC	3	0	0	3	3
18.	NE5079	Reconfigurable Architectures And Applications	PEC	3	0	0	3	3

19.	NE5014	Satellite Communication	PEC	3	0	0	3	3
20.	NE5015	Space time wireless Communication	PEC	3	0	0	3	3
21.	NE5016	Spread Spectrum Techniques and Applications	PEC	3	0	0	3	3
22.	WT5151	Wireless Sensor Network Design	PEC	3	0	0	3	3
23.	NE5077	Microwaves and Radar	PEC	3	0	0	3	3
24.	VE5151	Real Time Embedded System	PEC	3	0	0	3	3
25.	VE5071	VLSI Signal Processing Techniques	PEC	3	0	0	3	3
26.	CP5251	Advanced Operating Systems	PEC	3	0	0	3	3
27.	NE5080	VLSI Design Techniques	PEC	3	0	0	3	3
28.	VL5151	ASIC Design	PEC	3	0	0	3	3
29.	NE5074	Image Analysis and Computer Vision	PEC	3	0	0	3	3
30.	NE5071	Computational Intelligence	PEC	3	0	0	3	3
31.	CU5071	Cognitive Radio Networks	PEC	3	0	0	3	3

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MA5155 APPLIED MATHEMATICS FOR NETWORK ENGINEERS L T P C
3 1 0 4

OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To develop the ability to use the concepts of Special Functions for solving problems related to Networks.
- To analyze the Graph algorithms and understand their applications in Networks.
- To impart knowledge on Numerical Methods that will come in handy to solve numerically the problems that arise in engineering. This will also serve as a precursor for future research.
- To acquire skills in analyzing Queuing Models.

UNIT I LINEAR ALGEBRA 12

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

UNIT II SPECIAL FUNCTIONS 12

Bessel's equation – Bessel function – Recurrence relations - Generating function and orthogonal property for Bessel functions of first kind – Fourier-Bessel expansion.

UNIT III GRAPH ALGORITHMS 12

Graphs – Sub graphs – Complements – Graph isomorphism – Eulerian graphs –Hamiltonian graphs - Planar graphs– Kruskals algorithm – Dijkstras shortest path algorithm, Prims algorithm– Transport Networks.

UNIT IV ALGEBRAIC EQUATIONS 12

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method.

UNIT V RANDOM PROCESSES 12

Classification – Auto correlation - Cross correlation - Stationary random process – Markov process –- Markov chain - Poisson process – Gaussian process

TOTAL: 60 PERIODS

OUTCOMES:

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

- Work with vector spaces and linear transformations and their applications.
- Use the ideas of Special Functions in solving special types of problems.
- Apply Graph Theory algorithms in networks.
- Use various methods of solving systems of Algebraic Equations and eigenvalue problems.
- Apply the ideas of random processes.

REFERENCES:

1. Balakrishnan R., Ranganathan K., “A textbook of Graph theory”, Springer, 2nd Edition, New York, 2012.
2. Erwin Kreyszig. “Advanced Engineering Mathematics”, John Wiley & Sons, 10th Edition, New York, 2010.
3. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson/Prentice Hall, 5th Edition, Horlow, 2018.
4. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, Academic Press, (An imprint of Elsevier), Boston, 2014.
5. Peter V.O'Neil, “Advanced Engineering Mathematics”, Cengage Learning, 8th Edition, Singapore, 2017.

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6. Ralph P. Grimaldi, "Discrete and combinatorial Mathematics", Pearson Education, 5th Edition, New Jersey, 2004.
7. Richard Bronson and Gabriel B. Costa, “Linear Algebra”, Academic Press, 3rd Edition, Amsterdam, 2013.
8. Richard Bronson, “Matrix Operation”, Schaum’s outline series, McGraw Hill, 2nd Edition, New York, 2011.

NE5101 DIGITAL COMMUNICATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To have a comprehensive knowledge of the various signalling schemes.
- To have an in depth knowledge of synchronization and equalization.
- To have a comprehensive knowledge of the transmission techniques
- To understand the various channel coding techniques
- To be able to understand the various speech/ video and text compression schemes.

UNIT I SIGNALING SCHEMES 9

Line Coding schemes & their Power spectra- band pass Signaling - Geometric Representation of signals – Principles of Binary ASK, PSK, FSK - QPSK& QAM-CPFSK, OQPSK, MSK, GMSK – BER & PSDs-Link Budget.

UNIT II SYNCHRONIZATION & EQUALIZATION 9

Carrier Synchronization- Bit, Frame synchronization. Channel Models- ISI-Eye Diagram-Receiver Front End-ML Sequence estimation-Linear Equalization-Decision Feedback Equalization.

UNIT III ERROR CONTROL TECHNIQUES 9

Channel coding-bandwidth expansion-Error correction vs detection- coding gain-Matrix Parity Check Codes-Linear Block Codes – Error Detection & Correction capability- Cyclic Codes – CRC-Hamming codes – Convolutional codes – Viterbi Decoding algorithm-Turbo Codes-LDPC

UNIT IV COMPRESSION TECHNIQUES 9

Review of PCM,DPCM &DM- Principles of ADPCM –LPC- Vector Quantization- Transform coding techniques- Subband Coding- Huffman coding- LZW- Run Length coding- Intra-frame and inter-frame compression in video coding

UNIT V TRANSMISSON TECHNIQIUES 9

Subscriber Loop Transmission - xDSL, Trunk Transmission Line Coding / Framing / Multiplexing - Signaling- Timing Synchronization –-ARQ Protocols.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to design the various errors control coding schemes and carry out their implementations.
- To design a receiver to meet out the required power and BER requirements
- To be able to design compression techniques as applicable to the specific application
- To be able to design digital transmission systems
- To be able to design equalization algorithms.

REFERENCES:

1. B.Sklar, "Digital Communications, Fundamentals and Applications", 2nd Edition, Pearson Education 2001.
2. Simon Haykin, Michael Moher and David Koilpillai, Modern Wireless communications, Pearson, 2011.
3. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", Pearson Education 2014.
4. B.P.Lathi, "Modern Digital and Analog Communication Systems", 3rd Edition, Oxford University Press, 2011.
5. J.Bellamy, "Digital Telephony", John Wiley, 3rd Edition, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓	✓	✓
CO2	✓		✓	✓	✓	✓
CO3	✓		✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓
CO5	✓		✓	✓	✓	✓

NE5102 ADVANCED OPTICAL COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:

- Understand the concepts of optical communications and various systems
- Know the recent developments in optical components and their applications
- Understand the nonlinearities and dispersion issues in optical transmission.
- Understand the dispersion issues and compensation schemes in optical transmission.
- Be able to identify the merits and demerits of different modulation and detection schemes

UNIT I REVIEW OF OPTICAL COMMUNICATIONS SYSTEMS 9

Optical fibers, dispersion, link budget, Time Division Multiplexing, Sub Carrier Multiplexing and code division multiplexing. Systems: Passive optical Network, Hybrid fiber coax architectures, Radio over fiber technologies, free space optics

UNIT II MODERN OPTICAL COMPONENTS 9

VCSEL, QW lasers, Multi section DFB lasers, Tunable lasers, Electro absorption modulator, Integrated transmitters and receivers, optical switches and routers, WDM components , Optical schemes for microwave generation ,PCF and PCF components

UNIT III NON LINEAR FIBER OPTICS AND APPLICATIONS 9

Non linear optics – basics, Brilluion, Raman effects, Four wave mixing, optical phase conjugation. Optical Amplifiers-SOA, EDFA, DRFA.Fiber lasers, Solitons, Communication using solitons, WDM solitons

UNIT IV DISPERSION COMPENSATION SCHEMES 9

Pre, post and mixed compensation schemes, Optical filters for compensation, Delay line filters, Dispersion slope compensation, Dispersion and Non linearity, Dispersion maps, multichannel compensation schemes.

UNIT V ADVANCED MODULATION AND DETECTION TECHNIQUES 9

Limitations of direct modulation, ASK, PSK, FSK modulations in coherent systems, Analog schemes: QPSK, QAM, DQPSK, Carrier suppressed schemes. External modulators, single and Dual drive MZM, performance. Non coherent and coherent detection.

TOTAL:45 PERIODS

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OUTCOMES:

- A thorough knowledge of different optical communication systems
- A thorough knowledge of optical components and its performances
- Details of impairments in optical fiber links and schemes to mitigate them
- A thorough knowledge about the design and implementation of integrated optics
- To be able to compare the performance of various modulation and detection schemes

REFERENCES:

1. G.P.Agrawal, " Fiber optic communication systems" ,4 ed ,John Wiley and Sons,New jersy, 2010.
2. G.P.Agrawal, "Lightwave technology: Components and devices", John Wiley and Sons,New jersy, 2004
3. G.P Agrawal," Applications of Non linear fiber optics", Academic press, Elsevier, Burlington.2007.
4. Shiva kumar, M.Jamal Deeri, Fiber optic communications:"Fundamentals and applications",Wiley 2014
5. Frederic Zolla and 7 more, Foundations of photonic crystal fibers, 2nd edition , Imperial college press.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2	✓		✓		✓	✓
CO3	✓		✓		✓	✓
CO4	✓		✓	✓	✓	✓
CO5	✓		✓		✓	✓

NE5103 HIGH PERFORMANCE COMPUTER NETWORKS L T P C
3 0 0 3

OBJECTIVES:

- To understand the high speed computer network architectures.
- To understand the concepts of multimedia networking.
- To study the recent network concepts with reference to MPLS and VPN.
- To study about the mathematical models related to network performance analysis.
- To understand the current network management concepts.

UNIT I SWITCHING NETWORKS 9

Switching – Packet switching - Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched – SONET, DWDM, DSL, Intelligent Networks – CATV, ATM – Features, Addressing Signaling & Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.

UNIT II MULTIMEDIA NETWORKING APPLICATIONS 9

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

UNIT III ADVANCED NETWORKS CONCEPTS 9

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networks-P2P connections.-IPv4 vs. V6.

UNIT IV PACKET QUEUES AND DELAY ANALYSIS 9

Little's theorem, Birth and Death process, Queueing discipline- Control & stability -, Markovian FIFO Queueing system, Non-Markovian - Pollaczek-Khinchin Formula and M/G/1, M/D/1, self- similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.

UNIT V NETWORK MANAGEMENT & SNMP 9

Network Architecture, SNMP Basics, SNMP Naming and OIDs, MIBs, SNMPv1 Data Types, ASN.1 Syntax and SNMP, SNMP Tables, SNMP Operations, MIB Browsing, MIB-2 , SNMP and ASN.1 Encoding

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to design and implement network protocols in HPCN.
- To be able to design and implement protocols in multimedia networks.
- To be able to compare the various methods of providing connection-oriented services over an advanced network with reference to MPLS, VPN.
- To be able to analyze performance of network related issues using mathematical models.
- To be able to explore the concepts of network management.

REFERENCES:

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

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓	✓	✓
CO5	✓		✓	✓		✓

NE5151 RF ENGINEERING L T P C

3 0 0 3

OBJECTIVES

- To model high frequency circuit using scattering matrixes
- To acquire knowledge on the RF filter design
- To design microwave amplifier
- To get familiar with design of RF oscillator
- To learn about the high frequency antennas

UNIT I NETWORKS AND MATRICES 9

Scattering and chain scattering matrices, Generalized scattering matrix, Analysis of two port networks, Interconnection of networks. Positive real concepts, scattering matrix, representation of microwave components (directional coupler, circulators, hybrids and isolators).

UNIT II HIGH FREQUENCY CIRCUIT DESIGN 9

Tuned Circuits, Filter design- Butterworth filter, Chebyshev filter, impedance matching. High frequency amplifier, BJT and FET amplifier, Broadband Amplifiers RF Oscillators, Colpitts, Hartley Oscillators, PLL. High Frequency Integrated Circuits.

UNIT III MICROWAVE AMPLIFIER DESIGN 9

Types of amplifiers, Power gain equations. Introduction to narrow band amplifiers basic concepts, Maximum gain design, Low noise design. High power design, Negative resistance, reflection amplifiers – various kinds – stability considerations, Microwave transistor amplifier design – input and output matching networks – constant noise figure circuits.

UNIT IV MICROWAVE TRANSISTOR OSCILLATOR DESIGN 9

One port and two port negative resistance oscillators. Oscillator configurations, Oscillator design using large signal measurements, Introduction to Microwave CAD packages, Microwave integrated circuits, MIC design for lumped elements.

UNIT V RF AND MICROWAVE ANTENNAS 9

Radiation from surface current and line current distribution, Basic Antenna parameters, Feeding structure-Patch Antenna, Ring Antenna, Micro strip dipole, Micro strip arrays, Traveling wave Antenna, Antenna System for Mobile Radio-Antenna Measurements and Instrumentation. Propagation characteristics of RF and Microwave signals, Introduction to EBG structures.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the student should be able to

- Apply scattering parameters in RF circuit and systems
- Develop filters for high frequency applications
- Design amplifiers for RF transceivers
- Understand the RF oscillator design techniques
- Develop antennas for high frequency applications.

REFERENCES:

1. Matthew M.Radmanesh, "RF and Microwave Design Essentials", Author House, Bloomington, 2007.
2. Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design – Theory and Applications", 2nd Edition, Pearson, 2012.
3. E.da Silva, "High Frequency and Microwave Engineering", Butterworth Heinmann Publications, Oxford, 2001.
4. David.M.Pozar, "Microwave Engineering", John Wiley and Sons, Fourth Edition, 2012.
5. Kraus.J.D, Marhefka.R.J. Khan.A.S. "Antennas and Wave Propagation", Fifth edition, Tata Mc Graw Hill, New Delhi, 2017

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓	✓	
CO2	✓		✓	✓	✓	✓
CO3	✓		✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓
CO5	✓		✓	✓		✓

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RM5151 **RESEARCH METHODOLOGY AND IPR** **LT P C**
2 0 0 2

OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6
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.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

NE5111 **COMMUNICATION AND SIGNAL PROCESSING LABORATORY (SDR platform based)** **L T P C 0 0 4 2**

OBJECTIVE:

- To develop skills for implementing various modulations, coding and quantization schemes on a SDR platform.
- To understand the merits and demerits of different modulation schemes
- To understand the requirements of synchronization and acquire the ability to implement different techniques of synchronization
- To design equalization filters so as to mitigate the ill-effects of channel
- To understand the channel behaviour through suitable estimation techniques.

LIST OF EXPERIMENTS:

1. Pulse Shaping, Timing & Frequency Synchronization
2. BPSK Modulation and Demodulation
3. Differential BPSK
4. QPSK Modulation and Demodulation
5. 16-QAM
6. LMS based Channel Equalization
7. Decision Feedback Equalizer
8. OFDM -Synchronization & Channel estimation
9. Mini Project

TOTAL: 60 PERIODS

OUTCOMES:

- To be able to design and implement synchronization schemes for communication system.
- To be able to design and implement equalization schemes.
- To be able to design and implement various digital modulation schemes.
- To be able to design and implement OFDM systems.
- To be able to use SDR platform for design of communication systems.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓

NE5161 **RF SYSTEM DESIGN LABORATORY** **L T P C 0 0 4 2**

OBJECTIVES :

- To enable the student to design and develop RF components and systems
- To enable the student to learn RF measurements
- To design and develop RF filters
- To design and develop antennas for RF applications
- To design and characterize the RF systems

LIST OF EXPERIMENTS

1. Measurement of transmission line parameters using network analyzer
   (a) Inductor (b) Capacitor
2. Measurement of transmission line parameters using network analyzer

(a) Reflection coefficient (b) VSWR

3. Design of Microstrip transmission line
   (a) λ/2 line (b) λ/4 line (c) λ/8 line
4. Design and characterization of RF filters
5. Design of impedance matching network
6. Measurement of RF signals and their spectrum
7. Design and characterization of antennas
8. Design and characterization of LNA
9. Design and characterization of Mixer
10. Design and characterization of VCO

TOTAL: 60 PERIODS

OUTCOMES:
On completion of the course the student should be able to

- Measure the RF network parameters
- Design and develop RF filters
- Design and develop antennas for RF applications
- Construct new circuit and systems for high frequency applications
- Test RF components and systems.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		
CO2	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		
CO4	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓		

NE5251 ADAPTIVE SIGNAL PROCESSING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic principles of discrete random signal processing
- To understand the principles of spectral estimation
- To learn about the weiner and adaptive filters
- To understand the different signal detection and estimation methods
- To acquire skills to design synchronization methods for proper functioning of the system

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes, Random variables, Parseval's theorem, Wiener-Khintchine relation, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes.

UNIT II SPECTRAL ESTIMATION 9

Introduction, Nonparametric methods – Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods – ARMA, AR and MA model based spectral estimation, Solution using Levinson-Durbin algorithm.

UNIT III WEINER AND ADAPTIVE FILTERS 9

Weiner Filter: FIR wiener filter, IIR wiener filter, Adaptive Filter: FIR adaptive filters – Steepest descent method- LMS algorithm, RLS adaptive algorithm, Applications.

UNIT IV DETECTION AND ESTIMATION 9

Bayes detection techniques, MAP, ML,– detection of M-ary signals, NeymanPeason, minimax decision criteria. kalman filter- Discrete kalman filter, The Extended kalman filter, Application.

UNIT V SYNCHRONIZATION 9

Signal parameter estimation, carrier phase estimation, symbol timing estimator, joint estimation of carrier phase and symbol timing.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, students will be able to

- Analyze the basic principles of discrete random signal processing
- Analyze the principles of spectral estimation
- Analyze the weiner and adaptive filters
- Analyze the different signal detection and estimation methods
- Design the synchronization methods for proper functioning of the system

REFERENCES:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc, Singapore, 2009.
2. John G. Proakis., "Digital Communication", 4 th edition, McGraw Hill Publication, 2001.
3. Simon Haykin, “Adaptive Filter Theory”, Pearson Education, Fourth Edition, 2003.
4. Bernard Sklar and Pabitra Kumar Roy, “Digital Communications: Fundamentals and Applications”, 2/E, Pearson Education India, 2009
5. Paulo S. R. Diniz, “Adaptive Filtering Algorithms and Practical Implementation”, Springer, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5201 NETWORK SECURITY L T P C
3 0 0 3

OBJECTIVES:

- To learn the fundamentals of cryptography and its application to network security.
- To understand the mathematics behind cryptography.
- To learn about the principles and protocols that enables its application to wired and wireless networks.
- To develop an understanding of security policies such as authentication, integrity and confidentiality as well as protocols to implement such policies.
- To study about network security threats, security services, and counter measures.

UNIT I INTRODUCTION TO CRYPTOGRAPHY 9

Security Services and Mechanisms, Mathematics of symmetric cryptography and Asymmetric cryptography - Algebraic structures - GF(2^n) Fields - Primes - Fermat's Theorem and Euler's Theorem - Primality Testing – Factorization – Chinese Remainder Theorem – Quadratic – Exponentiation & Logarithm.

UNIT II SYMMETRIC AND ASYMMETRIC CIPHERS 9

Classical Techniques – Substitution Ciphers - Transposition Ciphers. Modern symmetric ciphers : Stream cipher - RC4, Block cipher - DES – AES – Uses of Modes of operation. Modern Asymmetric block ciphers - RSA, ElGamal.

UNIT III SECURITY TECHNIQUES 9

Message Integrity – MAC – Cryptographic Hash Functions - SHA 512. Digital Signature Schemes - RSA, Elgamal. Entity Authentication - Passwords, Challenge Response. Key management system- Key Distribution & Key Agreements.

UNIT IV SECURITY AT LAYERS 9

Application Layer - EMail Security: PGP, S/MIME. Transport Layer: TLS, SSL. Network Layer - IPsec.

UNIT V SYSTEM SECURITY 9

Intruders- Intrusion Detection , Malicious software - Types, viruses, countermeasures, worms. Firewalls - Need for firewalls, characteristics, types.

TOTAL:45 PERIODS

OUTCOMES:

- To design cryptographic algorithms and carry out their implementation.
- To carry out cryptanalysis on cipher.
- To be able to design and implement security protocols.
- To carry out system security for various threat environments.
- To understand the importance of firewall security for network.

REFERENCES:

1. Behrouz A. Ferouzan, Debdeep Mukhopadhyay —Cryptography & Network Security, 3rd edition, Tata McGraw Hill, 2015.
2. William Stallings “Cryptography and Network Security: Principles and Practice”, 3rd Edition, Pearson Education, 2002.
3. David M. Durton, “Elementary Number Theory”, Tata Mcgraw Hill, Sixth Edition, 2009.
4. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography: Principles and Protocols (Chapman & Hall/CRC Cryptography and Network Security Series)", 1st Edition , CRC Press Taylor and Francis Group, 2008.
5. Douglas R. Stinson," Cryptography: Theory and Practice, Third Edition (Discrete Mathematics and Its Applications), Chapman & Hall/CRC, 2005.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		

NE5202 WIRELESS MOBILE COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic concepts in cellular communication
- To understand the characteristics of wireless channels.
- To know the Impact of digital modulation techniques in fading
- To get exposed to diversity techniques in wireless communication.
- To acquire knowledge in multicarrier systems

UNIT I CELLULAR CONCEPTS 9

Frequency Reuse – Channel Assignment Strategies – Hand off Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring-Repeaters for Range Extension-Microcell Zone Concept.

UNIT II THE WIRELESS CHANNEL 9

Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver –Capacity comparisons – Capacity of Frequency Selective Fading channels.

UNIT III PERFORMANCE OF DIGITAL MODULATION OVER WIRELESS CHANNELS 9

Performance of flat fading and frequency selective fading – Impact on digital modulation techniques –- Outage Probability– Average Probability of Error –— Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference

UNIT IV DIVERSITY TECHNIQUES 9

Realization of Independent Fading Paths – Receiver Diversity – Selection Combing – Threshold Combing – Maximal-Ratio Combing – Equal - Gain Combing – Capacity with Receiver diversity – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme– Transmit & Receive Diversity-MIMO Systems.

UNIT V MULTICARRIER MODULATION 9

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub channels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to design solutions for cellular communication
- To be able to compute the capacity of wireless channels
- To be able to analyze the performance of the digital modulation techniques in fading channels.
- To apply various diversity techniques in wireless communication.
- To design multicarrier systems in wireless communication

REFERENCES:

1. Theodore.S. Rappaport, “Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2009.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.
3. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Wiley Series in Telecommunications, Cambridge University Press, 2005.
4. Keith Q. T. Zhang, “ Wireless Communications: Principles, Theory and Methodology” 1st edition, John Wiley & Sons, 2016.
5. Ramjee Prasad, "Ofdm for Wireless Communication Systems", Artech House,2004.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	
CO2	✓		✓		✓	
CO3	✓		✓		✓	
CO4	✓		✓		✓	
CO5	✓		✓		✓	Attested

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NE5211 **NETWORKING LABORATORY** **L T P C**
(Experiments using NS2/ QUALNET /NS3/ OMNET/ equivalent) **0 0 4 2**

OBJECTIVES:

- To understand the functioning of various protocols in Wired and Wireless Environment.
- To perform real time experimentation using the existing infrastructure.
- To impart programming skill using NS2/QUALNET.
- Gain knowledge to construct LAN, WLAN, and VLAN in a real-time environment.
- To understand the security algorithms for network.

LIST OF EXPERIMENTS:

1. AODV/DSR routing
2. Security algorithms in wired network
3. MAC protocols Wired and wireless
4. Configuration of LAN
5. Configuration of VLAN- Tunneling
6. Configuration of WLAN
7. MINI PROJECT

TOTAL: 60 PERIODS

OUTCOMES

- Ability to design MAC and routing protocols in Wired and Wireless Environment using NS2/QUALNET.
- To acquire the technical competence to meet out the industry expectation on the state – of the art wired / wireless technologies.
- To acquire the ability to design WLAN/ LAN systems meeting out real time requirements.
- To be able to design and configure a network.
- To be able to design VLAN for secured communication.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		✓
CO2	✓	✓	✓	✓		✓
CO3	✓	✓	✓	✓		✓
CO4	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓		✓

WT5261 **WIRELESS TECHNOLOGY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES :

- To understand the functioning of various protocols in Wired Environment.
- To understand the functioning of various protocols in Wireless Environment.
- To perform real time experimentation using the existing infrastructure.
- To get exposed to open source networking tools.
- To gain knowledge in constructing LAN, WLAN, and VLAN

LIST OF EXPERIMENTS

1. Wired and Wireless network scenario creation.
2. Study of Routing Protocols
3. Analysis of Network Security Algorithms
4. Study of ZigBee Energy Model and MAC protocols
5. Queuing mechanism.

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6. QoS analysis of Multimedia traffic.
7. Call establishment in cellular network
8. Handover in cellular network
9. Throughput performance for various terrain models, transmission modes, loading conditions,Traffic profiles in LTE network.

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to design MAC and routing protocols in Wired Environment
- Ability to design MAC and routing protocols in Wireless Environment
- Acquire the technical competence to meet out the industry expectation in the wired technologies
- Ability to meet out requirements of industries related to wireless technologies
- Acquire the ability to design WLAN/ LAN systems meeting out real time requirements.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓	✓	✓	✓		✓
CO2	✓	✓	✓	✓		✓
CO3	✓	✓	✓	✓		✓
CO4	✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓		✓

NE5072 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY **L T P C 3 0 0 3**

OBJECTIVES:

- To develop an understanding of basics of Electromagnetic interference in Electronic systems
- To acquire knowledge on the EMI coupling mechanisms
- To impart concepts of EMI control schemes
- To get acquainted with design PCB incorporating EMC principles
- To know about the current EMC standards and measurement techniques

UNIT I EMI/EMC CONCEPTS **9**

EMI/EMC Concepts, EMI-EMC definitions and Units of parameters, Sources and victim of EMI Conducted and Radiated EMI Emission, Susceptibility, Transient EMI, ESD, Radiation Hazards.

UNIT II EMI COUPLING PRINCIPLES **9**

EMI Coupling Principles - Conducted, radiated and transient coupling; Common ground impedance coupling ; Common mode and ground loop coupling ; Differential mode coupling ; Near field cable to cable coupling, cross talk ; Field to cable coupling ; Power mains and Power supply coupling. Simulation of Electromagnetic interference.

UNIT III EMI CONTROL TECHNIQUES **9**

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control.

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UNIT IV EMC DESIGN OF PCBs 9

EMC Design Of PCBs: Component selection and mounting; PCB trace impedance; Routing; Cross talk control; Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations; EM simulation of PCB's

UNIT V EMI MEASUREMENT AND STANDARDS 9

EMI Measurements: Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Receiver and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards: MIL461E/462.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the student should be able to:

- Understand EMI and susceptibility
- Identify EMI coupling mechanisms
- Use appropriate EMI control schemes in electronic systems
- Design PCBs with EMC
- Conduct EMI measurements according to standards.

REFERENCES:

1. David A Weston," Electromagnetic Compatibility – Methods, Analysis, Circuits and measurements", CRC press, Boca raton 2017
2. Tim Williams, "EMC for product Designers",5ed,Newness,2017.
3. Patrick G. Andre and Kenneth Wyatt," EMI Troubleshooting Cookbook for Product Designers (Electromagnetics and Radar),SciTech publishing,2014
4. C.R.Paul, "Introduction to Electromagnetic Compatibility", 2nd ed John Wiley and Sons, Inc, 2010.
5. Henry W.Ott.," Electromagnetic Compatibility Engineering, Revised edition, Wiley Black well Newyork, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5001 ANALYSIS AND DESIGN OF CMOS ANALOG INTEGRATED CIRCUITS L T P C
3 0 0 3

OBJECTIVES:

- To understand the behaviour of MOS Transistor.
- To learn the concepts of amplifiers, current mirrors and reference generator circuits.
- To understand data converters.
- To study the feedback and frequency compensation techniques.
- To acquire information about the different types of comparators

UNIT I MODELS FOR IC ACTIVE DEVICES 9

Introduction- Large signal behavior of MOS transistor- small signal behavior of the MOS transistor – Short channel effect in MOS transistor – Weak inversion in MOS transistor – Large signal and small signal analysis of single stage MOS amplifiers (CS, CG and CD) - SPICE simulation for MOS circuits.

UNIT II CMOS OPERATIONAL TRANSCODUCTANCE AMPLIFIER 9

Introduction –Difference between Op-Amp and OTA- Differential OTA – slew rate, PSRR, CMRR and Dynamic range of the OTA-Design of Telescopic Cascode and Folded Cascode OTAs. Design of two-stage amplifier- Miller compensation method for two-stage OTA- Noise in feedback OTAs-SPICE frequency simulation for CMOS OTA.

UNIT III CURRENT MIRROR AND REFERENCES 9

Introduction- Simple MOS current Mirror – Current Mirror with Degeneration – Cascode Current Mirror- Wilson Current Mirror – MOS Widlar current source – Supply insensitive biasing – Constant settling time biasing - Temperature insensitive biasing- Start-up circuit for biasing circuits - SPICE simulation for biasing circuits.

UNIT IV ANALOG COMPARATORS AND OUTPUT STAGES 9

Introduction – OTA based comparator – Drawbacks of OTA based comparator – Regenerative latch comparator – Resistive divider comparator- Output stages - SPICE simulation for comparators and output stages.

UNIT V ANALOG DESIGN WITH MOS TECHNOLOGY 9

Design of 8-bit flash type ADC- Design of 10-bit successive approximation (SAR) & pipelined ADC- A Systematic Design approach of DAC- SPICE simulations for the above designs – Introduction to concepts of power integrity, substrate noise, and reliability.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students will have the ability

- To design various OTAs.
- To design different kinds of data converters.
- To carry out SPICE simulation of various analog circuits.
- To design and analyze the performance of current mirrors.
- To apply the concepts of CMOS circuits for real time application.

REFERENCES:

1. Gray, Meyer, Lewis, Hurst, “Analysis and design of Analog IC"s”, 5th Edition, Willey International, 2009.
2. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw Hill, 2000.
3. Rudy J. Van De Plassche, “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters”, Springer, 2010.
4. Phillip E.Allen Douglas R. Holberg, “CMOS Analog Circuit Design”, Second Edition, Oxford University Press, 2011.
5. David A. Johns and Ken Martin, “Analog Integrated Circuit Design”, John Wiley International Publications, 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

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NE5002 ELECTROMAGNETICS FOR COMMUNICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To revise of basics of Electromagnetic theory and understand its importance in communication systems.
- To acquire knowledge on the EMI mechanisms
- To impart concepts of Electromagnetic compatibility schemes
- To understand the importance of EM wave propagation in communication
- To know about the basics of light wave and Radar systems

UNIT I FUNDAMENTALS OF ELECTROMAGNETIC THEORY 9

Electric and magnetic fields; Maxwell"s equations in integral and Differential forms, Boundary conditions; Poynting's vector and energy storage; Static fields and circuit elements; Quasi- static fields and frequency behaviour of circuit elements.

UNIT II ELECTROMAGNETIC INTERFERENCE 9

Electromagnetic Environment, Practical concerns, Frequency spectrum conservation, Sources of EMI: Lightning, ESD, EMP, EMI from apparatus and circuits. Modeling of Interferences, Test sites and measurements, Simulation of EMI.

UNIT III ELECTROMAGNETIC COMPATIBILITY 9

Capacitive and inductive couplings; Crosstalk on transmission lines; Common impedance coupling; Methods of solution of EMC problems; EMI filters, Grounding and Shielding; Cables and connectors, EMC standards.

UNIT IV ELECTROMAGNETIC WAVE PROPAGATION 9

EM Waves and Radiation. Overview of propagation effects; Ground wave, Sky wave, Tropospheric, Ionospheric propagation effects; Propagation models for satellite and Mobile links. EM Simulation of propagation models.

UNIT V ELECTROMAGNETICS FOR LIGHTWAVE & RADAR SYSTEMS 9

Reflection, refraction, Interference and diffraction of plane waves; Dielectric slab waveguide; Pulse broadening in a dispersive medium. RADAR, LIDAR range equations, Radar cross section (RCS). Introduction to electromagnetic field computation and simulation.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the student should be able to:

- Understand the importance of EM theory for communication
- Identify EMI in circuits and systems
- Use appropriate EM compatibility schemes in electronic systems
- Model wireless channels for communications
- Apply knowledge light wave and RADAR system design.

REFERENCES:

1. N.N.Rao, "Fundamentals of Electromagnetics for Engineering", Pearson Education, 2008. 2. Henry Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons, 2011.
2. Abdollah Gasemi, Ali Abedi, Farshid Gashemi, "Propagation Engineering in Wireless Communication". Springer Verlag, Newyork, 2016.
3. Clayton Paul," Introduction to Electromagnetic compatibility", Wiley Interscicne,2nd edition,2006.
4. G. Keiser, "Optical Fiber Communications", 5 Edition, Tata McGraw-Hill, New Delhi, 2013.
5. Michael. O. Kolawole, "Radar Systems, Peak Detection and Tracking", Elsevier, Burlington, 2006.

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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	
CO2	✓		✓		✓	✓
CO3	✓		✓		✓	✓
CO4	✓		✓		✓	✓
CO5	✓		✓		✓	✓

NE5075 INFORMATION THEORY AND CODING L T P C
3 0 0 3

OBJECTIVES :

- To understand the concepts of Information theory and Coding.
- To analyze the various techniques to improve the capacity of the channel.
- To understand the fundamental limits prescribed by the information theory.
- To get exposed to the gaussian channel
- To learn the various coding schemes in detail.

UNIT I QUANTITATIVE STUDY OF INFORMATION 9

Entropy, Relative Entropy, Mutual information, Chain rule, Relationship Bounds on entropy, Fisher information, Cramer Rao inequality, Entropy rates of a Stochastic process .

UNIT II CAPACITY OF NOISELESS CHANNEL 9

Fundamental theorem for a noiseless channel, Data compression, Kraft inequality, Shannon-Fano codes, Huffman codes , Asymptotic equi partition, Rate distortion theory.

UNIT III CHANNEL CAPACITY 9

Properties of channel capacity, jointly typical sequences, Channel Coding Theorem, converse to channel coding theorem, Joint source channel coding theorem.

UNIT IV DIFFERENTIAL ENTROPY AND GAUSSIAN CHANNEL 9

AEP for continuous random variables, relationship between continuous and discrete entropy, properties of differential entropy, Gaussian channel definitions, converse to coding theorem for Gaussian channel, channels with colored noise, Gaussian channels with feedback.

UNIT V CHANNEL CODING TECHNIQUES 9

Galois Fields, Fundamental Theorem of Galois Theory (FTGT), Reed-Solomon Codes, Turbo Codes, LDPC Codes, TCM.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be in a position to quantify information.

- To be able to implement various coding schemes.
- To be able to design efficient channel.
- To be able to apply coding techniques to information sources like video, audio and so on.
- To able to implement the information theory and coding technique for effective communication

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REFERENCES:

1. Thomas Cover, Joy Thomas, “Elements of Information Theory “, 2nd edition, Wiley, 2006
2. David J.C. MacKay, “Information Theory, Interference & Learning Algorithms”, 2nd edition, Cambridge University Press 2003
3. Monica Borda, " Fundamentals in Information Theory and Coding ", Springer 2011.
4. P.S. Satyanarayana , “Concepts of Information Theory & Coding”, 2nd edition, Medtech, 2016.
5. Varun Goyal, Gaurav Gupta “Information Theory & Coding”, S.K. Kataria& Sons, 2014 edition

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5003 **PARALLEL PROCESSING** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the various architectures for parallel processing
- To learn the concepts of Pipelining and Multithreading
- To Learn the Levels in Main Memory and Virtual Memory Hierarchy Schemes
- To understand the Address Translation Mechanisms available in Virtual Memory Technology
- To learn the concepts of Parallel Programming Languages and Constructs

UNIT I THEORY OF PARALLELISM **9**

Parallel computer models- the state of computing, Multiprocessors and multi computers and multivectors and SIMD computers, PRAM models

UNIT II PARALLEL PROCESSING APPLICATIONS **9**

Conditions of parallelism, Program partitioning and scheduling, Program flow mechanisms, system interconnect architectures. Principles of scalable performance, performance metrics and measures.

UNIT III HARDWARE TECHNOLOGIES **9**

Processor and memory hierarchy- advanced processor technology, superscalar and vector processors, memory hierarchy technology, virtual memory technology, bus cache and shared memory, backplane bus systems, cache memory organizations, shared memory Organizations.

UNIT IV PARALLEL PROGRAMMING **9**

Parallel Programming models- Shared Memory Multiprocessors- Constructs for specifying Parallelism- Sharing data- Parallel Programming Languages and Constructs- Opn MP- Introduction.

UNIT V PARALLEL ALGORITHMS **9**

Classification of Parallel Algorithms- Sorting Algorithms- Compare and Exchange sorting Algorithms- Sorting on Specific Networks. Numerical Algorithms- Implementing Matrix Multiplication- Solving of Linear Equations.

TOTAL: 45 PERIODS

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OUTCOMES:

On successful completion of this course, students will be able to

- Apply the problem solving techniques in parallel computing
- To solve problems related to memory management
- To design efficient memory hierarchical scheme with cost evaluations
- To translate the information from virtual memory to main memory
- To write programs in the parallel processing environment

REFERENCES:

1. Kai Hwang & Naresh Jotwani, “Advanced Computer Architecture”, Tata McGraw Hill, Second Edition.
2. V.Rajaraman, C.Siva Ram Murthy,”Parallel Computers” Architecture and Programming, Prentice Hall of India Private Limited, 2006.
3. Barry Wilkinson, Michael Allen, “Parallel Programming” Techniques and Applications using Networked Workststions and Parallel Computers, Pearson, 2012.
4. Hwang.K.Briggs F.A., “Computer Architecture and Parallel Processing”, Tata McGraw Hall, 2014.
5. Quinn M.J, “Designing Efficient Algorithm for Parallel Computers”, Mc Graw Hill, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5004 RF INTEGRATED CIRCUITS DESIGN L T P C

3 0 0 3

OBJECTIVES:

- To introduce the Integrated circuit design for Amplifiers at radio frequency.
- To get exposed to microwave oscillator design.
- To impart the concepts of RF IC
- To analyze and focus on circuits for radio frontends for mobile phone handsets.
- To understand noise amplifiers, mixers, power amplifiers, frequency synthesizers (phase locked loops) and modern radio architectures.

UNIT I BASIC RF IC COMPONENTS 9

Resistors, Capacitor, Inductor and Transformers at high frequency, Skin effect, Interconnect options. S-parameters with Smith chart, Impedance matching networks, Transmission lines, finite length effects, MOSFET characteristics, Noise: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR.

UNIT II RECEIVERS ARCHITECTURE AND LOW NOISE AMPLIFIERS 9

Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct up conversion Transmitter, Two step up conversion Transmitter, CMOS amplifiers, Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs, OC Time constants in bandwidth estimation and enhancement.

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UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

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

UNIT IV PLL AND FREQUENCY SYNTHESIZERS 9

Linearised PLL Model, Noise properties, Phase detectors, Loop filters and Charge pumps, PLL Design examples. Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

UNIT V MIXERS AND OSCILLATORS 9

Mixer characteristics, Non-linear based mixers, Multiplier based mixers, Single balanced and double balanced mixers, sub sampling mixers, Oscillators describing Functions, Resonators, Phase noise, Chip Design Examples: GPS Receiver, WLAN receiver.

TOTAL: 45 PERIODS

OUTCOMES:

- Design amplifier by using RF IC
- Develop RF oscillator for high frequency applications
- Apply RF technology in the high frequency IC design
- Understand the RF point to point system design
- Apply IC design techniques in the transmission line equipment

REFERENCES:

1. David Pozar, “Microwave and RF Design of Wireless Systems”, John Wiley, Second edition 2012.
2. John Rogers and Calvin Plett, “Radio Frequency Integrated Circuit Design”, Artech House, Second edition ,2002.
3. Thomas H Lee, “The Design of CMOS Radio Frequency Integrated Circuits” 2nd Edition, Cambridge University press, 2003.
4. Hooman Darabi, “Radio Frequency Integrated Circuits and Systems”, 1st edition, Cambridge University press, 2015.
5. Sorin Voinigescu, “High Frequency Integrated Circuits”, 1st edition, Cambridge University press, 2013.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5005 SPEECH RECOGNITION AND SYNTHESIS LT P C
3 0 0 3

OBJECTIVES:

- To understand the various speech models
- To understand the basic characteristics of speech
- To know the details of algorithms, techniques and limitations of state of the art speech systems.
- To investigate various speech synthesis mechanism
- To analyze the various speech recognition techniques

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UNIT I BASIC CONCEPTS 9

Speech fundamentals: Articulatory phonetics- Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-time Fourier transform, Filter Bank and LPC Methods.

UNIT II SPEECH ANALYSIS 9

Features, Feature Extraction and Pattern Comparison Techniques; Spectral distortion measures- mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Liftering, Likelihood Distortions, Spectral Distortion using a Warped frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, multiple Time – Alignment Paths.

UNIT III SPEECH MODELLING 9

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi search, Baum – Welch Parameter Re-estimation, Implementation issues.

UNIT IV SPEECH RECOGNITION 9

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary Continuous Speech Recognition system – acoustics and language models, Sub-word units- models for phonemes, syllables, triphones, Language models, n-grams, context dependent sub-word units.

UNIT V SPEECH SYNTHESIS 9

Text-to-speech synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody, Applications.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to carry out transform domain/ time domain implementation of speech algorithm
- To be able to analyse speech signal for various appliactions
- To design speech recognition systems
- To design speech synthesis systems
- To be able to implement various speech modelsss

REFERENCES:

1. Lawrence Rabiner and Biiing – Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education 2002.
3. Steven W. Smith, “The Scientist and Engineer"s Guide to Digital Signal Processing”, California Technical Publishing, 1997.
4. Thomas F Quatieri, “ Discrete- Time Speech Signal Processing- Principles and Practice”, Pearson Education, 2004.
5. Claudio Becchetti and Lucio Prina Ricotti, “ Speech Recognition”, John Wiley and Sons, 1999.
6. Bengold & Neoban margom “ Speech and Audio Signal Processing: Processing and Perception of Speech and Music”, John Wiley and Sons 2002.
7. Donglos O shanhnessy “Speech Communication: Human and Machine", 2nd Edition. University Press 2001.
8. F. Jebinek, "Statistical Methods for Speech Recognition”, MIT press, 1998.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5006 **VLSI DESIGN AUTOMATION** **L T P C**

3 0 0 3

OBJECTIVES:

- To learn the basics of logical design automation
- To give clear idea about VLSI Physical Design Cycle
- Study of different architectures of FPGA from different families.
- To learn the algorithmic concepts and complexity in physical design automation.
- To understand the faults in system and causes for occurrence of faults.

UNIT I INTRODUCTION AND LOGICAL DESIGN AUTOMATION 9

CAD for ASIC Design – design entry – Hardware Description Language (HDL) – Schematic / Graphical design entry – Net list extraction – functional simulation – synthesis – Combinational Logic Synthesis – Binary Decision Diagrams – Two Level Logic Synthesis. Data structures and algorithms for electronic design automation (EDA) – Complexity issues and NP-hardness, Basic Algorithms, Basic Data Structures.

UNIT II PHYSICAL DESIGN AUTOMATION 9

VLSI Design Cycle , Physical Design Cycle, New Trends, Design Styles, System Packaging Styles, Historical Perspectives, Existing Design Tools – Fabrication Process **–** Fabrication Materials, Fabrication of VLSI Circuits, Design Rules, Layout of the Basic Design, Scaling Methods, Status of Fabrication Process, Issues Related to Fabrication Process, Future of Fabrication Process, Tools and Process Development – Parasitic extraction, back annotation and simulation – Graph Algorithms for Physical Design.

UNIT III PARTITIONING, FLOORPLANNING, PLACEMENT, ROUTING AND AUTOMATION OF FPGAs AND MCMs 9

Introduction to Partitioning, Problem Formulation, Classification of Partitioning Algorithm, Group Migration Algorithm, Simulated Annealing and Evolution, Other Partitioning Algorithm, Performance Drive Partitioning – Floorplanning, Chip Planning, Pin Assignment, Integrated Approach, Placement. Global Routing, Detailed Routing, Clock Routing, Power and Ground Routing, Compaction, Physical Design Automation of the FPGA‟s and MCM‟s.

UNIT IV MODELLING, SIMULATION AND VERIFICATION 9

Modelling – Register transfer level (RTL) – Structural – Gate level, switch level and high level 34odeling – High-level modeling of VLSI Systems – System Verilog and SystemC concepts-Simulation & Verification – Event driven and continuous analog simulation methods – Analog and mixed signal simulation and verification – SPICE – Introduction to assertion-Based-Verification (ABV) and Formal Verification (FV).

UNIT V TESTING & VERIFICATION 9

Design for Testability, Boundary scan test, Fault simulation – ATPG – Application of ASICs – Analog and Mixed signal (AMS) test and DFT – Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, students will be able to

- Analyze the basics of logical design automation
- Analyze the basics of VLSI physical design cycle
- Analyze the different architectures of FPGA families.
- Design and analyze the algorithms in physical design automation
- Analyze and verify the faults in a VLSI system.

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REFERENCES:

1. Naveed Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer International Edition, 2005.
2. M.J.Smith, “Application Specific Integrated Circuits”, Addison Wesley, 1999.
3. S.H.Gerez, “Algorithms for VLSI Design Automation”, Wiley Publication, 1999.
4. Sadiq M. Sait and Habib Youssef , “VLSI Physical Design Automation: Theory and Practice” World Scientific Publishers, Singapore/New-Jersey, USA, 1999.
5. Sung Kyu Lim, “Practical problems in VLSI physical design automation” Springer 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓			✓
CO2	✓		✓			✓
CO3	✓		✓			✓
CO4	✓		✓			✓
CO5	✓		✓			✓

NE5076 **IoT FUNDAMENTALS** **L T P C**
3 0 0 3

OBJECTIVES:

- To assess the vision and introduction of IoT.
- To Implement Data and Knowledge Management and use of Devices in IoT Technology.
- To Understand State of the Art - IoT Architecture.
- To build a small low-cost embedded system using Single Board Computers
- To learn the various case study of IoT systems.

UNIT I INTRODUCTION AND APPLICATIONS 9

Introduction to IoT – Definition, Characteristics, functional requirements, motivation, Physical design - things in IoT, IoT protocols, Logical Design - functional blocks, communication models, Communication APIs, Applications – Home Automation, Cities, Environment, Energy, Agriculture, Health, Industry

UNIT II IoT DESIGN & SYSTEM MANAGEMENT 9

IoT &M2M – Machine to Machine, Difference between IoT & M2M, Software Defined Network, Network function virtualization, IoT system management – SNMP, NETCONF, YANG, IoT Design methodology.

UNIT III IoT PROTOCOLS & SYSTEM 9

Protocols – HTTP, UPnP, CoAP, MQTT, XMPP. IoT systems logical design using python - python data types & data structures, control flow, functions or modules. Modules & package of python, python packages of interest for IoT-JSON, XML, HTTP & URL Lib, SMTP Lib. Exemplary Device: Raspberry Pi - Linux on Raspberry Pi – Programming Raspberry Pi with Python.

UNIT IV IoT CLOUD & DATA ANALYTICS 9

Introduction to Cloud storage Models – WAMP – Xively Cloud for IoT – Python Web Application Framework-Django – Designing a RESTful based Web API. Data Analytics for IoT – Apache Hadoop, Apache Oozie.

UNIT V IoT SECURITY 9

IoT attacks - Phase attacks, Attacks as per architecture, Attacks based on components. Security Protocols - Time-Based Secure Key Generation and Renewal - Security access algorithms for unidirectional data transmissions, Security access algorithms for bidirectional data transmissions.

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TOTAL:45 PERIODS

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OUTCOMES:

Upon the completion of the course the student will be able to

- Interpret the vision of IoT from a global context.
- Compare and Contrast the use of Devices, Gateways and Data Management in IoT.
- Design a portable IoT using any Single Board Computer and relevant protocols
- Analyze applications of IoT in real time scenario
- Deploy an IoT application and connect to the cloud.

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hand on approach" ,Universities Press (India) Private Limited, 2014
2. Pethuru Raj, Anupama C. Raman, "The Internet of Things – Enabling Technologies, Platforms and Use cases" , CRC Press, Taylor & Francis Group, 2017.
3. William Stallings, Lawrie Brown, "Computer Security: Principles and Practice", Third Edition, Pearson, 2014.
4. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations," 1st edition, CRC Press, 2016.
5. Rajkumar Buyya, "Internet of Things – Principles and Paradigms" , Published by Morgan Kaufmann, Elsevier, 2016.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5007 DETECTION AND ESTIMATION THEORY LT P C
3 0 0 3

OBJECTIVES:

- To understand the basic probability and stochastic process
- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I REVEIW OF PROBABILITY AND STOCHASTIC PROCESS 9

Conditional Probability, Bayes' Theorem , Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete-Time Stochastic Processes, Spatial Stochastic Processes Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

UNIT II SINGLE AND MULTIPLE SAMPLE DETECTION 9

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise , Performance of Binary Receivers in AWGN.

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UNIT III FUNDAMENTALS OF ESTIMATION THEORY 9

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes Estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters.

UNIT IV WIENER AND KALMAN FILTERS 9

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, LeastSquares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

UNIT V APPLICATIONS 9

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to apply stochastic process concepts in various application
- To apply probability and stochastic process concepts in detection and estimation.
- To design Wiener and Kalman filters to solve linear estimation problems.
- To design optimal system in the process of Non-Gaussian noise
- To design various synchronized schemes in the receiver.

REFERENCES:

1. Thomas Schonhoff, "Detection and Estimation Theory", Prentice Hall, New Jersy, 2007.
2. Steven M. Kay, "Fundamentals of Statistical Processing, Volume I: Estimation Theory", Prentice Hall Signal Processing Series, Prentice Hall, PTR, New Jersy, 1993.
3. Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2001.
4. Ali saberi, Anton A.Stooryogel, Peddapullaiah Sannuti, "Filtering Theory: With Applications to Fault Detection, Isolation, and Estimation (Systems & Control: Foundations & Applications)",2006
5. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume II : Detection Theory, 1998

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	
CO2	✓		✓		✓	✓
CO3	✓		✓		✓	✓
CO4	✓		✓		✓	✓
CO5	✓		✓		✓	✓

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NE5078 PATTERN RECOGNITION AND MACHINE LEARNING L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of data processing and dimensionality reduction techniques
- To understand different learning models for classification
- To understand the principles and applications of ANN architectures
- To study the different Deep convolutional networks
- To learn deep generative models

UNIT I BASICS OF PROBABILITY AND RANDOM PROCESS 9

Probability Theory - Conditional and Joint Probability - Stationary and non-stationary process - Expectation - Auto correlation - Cross Correlation - Eigen values - Eigen vectors - Singular values - Singular vectors - Decision Theory - Information Theory

UNIT II DIMENSIONALITY REDUCTION 9

Introduction - Features, feature vectors - Feature selection and ranking - Discriminant functions - Fisher's Discriminant analysis - Principal Component Analysis - Kernel PCA - Independent component analysis

UNIT III LEARNING MODELS 9

Linear models for Classification and Regression - Classifiers based on Bayes Decision theory – Naïve Bayes - Nearest neighbor rules - Mixture models - Mixture of Gaussian - Hidden Markov Model

UNIT IV ARTIFICIAL NEURAL NEWORKS 9

Supervised Learning - Unsupervised Learning- Reinforcement Learning – Feed Forward and Feedback architectures - Multilayer Perceptron - Backpropagation Algorithm- Radial Basis Function networks - Support vector Machines

UNIT V DEEP LEARNING NETWORKS 9

Introduction to Deep neural networks – Convolution neural networks – Deep Belief Networks - Recurrent neural networks

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, students will be able to

- Employ different feature extraction and dimensionality reduction techniques
- Design different learning models
- Implement different neural network architectures
- Realize basic Deep neural network architectures
- Test and implement deep generative models for various data processing applications

REFERENCES:

1. Christopher M. Bishop, " Pattern Recognition and Machine Learning", Springer2011
2. R.O. Duda, P.E. Hart and D.G. Stork, "Pattern Classification" John Wiley, 2002
3. EthemAlpaydm, "Introduction to Machine Learning", Second Edition, The MIT Press, Cambridge, 2010.
4. Kevin P. Murphy, "Machine Learning - A Probabilistic Perspective", The MIT Press, Cambridge, 2012.
5. Josh Patterson and Adam Gibson, "Deep Learning - A Practitioner's Approach", O'Reilly Media, Inc, 2017.
6. Richard Szeliski, "Computer Vision - Algorithms and Applications", Springer Verlag London Limited, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓			
CO2	✓		✓	✓		
CO3	✓		✓			
CO4	✓		✓			✓
CO5	✓		✓	✓		✓

NE5009 COMPUTATIONAL ELECTROMAGNETICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the concepts and mathematical methods to analyze electromagnetic fields and wave phenomena.
- To learn analytical techniques to solve electromagnetic problems.
- To acquire knowledge on numerical methods for solving electromagnetic problems
- To get acquainted with field computations
- To understand computational techniques for high frequency systems

UNIT I INTRODUCTION 9

Review of Electromagnetic Theory – Electromagnetic fields – Magnetostatic fields - Maxwell‟s equations – Electro thermal formulation – Classification of EM problems.

UNIT II ANALYTICAL TECHNIQUES 9

Limitation of the conventional design procedure – Need for field analysis based design – problem definition – Direct Integration Method – Variable Separable Method – Method of Images – Conformal Mapping.

UNIT III NUMERICALTECHNIQUES 9

Finite Difference Method(FDM) – Finite Element Method(FEM) – Variational Method – Method of Moments – Transmission Line Matrix Method – Finite Difference Time Domain(FDTD).

UNIT IV FIELD COMPUTATION FOR BASIC STRUCTURES 9

Computation of Electric and Magnetic field intensities – Capacitance and Inductance – Semiconductor Structures – Resonant Circuit Method – Frequency Band Gap for surface wave propagation – Soft and Hard surfaces.

UNIT V CASE STUDIES 9

EBG structure analysis – EBG patch antenna – Surface wave antenna – PBG structures – Physical origin of PBG – Modes – PBG application in Waveguide, Cavity, Narrow Band Filter.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to understand EM problems
- To be able to solve EM problems using analytical techniques
- To identify numerical methods for EM problems
- To be able to use field computation methods
- To design and analyze antenna and other high frequency structures

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REFERENCES:

1. Nathan Ida, Joao P.A.Bastos, "Electromagnetics & Calculation of Fields", Springer-Verlag, London, 2012.
2. Fanyang & Yahya Rahmat Samii, "Electromagnetic Band Gap Structures in Antenna Engineering", The Cambridge RF & Microwave Engineering Series, 2009.
3. Mathew N.O.Sadiku, "Numerical Techniques in Electromagnetics with MATLAB", CRC Press, Bocaraton, 2009.
4. K.J.Binns, P.J.Lawrenson, C.W.Trowbridge, "The Analytical & Numerical Solution of Electric & Magnetic Fields", John Wiley & Sons, 1995.
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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		
CO5	✓		✓	✓		✓

NE5010 DIGITAL AUDIO AND VIDEO BROADCASTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of audio broadcasting technology
- To understand the basics of video broadcasting technology.
- To learn the principle of audio and video coding methods.
- To understand the technology of digital TV transmission.
- To understand digital audio broadcasting.

UNIT I INTRODUCTION 9

Basic television, analog and digital TV, standards for analog and digital TV, scanning on original black and white picture, synchronization, horizontal and vertical synchronization, adding colour information, transmission methods, distortion and interference, measurements on analog video standards.

UNIT II VIDEO CODING 9

Video compression, MPEG-2 data stream, coding, modulation of moving pictures, DPCM of moving pictures, DCT and quantization, Huffman coding, structure of video elementary system, recent compression methods, MPEG-4 –H.263-advanced video coding. HDTV.

UNIT III AUDIO AND VIDEO COMPRESSION 9

Digital audio signal, MPEG and dolby digital, subband coding, transform coding for MPEG, multi channel sound, Comparison digital video signal, MPEG- 1, MPEG-- 2, VCD, DVD, MPEG 3, MPEG-4, MPEG- 7 and MPEG- 21, measurement of MPEG-2 transport system, picture quality analysis.

UNIT IV DIGITAL AUDIO BROADCASTING 9

Digital audio broadcasting (DAB),comparing DAB and DVB, physical layer of DAB, forward error correction of DAB, modulator and transmitter for DAB, single frequency networks, DAB data broadcasting.

UNIT V DIGITAL TV SIGNAL TRANSMISSION 9

Digital TV signal transmission by satellite, DVB-S/S2, parameters, modulator, signal processing in satellite, receiver, satellite transmission link, DVB-S measurement of CNR, SNR and Eb/No, noise power, broadcast cable transmission, DVB-C, modulator and receiver, DVB-T and DVB-H standards.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to design and implement digital compression techniques.
- To be able to design video coding and audio compression
- To be able to design digital audio schemes
- To be able to design digital TV systems
- To identify issues and provide solutions for digital TV transmission.

REFERENCES:

1. W.Fischer, "Digital Video and Audio Broadcasting Technology, A Practical Engineering Guide", 2nd Edition, Springer, 2010.
2. W.Fischer, "Digital Television, A Practical Engineering Guide", 2nd Edition, Springer,2004.
3. Ken C Pohlmann, “Principles of Digital Audio”, 6th Edition, McGraw Hill, 2010.
4. Herve Benoit, “Digital Television, MPEG-1,MPEG-2 and Principles of DVB Systems”, Focal Press, Elsevier Science Imprint, 2002.
5. Jerry Whitaker,Blair Benson, “Standard Handbook of Audio Engineering” Second Edition.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓		✓	✓

NE5011 FUNDAMENTALS OF CLOUD COMPUTING L T P C
3 0 0 3

OBJECTIVES

- To Introduce the fundamentals of Cloud Computing and virtualization.
- To familiarize various standards related to cloud computing.
- To be familiar with the lead players in cloud.
- To understand various cloud services in cloud computing.
- To install and use current cloud technologies

UNIT I INTRODUCTION TO CLOUD 9

Cloud Computing – History, Architecture, Storage, Advantages, Disadvantages, Services, Server Virtualization- Parallel Processing, Vector Processing, Symmetric Multiprocessing Systems and Massively Parallel Processing Systems.

UNIT II CLOUD BASED WEB SERVICES 9

Understanding Private and Public cloud environments – Communication as a Service (CaaS)- Infrastructure as a Service (IaaS) – On-demand, Amazon‟s Elastic, Amazon EC2, Mosso– Monitoring as a Service (MaaS) –Platform as a Service (PaaS) – On-Premises model, new cloud model – Software as a Service (SaaS) –implementation issues, characteristics, SaaS model.

UNIT III CLOUD COMPUTING FOR EVERYONE 9

Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists– Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation

UNIT IV USING CLOUD SERVICES 9

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files

UNIT V FUTURE DIRECTIONS TO CLOUD 9

Cloud Security – Software as a Service Security – Standards for application developers –Ajax, XML, JSON, LAMP, LAPP –Standards for Messaging –SMTP, POP, IMAP, HTTP, SIMPLE, XMPP – Standards for Security –SAML oAuth, OpenID, SSL/TLS, Collaborating via Blogs and Wikis – Mobile Platform Virtualization –KVM, VMWare.

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to build custom made clouds.
- To be able to develop remote access applications, alert generation using cloud.
- To be able to work with commercial cloud packages.
- To identify core issues of cloud computing such as security.
- To be able to install and use current cloud technologies

REFERENCES:

1. John W.Ritting house and James F.Ransome, “Cloud Computing – Implementation, Management and Security", CRC press, 2012.
2. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Pearson, 2008.
3. Barrie Sosinsky, “Cloud Computing –Bible”, Wiley Indian Edition, 2011.
4. Anthony T Velte, Toby J Velte, Robert Elsenpeter, Cloud Computing : A Practical Approach, Tata McGraw-Hill 2010.
5. David E.Y. Sarna Implementing and Developing Cloud Application, CRC press 2011.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5073 GAME THEORY FOR WIRELESS COMMUNICATION AND NETWORKING **L T P C 3 0 0 3**

OBJECTIVES :

- To give an overview of a broad range of models that is studied in game theory
- To attain understanding on concepts related to non- cooperative games
- To understand a range of mathematical models of conflict and co-operation between two or more agents
- To attain understanding on concepts related to Bayesian games
- To discuss the application of game theory in wireless communication and networking

UNIT I INTRODUCTION 9

Introduction to theory of games- conflict, strategy, utility theory, games in extensive and normal forms, Examples.

UNIT II NON CO-OPERATIVE GAMES 9

Basics of Non-Cooperative games, Non-Cooperative games in strategic form – Matrix games, Nash Equilibrium, Mixed Strategies. Dynamic Non-Cooperative games – Non-Cooperative game in extensive form, repeated games, and stochastic games.

UNIT III COOPERATIVE GAMES 9

Basics of Cooperative games, bargaining theory – Introduction, Nash bargaining solution, Coalition game theory – shape value, Dynamic Coalition formation algorithms.

UNIT IV BAYESIAN GAMES 9

Overview of Bayesian Games, Bayesian Games in extensive form, Cournot duopoly model with incomplete information, Super-Modular games, Learning in games: Fictitious play, and Regret minimization, Vickrey-Clarke-Groves Auction, Optimal Auction.

UNIT V APPLICATIONS TO NETWORKING 9

Cellular & Broadband wireless access networks – Routing & Resource allocation, Power allocation, Network selection in Multi-technology, WLAN – MAC Protocol design, Random Access Control, Rate Selection for VOIP services, throughput efficiency, competition and implication on network performance – Game theoretic solutions for cooperation in ad hoc networks.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to understand new concept in game theory
- To be able to design non cooperative game theory based models
- To be able to design cooperative game theory based models
- To be able to design Bayesian game theory based models
- To be able to apply game theory to solve network related issues.

REFERENCES:

1. Martin J. Osborne, “An Introduction to Game Theory”, Oxford Press 2006.
2. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar, Are Hjorungnes, “Game Theory in Wireless and Communication Networks: Theory, Models, and Applications”, University Press Cambridge, 1st Edition, 2012.
3. Allan MacKenzie, Luiz DaSilva, "Game Theory for Wireless Engineers, Synthesis Lectures on Communication", Morgan and Claypool Publishers, 2006.
4. Drew Fudenberg and Jean Tirole, "Game Theory", MIT Press, 1991.
5. Vijay Krishna, "Auction Theory", Academic Press, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		
CO5	✓		✓	✓		✓

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NE5012 **MICROWAVE PHOTONICS** **LT P C**

3 0 0 3

OBJECTIVES:

- To understand the role of optical fiber to transmit RF and microwave signal for wireless communication applications.
- To acquire knowledge on optical modulation techniques
- To identify different optoelectronic and all optical techniques for microwave signal generation and signal processing.
- To learn the applications of radio over fiber in the field of mobile communication networks
- To impart concepts on ROF for CATV and RADAR.

UNIT I RADIO OVER FIBER (ROF) LINK 9

Introduction to microwave photonics, Radio over fiber, figure of merit and performance of microwave photonics, gain and frequency response, noise figure, distortion in RF links, directly modulated optical links, RF subcarrier link for local access networks.

UNIT II MODULATION TECHNIQUES FOR MICROWAVE PHOTONICS 9

Laser diode fundamentals, rate equation analysis, small signal analysis, microwave loss, modulation effect on link performance, frequency modulation, intensity modulation, External modulation, $LiNbO_3$ and polymer based electro optic modulator, broad band travelling wave modulator, Electro absorption modulator.

UNIT III OPTO-ELECTRONIC OSCILLATOR AND MICROWAVE GENERATION 9

Basics of opto-electronic oscillators, signal generation for RF photonic systems, multi loop opto electronic oscillator, photonic link technique for microwave frequency conversion, benefits of frequency converting, optical local oscillator, microwave frequency conversion in photonic links.

UNIT IV ROF FOR CELLULAR SYSTEMS 9

Analysis of analog fiber optic link, fiber optic remote antenna feeding links, comparison of fiber optic and co axial remote antenna feeding links, ROF for micro cellular system, fiber optic micro cell repeater, performance evaluation, WCDMA for 3G cellular systems, WCDMA based ROF system performance, ROF for micro cellular communication networks

UNIT IV ROF FOR RADAR AND CATV APPLICATIONS 9

ROF for mobile communications, antenna remoting applications, phased array antennas, wide band photonic phased array antenna, photonic beam steering, ROF for CATV applications, mobile CATV, ROF application for multiservice wireless communication systems, fixed and integrated multi service mobile communication.

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to understand the properties of Radio over fiber link.
- To identify suitable optical modulation techniques for various applications.
- To be able to understand optical methods for microwave generations.
- To be able to design RoF based cellular systems.
- To be able apply ROF techniques for Radar and CATV applications.

REFERENCES:

1. Chi H. Lee," Microwave Photonics", 2 ed, CRC press, Boca raton,2013
2. Stacros Iezekiel, "Microwave Photonics, Devices and Applications", John Wiley and Sons, New York 2009.
3. Nathan J. Gomes, Paulo P.Monterio and Atilio Gameiro "Next Generation Wireless Communication using Radio Over Fiber" John Wiley and Sons, New York,2012.
4. Xavier Fernando ," Radio over fiber for wireless communication", John Wiley and Sons, New York ,2014.
5. Hamed Al-Rawesshidy and Shozo Komaki, "Radio Over Fiber Technology for Mobile Communication Networks", Artech House, London, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		
CO5	✓		✓	✓		

NE5013 **OPTICAL NETWORKS** **L T P C**
3 0 0 3

OBJECTIVES:

- Understand the concepts of optical components and networks.
- To gain an understanding of various issues in designing a high speed, high date rate and huge bandwidth optical network.
- To acquire knowledge of architecture and standards of optical networks.
- Thorough knowledge about the routing and access mechanism in optical networks.
- Thorough understanding of the scientific and engineering principles underlying the photonics technology.

UNIT I OPTICAL SYSTEM COMPONENTS 9

Light propagation in optical fibers-Loss& Bandwidth, System limitations, Non-Linear effect, Solitons, Optical Network \ Components- Couplers, Isolators & Circulators, Multiplexers & Filters Optical Amplifiers, Switches Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks**;** WDM networks , SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks- Topologies for Broadcast Networks, Media-Access Control Protocols, Wavelength Routing Architecture. WOBAN and OTDM networks. Introduction to ASON.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The Optical layer, Node Designs, Optical layer cost tradeoff, Routing and Wavelength Assignment algorithms, Virtual Topology design, Architectural variations

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching – OTDM , Multiplexing and De multiplexing, Synchronization, Broadcast OTDM networks, Switch based networks; Access Networks- Network Architecture overview , Future Access Networks, Optical Access Network Architectures.

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Transmission system Engineering-system model, Power penalty-transmitter, receiver, Optical amplifiers, crosstalk, dispersion, wavelength stabilization; overall design consideration; Control and Management-Network management functions, Configuration management, Performance management, Fault management. Optical safety, Service interface.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to apply design state-of-the-art optical networks.
- To be able to implement optical network protocols.
- To be able to design high speed networks using optical fibers
- To be able to simulate access network
- To able to design the optical network infrastructure and network management methods.

REFERENCES:

1. Rajiv Ramaswami and Kumar N.Sivarajan, “Optical Networks: A Practical Perspective”, Harcourt Asia Pvt Ltd., Second Edition 2004.
2. C.Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks: Concept, Design and Algorithms”, PHI, 1st Edition, 2002.
3. P.E.Green, jr., "Fiber Optical Networks", Prentice Hall, New Jersey, 1993.
4. Optical Networks: Third Generation Transport Systems, Prentice Hall, 2002.
5. Martin Maier, "Optical Switching Networks", Cambridge India, 2014.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5079 RECONFIGURABLE ARCHITECTURES AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- The student shall develop an overview and deeper insight into the research and development that is underway to meet future needs of flexible processors
- To learn the concepts of implementation, synthesis and placement of modules in reconfigurable architectures
- To understand the communication techniques and system on programmable chip for reconfigurable architectures
- To learn the process of reconfiguration management
- To familiarize the applications of reconfigurable architectures

UNIT I INTRODUCTION 9

General purpose computing – domain specific processors – application specific processors – reconfigurable computing – fields of application – evolution of reconfigurable systems – simple programmable logic devices – complex programmable logic devices – field programmable gate arrays – coarse grained reconfigurable devices.

UNIT II IMPLEMENTATION, SYNTHESIS AND PLACEMENT 9

Integration – FPGA design flow – Logic synthesis – LUT based technology mapping – modeling – temporal partitioning algorithms – offline and online temporal placement – managing device’s free and occupied spaces.

UNIT III COMMUNICATION AND SoPC 9

Direct communication – communication over third party – bus based communication – circuit switching – network on chip – dynamic network on chip – system on a programmable chip – adaptive multi processing on chip.

UNIT IV RECONFIGURATION MANAGEMENT 9

Reconfiguration – configuration architectures – managing the reconfiguration process – reducing configuration transfer time – configuration security.

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UNIT V APPLICATIONS 9

FPGA based parallel pattern matching - Low power FPGA based architecture for microphone arrays in wireless sensor networks - Exploiting partial reconfiguration on a dynamic coarse grained reconfigurable architecture – Parallel pipelined OFDM baseband modulator with dynamic frequency scaling for 5G systems.

TOTAL: 45 Periods

OUTCOMES:

On successful completion of this course, students will be able to

- Analyze the different architecture principles relevant to reconfigurable computing systems
- Compare the tradeoffs that are necessary to meet the area, power and timing criteria of reconfigurable systems
- Analyze the algorithms related to placement and partitioning
- Analyze the communication techniques and system on programmable chip for reconfigurable architectures
- Analyze the principles of network and system on a programmable chip

REFERENCES:

1. Christophe Bobda, “Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications”, Springer 2007.
2. Scott Hauck and Andre Dehon, “Reconfigurable Computing: The Theory and Practice of FPGA based Computation”, Elsevier 2008.
3. M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
4. Nikoloas Voros et al. “Applied Reconfigurable Computing: Architectures, Tools and Applications” Springer, 2018.
5. Koen Bertels, João M.P. Cardoso, Stamatis Vassiliadis, “Reconfigurable Computing: Architectures and Applications”, Springer 2006.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓		✓	✓
CO5	✓		✓	✓		

NE5014 SATELLITE COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:

- To provide exposure to orbital mechanics and launching techniques.
- To understand various satellite subsystems.
- To provide an in-depth knowledge in Earth station equipments and measurements.
- To know the basic parameters in satellite link design.
- To get exposed to practical applications of satellite.

UNIT I ELEMENTS OF SATELLITE COMMUNICATION 10

Satellite Frequency Bands, Satellite Systems, Frequency Reuse by Orthogonal Polarizations, Kepler’s Laws, Orbital Period and Velocity, Effects of Orbital Inclination, look angle calculation, Coverage angle and Slant range, Eclipse, Placement of a Satellite in a Geostationary Orbit.

UNIT II SATELLITE SUBSYSTEM 9

Satellite Subsystems—Attitude Control Subsystem, Telemetry, Command, and Ranging Subsystem, Communication Subsystem, Electrical Power Subsystem.

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UNIT III EARTH STATION 9

Earth Station Antenna-Antenna Types, Effective Isotropic Radiated Power, Antenna Gain-to-Noise Temperature Ratio, G/T measurement, High Power Amplifier, Low-Noise Amplifier, Upconvertor, DownConvertor, Monitoring and Control, Reliability.

UNIT IV SPACE LINK 9

Basic Link Design: EIRP, Transmission Losses, Link-Power Budget Equation, System Noise, Carrier-to-Noise Ratio, The Uplink & Downlink, Effects of Rain, Intermodulation Noise.

UNIT V SATELLITE APPLICATIONS 8

Communication Satellites, Remote Sensing Satellites, Weather Satellites, Navigation Satellites, Scientific Satellites, Military Satellites.

TOTAL: 45 PERIODS

OUTCOMES:

- To design elements of satellite communication system.
- To be able to design satellite subsystems.
- To be able to implement earth station.
- To be able to calculate satellite link budget.
- To realize various satellite applications.

REFERENCES

1. Tri. T. Ha, “Digital Satellite Communications”, McGraw Hill, Second Edition, 2009.
2. Dennis Roddy, “Satellite Communications”, McGrawHill, 4th Edition, 2008.
3. Louis J.Ippolito, "Satellite Communications Systems Engineering", John Wiley & Sons, 2017
4. M. Richharia, “Satellite Systems For Personal applications”, John Wiley, 2010.
5. T.Pratt, C. Bostian and J.Allnutt; “Satellite Communications”, John Wiley & Sons, Second Edition., 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	
CO2	✓		✓		✓	
CO3	✓		✓		✓	
CO4	✓		✓		✓	
CO5	✓		✓		✓	

NE5015 SPACE TIME WIRELESS COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:

- To acquire the knowledge on Space time wireless technology using multiple antennas.
- To understand Space time wireless propagation and space time channel.
- To understand diversity and capacity performance of space time wireless communication.
- To exploit the channel knowledge at the transmitter.
- To realize space time multiuser communication and system design.

UNIT I MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION 9

Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Physical scattering model, sampled signal model, ST multiuser and ST interference channels.

UNIT II CAPACITY OF MULTIPLE ANTENNA CHANNELS 9

Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

UNIT III SPATIAL DIVERSITY 9

Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

UNIT IV MULTIPLE ANTENNA CODING AND RECEIVERS 9

Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers(SISO,SIMO,MIMO),Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.

UNIT V ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION 9

SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMO-OFDM,SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO-S S.MIMO-MAC,MIMO-BC, Outage performance for MIMO-MU,MIMO-MU with OFDM.

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to apply the knowledge of wireless technology using multiple antennas.
- To be able to analyze space time wireless propagation and space time channel.
- To be able to evaluate the performance of space time wireless communication.
- To be able to utilize the channel knowledge at the transmitter.
- To be able to understand space time multiuser communication.

REFERENCES

1. A. Paulraj, Rohit Nabar, Dhananjay Gore., “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2003.
2. Claude Oestges, Bruno Clerckx., "MIMO Wireless Communications: From Real-World Propagation to Space-Time Code Design" , Academic Press, 2010.
3. Erik G. Larsson, Petre Stoica., "Space-Time Block Coding for Wireless Communications", Cambridge University Press, 2008.
4. H. Bölcskei, D. Gesbert, Constantinos, B. Papadias A.-J. van der Veen., "Space-Time Wireless Systems: From Array Processing to MIMO Communications ", Cambridge University Press, 2006.
5. Tolga M. Duman, Ali Ghrayeb., "Coding for MIMO Communication Systems", John Wiley & Sons, 2008.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2	✓		✓		✓	✓
CO3	✓		✓		✓	✓
CO4	✓		✓		✓	✓
CO5	✓		✓		✓	✓

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NE5016 SPREAD SPECTRUM TECHNIQUES AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concept of spread spectrum modulation.
- To understand the generation of PN sequence and their properties.
- To understand the performance of spread spectrum in jamming environment.
- To understand the way in which spread spectrum is applied to CDMA and GPS systems.
- To get expose to the applications of spread spectrum.

UNIT I SPREADING CODES 9

Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of Shift-Register Generators-Generation &Properties of m-Sequences Gold Codes - Kasami Sequences (Small Set) - Quaternary Sequences - Complementary Code Keying - Walsh–Hadamard Sequences.

UNIT II SPREAD SPECTRUM SYSTEMS 9

Direct Sequence Spread Spectrum (DSSS)- Processing Gain- Frequency Hop Spread Spectrum (FHSS)- Coherent & Noncoherent Slow FHSS – Coherent & Noncoherent Fast FHSS- Hybrid DS/FH Spread Spectrum.

UNIT III SYNCHRONIZATION IN SPREAD SPECTRUM 9

Sources of synchronization Uncertainty, Carrier Synchronization - Code Synchronization & Acquisition - Matched Filter Acquisition, Serial Search Acquisition, Sequential Acquisition, Code Tracking- Delay Lock Tracking loop, Noncoherent Tracking loop.

UNIT IV SPREAD SPECTRUM IN CELLULAR COMMUNICATION 9

Cellular Network and Power Control- DS-CDMA Cellular Networks, FH-CDMA Cellular Networks, Performance in Jamming Environment – Low Probability of Intercept methods- Optimum Intercept Receives for Spread - Spectrum Signals.

UNIT V APPLICATIONS OF SPREAD SPECTRUM METHODS 9

Space Systems, Avionics Systems, Test Systems and equipment, Message Protection, GPS System-Principles-Differential GPS.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to arrive at detailed specifications of the spread spectrum systems.
- To be able to realize the generation of PN sequence.
- To be able to analyze synchronization issues in spread spectrum.
- To design systems based on spread spectrum to mitigate the jamming.
- To be able to design GPS system.

REFERENCES:

1. Rodger E. Ziemer, "Fundamentals of Spread Spectrum Modulation", Morgan & Claypool, Publishers series, 2007.
2. Robert C. Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994.
3. R. L. Peterson, R. E. Ziemer, and D. E. Borth, "Introduction to Spread Spectrum Communications", Upper Saddle River, NJ: Prentice Hall, 1995.
4. M.K. Simon, J.K. Omura, R.A. Scholtz, and B.K. Levitt, "Spread Spectrum Communications Handbook", Electronic Edition, McGraw-Hill, 2002.
5. Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Springer Science, Business Media, Inc Boston, 2005.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓		✓	✓
CO2	✓		✓		✓	✓
CO3	✓		✓		✓	✓
CO4	✓		✓		✓	✓
CO5	✓		✓		✓	✓

WT5151 WIRELESS SENSOR NETWORK DESIGN L T P C
3 0 0 3

OBJECTIVES :

- To understand the fundamentals of wireless sensor network
- To gain knowledge on the MAC and Routing Protocols of WSN
- To get exposed to 6LOWPAN technology
- To acquire knowledge on the protocols required for developing real time applications using WSN and 6LOWPAN.
- To gain knowledge about operating system related to WSN and 6LOWPAN

UNIT I INTRODUCTION 9

Principle of Wireless Sensor Network -Introduction to wireless sensor networks- Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4, Zigbee and Bluetooth. Physical layer and transceiver design considerations.

UNIT II MAC AND ROUTING PROTOCOLS 9

MAC protocols – fundamentals, low duty cycle protocols and wakeup concepts, contention and Schedule-based protocols - SMAC, BMAC,TRAMA, Routing protocols – Requirements, Classification -SPIN, Directed Diffusion, COUGAR, ACQUIRE, LEACH, PEGASIS.

UNIT III 6LOWPAN 9

6LoWPAN Architecture - protocol stack, Adaptation Layer, Link layers – Addressing, Routing - Mesh-Under - Route-Over, Header Compression - Stateless header compression - Context-based header compression, Fragmentation and Reassembly , Mobility – types, Mobile IPv6, Proxy Home Agent, Proxy MIPv6, NEMO –Routing – MANET, ROLL, Border routing.

UNIT IV APPLICATION 9

Design Issues, Protocol Paradigms -End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms, Common Protocols -Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP),Service discovery, Simple network management protocol (SNMP), Real-time transport and sessions, Industry- Specific protocols.

UNIT V TOOLS 9

TinyOS – Introduction, NesC, Interfaces, modules, configuration, Programming in TinyOS using NesC, TOSSIM, Contiki – Structure, Communication Stack, Simulation environment – Cooja simulator, Programming

TOTAL: 45 PERIODS

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OUTCOMES:

- To be able to design solutions for WSNs applications
- To be able to develop efficient MAC and Routing Protocols
- To be able to design solutions for 6LOWPAN applications
- To be able to develop efficient layered Protocols in 6LOWPAN
- To be able to use Tiny OS and Contiki OS in WSNs and 6LOWPAN applications

REFERENCES:

1. Holger Karl , Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley Publication, 2006.
2. Anna Forster, “Introduction to Wireless Sensor Networks”, Wiley, 2017.
3. Zach Shelby Sensinode and Carsten Bormann, “ 6LoWPAN: The Wireless Embedded Internet” John Wiley and Sons, Ltd, Publication, 2009.
4. Philip Levis, “TinyOS Programming”, 2006 – www.tinyos.net.
5. The Contiki Operating System. http://www.sics.se/contiki.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		✓
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5077 **MICROWAVES AND RADAR** **L T P C**
3 0 0 3

OBJECTIVES:

- To provide knowledge on the electronic devices and their implementation in generating RADAR signal
- To study the principles of operation and types of RADAR.
- To understand the theoretical principles underlying microwave sources for RADAR.
- To provide knowledge on signal processing involved in RADAR
- To learn about RADAR tracking.

UNIT I MICROWAVESOURCES **9**

Passive waveguide components, Microstrip line structure and components, Simple theory and operating characteristics of Reflex klystrons, Two cavity Klystrons, Magnetrons, and TWTS - solid state source - TEDS, IMPATTS, TRAPATT, GaAs FETs and Tunnel diode.

UNIT II RADAR PRINCIPLES **9**

Introduction to Radar – Radar range equation – Receiver noise and signal to noise ratio- Radar cross section (RCS) – Radar system – Radar Antennas

UNIT III TYPES OF RADARS **9**

CW and FMCW radars-Tracking radars-MTI radar -Principles of coherent MTI radars - Digital MTI, Synthetic Aperture radar, Principles of Pulsed Doppler Radar, Low-, High-, and medium-PRF Mode.

UNIT IV RADAR SIGNAL PROCESSING **9**

Radar requirements –Matched filters- Radar ambiguity function – Optimum waveforms for detection in clutter – Classes of waveforms – Digital representation of signals -Pulse compression

UNIT V TRACKING RADAR **9**

Tracking with radar – Monopulse Tracking – conical scan and sequential lobing –limitations to tracking Accuracy- Kalman Tracker -Fundamentals of Airborne radar

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To understand the concepts of radar
CO2: To derive a radar equations
CO3: To design a radar system.
CO4: To design and implement radar tracking algorithms.
CO5: To review the types of microwave sources

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓		✓	✓							
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓		✓		✓	✓					

REFERENCES:

1. Blackman S.S., —Multiple target tracking with radar applicationsǁ, Artech House 1986.
2. Filipo Neri, "Introduction to Electronic Defense Systems", 2nd Edition, Scitech, 2006.
3. Fred E. Nathanson— Radar design Principles — Signal processing and the environment, Prentice Hall, 2007
4. Guy V. Morris, Linda L. Harkness, Airborne Pulsed Doppler radar, Second Edition, Artech House Publishers, 1996.
5. Liao, Y. Microwave Devices and Circuits, Prentice Hall, 1980.
6. Michael. O. Kolawole, "Radar Systems, Peak Detection and Tracking", Elsevier, Burlington, 2002.
7. Skolnik, M.I. Introduction to Radar System (Second Edition) McGraw Hill, 2017.
8. Toomay J.C. and Paul. J. Hannen, "Principles of Radarǁ, 3rd Edition, PHI, 2010.

VE5151 REALTIME EMBEDDED SYSTEM **L T P C**
3 0 0 3

OBJECTIVES :

- To have a detailed knowledge about the process involved in the design and development of real-time embedded system.
- To develop a programmable embedded platform from scratch on ARM Processor.
- To develop an integrated approach in low-power systems with hardware, software, sensors, actuators and controllers.
- To improve the knowledge base of students in Real time operating system, Systems modeling and Verification.
- To study about the different methods involved in software development, Emulation and Debugging.

UNIT - I INTRODUCTION **9**

Complex Systems and Microprocessors - Embedded System Design Process - Formalism for System Design - CPU - Programming Input and Output - Supervisor Mode, Exceptions and Traps - Coprocessors - Memory System Mechanism - CPU Bus - CPU performance - CPU Power Consumption.

UNIT II ARM PROCESSOR **9**

Fundamentals - ARM Instruction set - Thumb Instruction set - Writing and Optimizing ARM assembly codes - Efficient C programming - Optimized Primitives - Digital Signal Processing - Exception and Interrupt Handling - Firmware.

UNIT III REAL TIME OPERATING SYSTEM **9**

Operating System Internals - Multitasking Operating Systems - Scheduler Algorithms - Priority Inversion - Tasks, threads and Processes - Exception - Memory model - Memory management address translation - Commercial operating systems - Resource protection - Linux - Disk partitioning.

UNIT IV EMBEDDED SYSTEM MODELING AND VERIFICATION **9**

Finite State Machines - Moore Machine - Mealy Machine - Nondeterministic Finite Automation - Programming - UML State Machines - Petri Net Definition -Properties - Timed Petri Nets - Model Checking - Temporal Logic - NuSMV Model Checking Tool - Real Time Computation Tree Logic - Practical Issues.

UNIT V SOFTWARE DEVELOPMENT, EMULATION AND DEBUGGING TECHNIQUES **9**

Compilation process - Native vs Cross-Compilers - Run-time libraries - Writing a library - Using Standard and alternative libraries - Porting Kernels - C extensions - Downloading - Debugging techniques - Emulation techniques

TOTAL: 45 PERIODS

OUTCOMES:

To be able to design and program for real time embedded system application.
To be able to model and design on embedded platform.
To be able to design a system in different hardware and software platforms.
To be able to port an operating system in Embedded Systems.
Complete understanding of real-time embedded platform.

REFERENCES:

1. Wayne Wolf, "Computers as Components - Principles of Embedded Computing System Design", Morgan Kaufmann Publishers, Second Edition,June 2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide - Designing and Optimizing System Software", Morgan Kaufmann Publishers, 2004.
3. Steve Heath, "Embedded Systems Design", Newnes Publications, Second Edition, 2003.
4. Doug Abbott, "Linux for Embedded and Real-time Applications", Newnes Publication, 2003.
5. Phillip A. Laplante, "Real-Time System Design and Analysis", A John Wiley & Sons, Inc, Third Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

VE5071 **VLSI SIGNAL PROCESSING TECHNIQUES** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the overview of DSP systems and the concepts of parallel and pipeline techniques
- To acquire knowledge on various retiming algorithms and architectures
- To acquire knowledge on fast convolution algorithms
- To understand the architecture of parallel and pipelined recursive filters
- To develop knowledge on the clocking styles of the digital circuits

UNIT - I **INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING FOR FIR FILTERS** **9**

Overview of DSP systems – FPGA Technology- DSP Technology Requirements- Data flow and Dependence graphs - Critical path, Loop bound, Iteration bound, Longest path matrix Algorithm, Pipelining and Parallel Processing of FIR filters.

UNIT - II **RETIMING, ALGORITHMIC STRENGTH REDUCTION** **9**

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – Parallel FIR filter - Fast FIR algorithms - Parallel Architectures for Rank-order filters - Odd-Even merge-sort architecture, parallel rank-order filters.

UNIT – III **FAST CONVOLUTION, PIPELINED AND PARALLEL RECURSIVE AND ADAPTIVE FILTERS** **9**

Fast convolution – Cook-Toom algorithms, Winograd algorithms, Pipelined and parallel recursive filters – Pipeline Interleaving in Digital Filters- Pipelining in I & II order Digital Filter – Parallel Processing for IIR Filter- Pipelined Adaptive Digital Filters.

UNIT – IV **BIT-LEVEL ARITHMETIC ARCHITECTURES** **9**

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 design - CSD Arithmetic, CSD multiplication using Horner‟s rule for precision improvement - Distributed Arithmetic - Offset binary coding.

UNIT – V **NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINING** **9**

Sub-expression Elimination, Multiple Constant Multiplication, Sub-expression sharing - Synchronous pipelining and Clocking styles - Clock skew in edge-triggered single phase clocking and Two-phase clocking - Wave Pipelining - NPCPL - Asynchronous Pipelining.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, students will be able to

- Analyze the critical path of the DSP architectures
- Design efficient retiming architecture for FIR filter using data flow graphs
- Analyze various bit-level arithmetic architectures used in signal processing applications
- Design fast convolution algorithms to minimize computational complexity
- Analyze and implement proper clocking techniques on VLSI circuits

REFERENCES:

1. Keshab K. Parhi, “VLSI Digital Signal Processing Systems, Design and implementation “, Wiley, Interscience, 2007.
2. U. Meyer Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer, Second Edition, 2013.
3. Roger Woods, John McAllister, Gaye Lightbody and Ying Yi, "FPGA-based Implementation of Signal Processing Systems", Digital Signal and Image Processing Series, A John Wiley and Sons, Ltd., Publication, 2017.
4. Roger Woods, John McAllister, Gaye Lightbody and Ying Yi, "FPGA-based Implementation of Signal and Data Processing Systems**",** Wiley, 2017.
5. Shoab Ahmed Khan, "Digital Design of Signal Processing Systems - A Practical Approach", A John Wiley and Sons, Ltd., Publication, 2011.
6. Lars Wanhammar, "DSP Integrated Circuits", Academic Press, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

CP5251 ADVANCED OPERATING SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To understand the concepts of distributed systems.
- To get an insight into the various issues and solutions in distributed operating systems.
- To learn about real-time operating systems.
- To gain knowledge on the design concepts of mobile operating systems.
- To understand cloud operating systems.

UNIT I INTRODUCTION 9

Distributed Operating Systems – Issues – Communication Primitives – Limitations of a Distributed System – Lamport’s Logical Clocks – Vector Clocks – Causal Ordering of Messages

UNIT II DISTRIBUTED OPERATING SYSTEMS 9

Distributed Mutual Exclusion Algorithms – Classification – Preliminaries – Simple Solution – Lamport’s Algorithm – Ricart-Agrawala Algorithm – Suzuki-Kasami’s Broadcast Algorithm – Raymond’s Tree-Based Algorithm – Distributed Deadlock Detection – Preliminaries – Centralized Deadlock Detection Algorithms – Distributed Deadlock Detection Algorithms – Path Pushing Algorithm – Edge Chasing Algorithm – Hierarchical Deadlock Detection Algorithms – Agreement Protocols – Classification – Solutions to the Byzantine Agreement Problem – Lamport-Shostak-Pease Algorithm

UNIT III DISTRIBUTED RESOURCE MANAGEMENT 9

Distributed File Systems – Design Issues – Google File System – Hadoop Distributed File System – Distributed Shared Memory – Algorithms for Implementing Distributed Shared Memory – Load Distributing Algorithms – Synchronous and Asynchronous Check Pointing and Recovery – Fault Tolerance – Two-Phase Commit Protocol – Nonblocking Commit Protocol

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UNIT IV REAL TIME OPERATING SYSTEMS 9

Basic Model of Real Time Systems – Characteristics – Application of Real Time Systems – RealTime Task Scheduling – Handling Resource Sharing

UNIT V MOBILE AND CLOUD OPERATING SYSTEMS 9

Android – Overall Architecture – Linux Kernel –Hardware Support – Native User-Space – Dalvik and Android's Java – System Services – Introduction to Cloud Operating Systems.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to

- Identify the features of distributed operating systems.
- Demonstrate the various protocols of distributed operating systems.
- Identify the different features of real time operating systems.
- Discuss the features of mobile operating systems.
- Discuss the features of cloud operating systems.

REFERENCES:

1. Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database and Multiprocessor Operating Systems", Tata Mc Graw-Hill, 2001.
2. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
3. Karim Yaghmour, "Embedded Android", O'Reilly, First Edition, 2013.
4. Nikolay Elenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 2014.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5080 VLSI DESIGN TECHNIQUES L T P C
3 0 0 3

OBJECTIVES :

- To learn the fundamentals of VLSI design
- To understand the IC Manufacturing Process
- To familiarize with VLSI combinational logic circuits design
- To familiarize with VLSI sequential logic circuits design
- To learn the various arithmetic circuits and testing methodologies

UNIT - I MOS TRANSISTOR PRINCIPLES 9

MOS Technology and VLSI, CMOS Fabrication process and Electrical properties of CMOS circuits – secondary effects – device modeling – process variations – static and dynamic behavior of CMOS inverter – power and energy – scaling principles – stick diagram.

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UNIT - II COMBINATIONAL LOGIC CIRCUITS 9

Static CMOS logic design - Complementary CMOS – Ratioed logic – Pass transistor Logic. Dynamic CMOS logic – principles – speed and power dissipation – signal integrity issues – cascading dynamic gates.

UNIT – III SEQUENTIAL LOGIC CIRCUITS AND MEMORY ARRAY STRUCTURES 9

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory core and peripheral circuitry, memory reliability and power dissipation. Case Studies: PLA, SRAM and NAND flash memories.

UNIT – IV DESIGNING ARITHMETIC BUILDING BLOCKS & TESTING 9

Data paths - Architectures for Adders - Multipliers and Shifters, Test procedures - Design for testability – Scan based test – built in self test – test pattern generation – fault models and fault simulation.

UNIT – V IMPLEMENTATION STRATEGIES 9

Full custom and semicustom design – cell based design – array based implementation - Programmable ASIC logic cells - Actel ACT - Xilinx LCA - Altera FLEX and MAX.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students will be

- Able to familiarize the basics of VLSI design.
- Able to design combinational logic circuits.
- Able to design sequential logic and memory circuits.
- Able to analyze the various design techniques involved in arithmetic building blocks.
- Able to analyze the implementation strategies in circuit design.

REFERENCES:

1. N.Weste, D.M.Harris, “CMOS VLSI Design: Circuits and System Perspective”, Fourth Edition, Pearson, 2015.
2. N.Weste, K.Eshraghian, “Principles of CMOS VLSI DESIGN”, A system Perspective, second edition,Addision Wesley 2010.
3. A.Pucknell, Kamran Eshraghian, “BASIC VLSI DESIGN”, Third edition, Prentice Hall of India, 2007.
4. M.J. Smith, “Application specific integrated circuits”, Addisson Wesley, 2009.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, 2005 Prentice Hall of India.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		
CO5	✓		✓	✓		

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VL5151 **ASIC DESIGN** **L T P C**
3 0 0 3

OBJECTIVES:

- The course focuses on the semi-custom IC Design and introduces the principles of design logic cells, I/O cells and interconnect architecture, with equal importance given to FPGA and ASIC styles.
- The entire FPGA and ASIC design flow is dealt with from the circuit and layout design point of view.

UNIT I INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN **9**

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.

UNIT II PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS **9**

Anti fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

UNIT III PROGRAMMABLE ASIC ARCHITECUTRE **9**

Architecture and configuration of Artix / Cyclone and Kintex Ultra Scale / Stratix FPGAs – Micro-Blaze / Nios based embedded systems – Signal probing techniques.

UNIT IV LOGIC SYNTHESIS, PLACEMENT AND ROUTING **9**

Logic synthesis - Floor Planning Goals and Objectives, Measurement of Delay in floor planning, Floor planning tools ,I/O and Power planning, Clock planning, Placement Algorithms. Routing: Global routing, Detailed routing ,Special routing.

UNIT V SYSTEM-ON-CHIP DESIGN **9**

SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, High performance filters using delta-sigma modulators.
Case Studies: Digital camera, SDRAM, High speed data standards.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to apply logical effort technique for predicting delay, delay minimization and FPGA architectures
- Ability to design logic cells and I/O cells
- Ability to analyze the various resources of recent FPGAs
- Ability to use algorithms for floorplanning and placement of cells and to apply routing algorithms for optimization of length and speed.
- Ability to analyze high performance algorithms available for ASICs

REFERENCES:

1. M.J.S.Smith, " Application - Specific Integrated Circuits", Pearson,2003
2. Steve Kilts, “Advanced FPGA Design,” Wiley Inter-Science.
3. Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, “FPGA-based Implementation of Signal Processing Systems”, Wiley, 2008
4. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing ", Mc Graw Hill, 1994.
5. Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
6. Jose E. France, Yannis Tsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994 28
7. S.Pasricha and N.Dutt,” On-Chip Communication Architectures System on Chip Interconnect, Elsveir”, 2008

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

NE5074 IMAGE ANALYSIS AND COMPUTER VISION L T P C
3 0 0 3

OBJECTIVES:

- To understand the general process of image acquisition and enhancement
- To study the different image transform techniques
- To get exposed to algorithms related to image segmentation and restoration
- To learn basic concepts and methodologies in image compression
- To understand the basics of video processing for computer vision applications

UNIT I IMAGE ENHANCEMENT 9

Digital image fundamentals - Image sampling - Quantization - Spatial domain filtering - intensity transformations - Contrast stretching - Histogram equalization - Smoothing filters, Sharpening filters - Noise distributions - Mean filters - Order statistics filters

UNIT II IMAGE TRANSFORMS 9

1D DFT- 2D Transforms - DFT- DCT- Walsh - Hadamard - Slant - Haar - KLT- SVD- Wavelet transform

UNIT III IMAGE RESTORATION AND SEGMENTATION 9

Image restoration - degradation model - Unconstrained and Constrained restoration - Inverse filtering - Wiener filtering - Image segmentation - Thresholding - Edge detection, Edge linking - Region based methods

UNIT IV IMAGE COMPRESSION 9

Need for data compression - Huffman - Arithmetic coding - LZW technique - Vector Quantization - JPEG - MPEG

UNIT V VIDEO PROCESSING 9

Back ground Subtraction - Video analytics - Video object Segmentation - Object Detection - Face Recognition - Motion Estimation

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to implement image enhancement algorithms
- To be able to apply image transform for different imaging modalities
- To be able to perform different segmentation and restoration processes
- To be able to implement different compression techniques
- To be able to develop algorithms for computer vision problems

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson Education, Inc., Third Edition, 2007
2. Anil K. Jain, "Fundamentals of Digital Image Processing”, Prentice Hall of India, 2004.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and Machine Vision”, Brookes/ Cole, Vikas Publishing House, 2nd edition,1999.
4. Sid Ahmed, M.A., “ Image Processing Theory, Algorithms and Architectures”, Mc Graw Hill, 1995.
5. Richard Szeliski, "Computer Vision - Algorithms and Applications", Springer Verlag London Limited, 201

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

NE5071 COMPUTATIONAL INTELLIGENCE L T P C
3 0 0 3

OBJECTIVES:

- To get exposed to neural network learning techniques and architectures
- To study fuzzy concepts and models
- To get exposed to hybrid neuro -fuzzy techniques
- To learn the basic concepts in Deep Learning networks
- To understand different optimization techniques and apply the same in different scenarios

UNIT I NEURAL NETWORKS 9

Biological Neurons Networks - Artificial Neural Networks - Supervised -.unsupervised learning - Reinforcement Learning - Activation functions - Perceptrons - Back Propagation networks - Radial Basis Function Networks - Adaptive Resonance architectures - Support Vector Machines

UNIT II FUZZY LOGIC 9

Fuzzy Sets - Operations on Fuzzy Sets - Fuzzy Relations - Membership Functions - Fuzzy Rules and Fuzzy Reasoning - Fuzzy Inference Systems - Fuzzy Expert Systems - Fuzzy Decision Making

UNIT III NEURO-FUZZY MODELING 9

Adaptive Neuro - Fuzzy Inference Systems - Coactive Neuro - Fuzzy Modeling - Classification and Regression Trees - Data Clustering Algorithms - Hybrid learning algorithms - Applications of Neuro - fuzzy concepts

UNIT IV DEEP LEARNING NETWORKS 9

Introduction to Deep neural networks - Convolution neural networks - Deep Belief Networks - Recurrent neural networks

UNIT V EVOLUTIONARY ALGORITHMS 9

Heuristic search and optimization techniques - Random search - Introduction to Genetic Algorithms - Social Algorithms

OUTCOMES:

- To be able to design systems based on neural network architectures
- To be able to perform basic operations in fuzzy
- To be able to implement fuzzy models and work on fuzzy tool box
- To be able to design and implement deep learning architectures
- To be able to design optimization based algorithm for a given application

TOTAL: 45 PERIODS

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro - Fuzzy and Soft Computing”, Pearson Edn., 2015.
2. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic -Theory and Applications”, Prentice Hall, 2011.
3. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn., 2003.
4. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2008.
5. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning” The MIT Press, Cambridge, 2016.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓			✓		
CO2	✓			✓		✓
CO3	✓		✓	✓		✓
CO4	✓		✓	✓		✓
CO5	✓		✓	✓		✓

CU5071 COGNITIVE RADIO NETWORKS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To enable the student to understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
- To expose the student to the evolving next generation wireless networks and their associated challenges.

UNIT I SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE 9

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

UNIT II COGNITIVE RADIOS AND ITS ARCHITECTURE 9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architechture.

UNIT III SPECTRUM SENSING AND IDENTIFICATION 9

Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector,Matched Filter ,Cooperative Sensing , Definition and Implications of Spectrum Opportunity, Spectrum Opportunity Detection , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

UNIT IV USER COOPERATIVE COMMUNICATIONS 9

User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel , User Cooperation in Wireless Networks: Two-User Cooperative Network, Cooperative Wireless Network , Multihop Relay Channel

UNIT V INFORMATION THEORETICAL LIMITS ON CR NETWORKS 9

Types of Cognitive Behavior, Interference-Avoiding Behavior: Spectrum Interweave, Interference-Controlled Behavior: Spectrum Underlay, Underlay in Small Networks: Achievable Rates, Underlay in Large Networks: Scaling Laws, Interference-Mitigating Behavior: Spectrum Overlay, Opportunistic Interference Cancellation, Asymmetrically Cooperating Cognitive Radio Channels.

TOTAL: 45 PERIODS

OUTCOMES:

- The student would be able to appreciate the motivation and the necessity for cognitive radio communication strategies.
- The student would be able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
- The student would be able to demonstrate the impact of the evolved solutions in future wireless network design.

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, — Cognitive Radio Communications And Networks - Principles And Practice‖, Elsevier Inc. , 2010.
2. Kwang-Cheng Chen and Ramjee Prasad, ‖ Cognitive Radio Networks‖ , John Wiley & Sons, Ltd, 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, —Cognitive Radio Networks - From Theory to Practice‖, Springer Series: Analog Circuits and Signal Processing, 2009.
4. J. Mitola, — Cognitive Radio: An Integrated Agent Architecture for software defined radio‖, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Simon Haykin, —Cognitive Radio: Brain –empowered wireless communications‖, IEEE Journal on selected areas in communications, Feb 2005.
6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, — NeXt generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks, May 2006.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✓		✓	✓		
CO2	✓		✓	✓		
CO3	✓		✓	✓		✓

Attested

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OE5091 **BUSINESS DATA ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

SUGGESTED ACTIVITIES:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

SUGGESTED EVALUATION METHODS:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

SUGGESTED ACTIVITIES:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

SUGGESTED EVALUATION METHODS:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

SUGGESTED ACTIVITIES:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

SUGGESTED EVALUATION METHODS:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

SUGGESTED ACTIVITIES:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

SUGGESTED EVALUATION METHODS:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

SUGGESTED ACTIVITIES:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

SUGGESTED EVALUATION METHODS:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: Ability to summarize basics of industrial safety

CO2: Ability to describe fundamentals of maintenance engineering

CO3: Ability to explain wear and corrosion

CO4: Ability to illustrate fault tracing

CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH L T P C

3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the costing concepts and their role in decision making

CO2–Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

Attested

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OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION **9**

Definition – Classification and characteristics of Composite materials – Advantages and application of composites – Functional requirements of reinforcement and matrix – Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers – Properties and applications of whiskers, particle reinforcements – Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures – Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES **9**

Casting – Solid State diffusion technique – Cladding – Hot isostatic pressing – Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving – Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding – Properties and applications.

UNIT V STRENGTH **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

- CO1 – Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓		✓								
CO2		✓		✓								
CO3							✓					
CO4							✓					
CO5			✓				✓					

REFERENCES:

1. Cahn R.W. – Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the various types of wastes from which energy can be generated

CO2 – Gain knowledge on biomass pyrolysis process and its applications

CO3 – Develop knowledge on various types of biomass gasifiers and their operations

CO4 – Gain knowledge on biomass combustors and its applications on generating energy

CO5 – Understand the principles of bio-energy systems and their features

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓				✓					✓
CO5	✓	✓	✓									✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

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OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

Attested

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OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.

3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES
- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** **L T P C**
2 0 0 0

OBJECTIVES
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Attested

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UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016