ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

M. E. WIRELESS TECHNOLOGIES
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students to excel in research or to succeed in Wireless Communication and Networking domain through global, rigorous post graduate education.

II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve problems in Signal Processing, Wireless Communication and Networking.

III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.

IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate issues in High Frequency Communication and Next Generation Networks to broader social context and life-long learning for a successful professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓	✓	✓	✓	✓		✓	✓	✓
II		✓	✓		✓	✓				
III				✓	✓	✓	✓			
IV		✓	✓				✓	✓	✓	✓

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Applied Mathematics for Network Engineers	✓	✓			✓				✓	
		Signal Processing and Baseband Techniques	✓	✓	✓	✓	✓	✓			✓	
		Wireless Broadband Networks	✓	✓	✓	✓	✓	✓			✓	
		RF Engineering	✓	✓	✓	✓	✓	✓				
		Elective-I										
		RF System Design Laboratory			✓	✓	✓	✓	✓	✓		✓
		Technical Seminar and Report Writing		✓					✓	✓	✓	✓
	SEM 2	Communication Satellite Systems				✓		✓	✓		✓	✓
		Optical and Wire Line Technology	✓	✓	✓	✓		✓			✓	
		Ad Hoc and Sensor Networks	✓	✓	✓	✓		✓				
		Electromagnetic Interference and Electromagnetic Compatability	✓	✓		✓	✓	✓				
		Wireless Communication Techniques	✓			✓		✓	✓			✓
		Elective-II										
		Wireless Technology Laboratory	✓		✓	✓	✓	✓	✓	✓		✓
YEAR 2	SEM 1	Elective-III										
		Elective-IV										
		Elective-V										
		Project Work Phase-I				✓		✓		✓		✓
	SEM 2	Project Work Phase-II										
						✓		✓		✓		✓

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CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER - I

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA7157	Applied Mathematics for Network Engineers	FC	4	4	0	0	4
2.	CU7103	Signal Processing and Baseband Techniques	PC	3	3	0	0	3
3.	WT7101	Wireless Broadband Networks	PC	3	3	0	0	3
4.	NE7151	RF Engineering	PC	3	3	0	0	3
5.		Elective-I	PE	3	3	0	0	3
PRACTICALS								
6.	WT7111	RF System Design Laboratory	PC	4	0	0	4	2
7.	WT7112	Technical Seminar and Report Writing	EEC	2	0	0	2	1
			TOTAL	**22**	**16**	**0**	**6**	**19**

SEMESTER - II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	WT7202	Communication Satellite Systems	PC	3	3	0	0	3
2.	WT7204	Optical and Wireline Technology	PC	4	4	0	0	4
3.	WT 7201	Adhoc and Sensor Networks	PC	3	3	0	0	3
4.	WT7203	Electromagnetic Interference and Electromagnetic Compatibility	PC	4	4	0	0	4
5.	WT7205	Wireless Communication Techniques	PC	3	3	0	2	4
6.		Elective-II	PE	3	3	0	0	3
PRACTICALS								
7.	WT7211	Wireless Technology Laboratory	PC	4	0	0	4	2
			TOTAL	**24**	**20**	**0**	**6**	**23**

III SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective-III	PE	3	3	0	0	3
2.		Elective–IV	PE	3	3	0	0	3
3.		Elective–V	PE	3	3	0	0	3
PRACTICALS								
4.	WT7311	Project Work Phase–I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**2**	**15**

IV SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	WT7411	Project Work Phase–II	EEC	12	0	0	24	12
			TOTAL	**12**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS:69

ANNA UNIVERSITY, CHENNAI

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M.E. WIRELESS TECHNOLOGIES

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI I TO VI SEMESTERS

I SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA7157	Applied Mathematics for Network Engineers	FC	4	4	0	0	4
2.	CU7103	Signal Processing and Base Band Techniques	PC	3	3	0	0	3
3.	NE7151	RF Engineering	PC	3	3	0	0	3
PRACTICALS								
4.	WT7111	RF System Design Laboratory	PC	4	0	0	4	2
			TOTAL	**14**	**10**	**0**	**4**	**12**

II SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	WT7202	Communication Satellite Systems	PC	3	3	0	0	3
2.	WT7203	Wireless Communication Techniques	PC	4	4	0	0	4
3.	WT7204	Optical and Wireline Technology	PC	4	4	0	0	4
PRACTICALS								
4.	WT7211	Wireless Technology Laboratory	PC	4	0	0	4	2
			TOTAL	**15**	**11**	**0**	**4**	**13**

III SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	WT7101	Wireless Broadband Networks	PC	3	3	0	0	3
2.		Elective-I	PE	3	3	0	0	3
3.		Elective-II	PE	3	3	0	0	3
PRACTICALS								
4.	WT7112	Technical Seminar and Report Writing	EEC	2	0	0	2	1
			TOTAL	**11**	**9**	**0**	**2**	**10**

IV SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	WT7203	Electromagnetic Interference and Electromagnetic Compatibility	PC	4	4	0	0	4
2.	WT7201	Adhoc and Sensor Networks	PC	3	3	0	0	3
3.		Elective-III	PE	3	3	0	0	3
			TOTAL	**10**	**10**	**0**	**0**	**10**

V SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective-IV	PE	3	3	0	0	3
2.		Elective –V	PE	3	3	0	0	3
PRACTICALS								
3.	WT7311	Project Work Phase – I	EEC	12	0	0	12	6
			TOTAL	**18**	**6**	**0**	**12**	**12**

VI SEMESTER

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	WT7411	Project Work Phase –II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 69

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.		Applied Mathematics for Network Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Signal Processing and Base Band Techniques	PC	3	3	0	0	3
2.		Optical and Wireline Technology	PC	4	4	0	0	4
3.		RF Engineering	PC	3	3	0	0	3
4.		Communication Satellite Systems	PC	3	3	0	0	3
5.		Wireless Broadband Networks	PC	3	3	0	0	3
6.		Ad hoc and Sensor Networks	PC	3	3	0	0	3
7.		Electromagnetic Interference/Electromagnetic Compatibility	PC	4	4	0	0	4
8.		Wireless Communication Techniques	PC	3	3	0	0	3
9.		Wireless Technology Laboratory	PC	3	3	0	0	3
10.		RF System Design Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	WT7005	Multirate Signal Processing for Communication	PE	3	3	0	0	3
2.	WT7010	Wireless Network Security	PE	3	3	0	0	3
3.	NE7080	Space Time Wireless Communication	PE	3	3	0	0	3
4.	CU7072	Cognitive Radio Networks	PE	3	3	0	0	3
5.	WT7007	Radio Frequency Integrated Circuit Design	PE	3	3	0	0	3
6.	NE7081	VLSI Design Techniques	PE	0	3	0	0	3
7.	WT7008	Spread Spectrum Communication	PE	3	3	0	0	3
8.	NE7073	Broadband Access Technologies	PE	3	3	0	0	3
9.	WT7003	Micro Electro Mechanical System for Wireless Communication	PE	3	3	0	0	3
10.	WT7002	Global Positioning Systems	PE	3	3	0	0	3
11.	NE7078	Information Theory and Coding	PE	3	3	0	0	3
12.	WT7004	Modelling and Simulation of Wireless Communication Systems	PE	3	3	0	0	3
13.	MM7351	Multimedia Compression Techniques	PE	3	3	0	0	3
14.	NE7251	Real Time Embedded System	PE	3	3	0	0	3
15.	WT7001	Free Space Optical Communication	PE	3	3	0	0	3
16.	WT7009	Ultra Wideband Communication	PE	3	3	0	0	3
17.	WT7006	Network Routing Protocols	PE	3	3	0	0	3
18.	NE7074	Computational Intelligence	PE	3	3	0	0	3
19.	NE7077	Game Theory for Wireless Communication and Networking	PE	3	3	0	0	3
20.	AP7252	Digital Image Processing	PE	3	3	0	0	3
21.	CU7251	Wireless Transceiver Design	PE	3	3	0	0	3
22.	CU7151	Advanced Radiation Systems	PE	3	3	0	0	3
23.	CU7071	Advanced Wireless Communication Techniques	PE	3	3	0	0	3
24.	MM7011	Mobile and Pervasive Computing	PE	3	3	0	0	3
25.	CP7083	Internet of Things in the Cloud	PE	3	3	0	0	3
26.	IF7075	Mobile Application Development	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Technical Seminar and Report Writing	EEC	2	0	0	2	1
2.		Project Work Phase –I	EEC	12	0	0	12	6
3.		Project Work Phase –II	EEC	24	0	0	24	12

MA7157 APPLIED MATHEMATICS FOR NETWORK ENGINEERS L T P C
4 0 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 Theory algorithms and understand its 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 – Eigen values 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 THEORY AND ALGORITHMS 12

Graphs – Sub graphs – Complements – Graph isomorphism – Eulerian graphs –Hamiltonian graphs - Planar graphs– Kruskal's algorithm – Dijkstra's shortest path algorithm, Prim's 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, Faddeev – Leverrier Method.

UNIT V QUEUEING MODELS 12

Markovian queues - Steady State analysis of Single and Multi-server Models - Little's formula - Machine Interference Model - Self Service queue.

TOTAL: 60 PERIODS

OUTCOMES

- On successful completion of this course, all students will have developed knowledge and understanding in the fields of Linear Algebra, special functions, Graph Theory, Algebraic Equations and Queuing Models.

REFERENCES:

1. Richard Bronson, Gabriel B.Costa, "Linear Algebra", 2nd Edition, Academic Press, 2007.
2. Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd edition, Pearson/Prentice Hall, 2004.
4. Peter V.O'Neil, "Advanced Engineering Mathematics" , 7th Edition, Cengage Learning, 2011.
5. Erwin Kreyszig. "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2010
6. R.Balakrishnan, K.Ranganathan, "A textbook of Graph theory". 2nd Edition, Springer 2012.
7. Adrian Bondy, U.S.R.Murthy, "Graph Theory", Springer 2008
8. Douglas Brent West, "Introduction to Graph Theory",3rd Edition, Prentice Hall , 2008.

CU7103 SIGNAL PROCESSING AND BASEBAND TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To enable the student to understand the basic principles of random signal processing , spectral estimation methods and adaptive filter algorithms and their applications.
- To enable the student to understand the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations.

UNIT II SPECTRAL ESTIMATION 9

Estimation of spectra from finite duration signals, 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 ADAPTIVE FILTERS 9

FIR adaptive filters – Steepest descent method- LMS algorithm, LMS algorithm, RLS adaptive algorithm – Application: channel equalization, noise cancellation, prediction.

UNIT IV DETECTION AND ESTIMATION 9

Detection criteria : Bayes detection techniques, MAP, ML,– detection of M-ary signals, Neyman Peason, minimax decision criteria. Estimation: linear estimators, non-linear estimators, Bayes, Kalman, MAP,ML, properties of estimators, phase and amplitude estimation.

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:

- The student would be able to demonstrate an understanding of the basic principles of random signal processing, spectral estimation methods and adaptive filter algorithms and their applications.
- The student would be able to demonstrate an understanding of the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.
- The student would be in a position to apply his knowledge for designing a baseband system addressing the channel impairments

REFERENCES

1. Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002
2. John J. Proakis, Dimitris G. Manolakis, : Digital Signal Processing', Pearson Education, 2002.
3. John G. Proakis., 'Digital Communication', 4 th edition, Mc Graw Hill Publication, 2001.
4. Bernard Sklar and Pabitra Kumar Roy, Digital Communications: Fundamentals and Applications, 2/E, Pearson Education India, 2009
5. John G. Proakis, Masoud Salehi, "Communication Systems Engineering", Prentice Hall, 1994.

WT7101 WIRELESS BROADBAND NETWORKS L T P C
3 0 0 3

OBJECTIVES:

- To learn the technical, economic and service advantages of next generation networks.
- To learn the basic architecture of a next generation network (NGN) with reference
- To understand NGN services
- To learn the role of P Multimedia Sub-System (IMS), network attachment and admission control functions.
- To learn and compare the various methods of providing connection-oriented services over NGN.

UNIT I EVOLUTION OF WIRELESS NETWORKS 9

Review of cellular standards, migration and advancement of GSM architecture and CDMA architecture, WLAN – IEEE 802.11and HIPERLAN, Bluetooth.

UNIT II WIRELESS PROTOCOLS 9

Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements-Indirect TCP, snooping TCP, Mobile TCP

UNIT III 3G EVOLUTIONS 9

IMT-2000 - W-CDMA, CDMA 2000 – radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA,HSUPA.

UNIT IV 4G AND BEYOND 9

Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, E- UTRAN architecture - mobility management, resource management, services, channel -logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

UNIT V LAYER-LEVEL FUNCTIONS 9

Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.

TOTAL: 45 PERIODS

OUTCOMES

- To be able to design routing mechanism meeting the desired QoS in NGN.
- To be able to compare various methods of providing connection-oriented services over a NGN.
- To be able to compare various NGN virtual network services with reference to VPNs, VLANs, pseudo wires, VPLS and typical applications.

REFERENCES

1. Kaveh Pahlavan, “Principles of wireless networks”, Prentice-Hall of India, 2008.
2. Vijay K.Garg, “Wireless Network Evolution- 2G & 3G” Pearson, 2013.
3. Clint Smith,P.E, Dannel Collins, “3G Wireless Networks” 2nd edition, Tata McGraw-Hill, 2008.
4. Jochen H.Schiller, “Mobile Communications”, 2/e, Pearson, 2014.
5. Sassan Ahmadi, “LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies”, Elsevier, 2014.

NE7151 RF ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of RF Engineering.
- To introduce the design of RF and microwave systems.
- To learn the basic simulation tools for the design and analysis of RF components and circuits.

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:

- The ability to design RF amplifier, mixer and other related circuits.
- To be able to use Smith Chart to design amplifier and circuits for impedance transformation and transmission line matching.

REFERENCES:

1. Matthew M.Radmanesh, "RF and Microwave Design Essentials", Author House, Bloomington, 2007.
2. Daniel Dobkin, "RF Engineering for Wireless Networks", Elsevier, London, 2005.
3. Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design – Theory and Applications", 2nd Edition, Pearson, 2012.
4. E.da Silva, "High Frequency and Microwave Engineering", Butterworth Heinmann Publications, Oxford, 2001.
5. David.M.Pozar, "Microwave Engineering", John Wiley and Sons,Third Edition, 2005.
6. Kraus.J.D, Marhefka.R.J. Khan.A.S. "Antennas for All Applications", 3rd Edition, Tata McGraw Hill, 2006.
7. Balanis. A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, Third Edition, 2005.

WT7111 RF SYSTEM DESIGN LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To enable the students to verify the basic principles and design aspects involved in high frequency communication systems
- To expose the student to the different high frequency system and conduct the experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts.
    1) Measurement of transmission line parameters using network analyzer (a) Inductor (b) Capacitor (c) impedance matching circuits
    2) Design and characterization of antennas using ADS/IE3D/HFSS
    3) Design and characterization of LNA using ADS/IE3D/HFSS
    4) Design and characterization of Mixer using ADS/IE3D/HFSS
    5) Design and characterization of VCO using ADS/IE3D/HFSS
    6) Design of RF filters
    7) Design of micro strip lines

TOTAL: 60 PERIODS

OUTCOMES:

- Given the user requirements and the type of channel over which the system has to function the student would be in a position to understand the challenges and apply his knowledge to identify a suitable architecture and systematically design an RF system.
- The students would be able to comprehensively record and report the measured data, and would be capable of analyzing, interpreting the experimentally measured data and produce the meaning conclusions.

WT7202 COMMUNICATION SATELLITE SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To provide basic understanding about satellite communication technologies.
- To have an exposure to orbital mechanics, launching techniques and satellite link design.
- To know the basic satellite link parameters.
- To get exposed to modulation, antennas and mobile terminals for mobile satellite communication system.
- To understand various applications of mobile satellite.

UNIT I BASIC PRINCIPLES 9

General features- frequency allocation for satellite services- properties of satellite communication systems- Kepler's laws- orbital dynamics- orbital characteristics- satellite spacing and orbital capacity- GSO & LEO Satellites – Launch Vehicle Technology-GSLV.

UNIT II SATELLITE SUBSYSTEMS AND SATELLITE LINKS 12

Attitude and orbit control system- telemetry, tracking and command- power systems- communication subsystems- antenna subsystem- equipment reliability and space qualification. Free space loss-Atmospheric effects-Ionospheric scintillation-link design- Power Budget Calculation -system noise temperature – Modulation for satellite communication.

UNIT III MOBILE SATELLITE NETWORK 8

GSM signaling and S-PCN signaling protocol architecture, Mobility management-cell location, location management, handover management. Resource Management- Resource allocation strategies, Network operation and procedures.

UNIT IV ANTENNAS AND MOBILE TERMINALS 8

Antennas for MSS, Architecture of Hand held, Vehicle mounted, Ship borne, Aeronautical terminals, CODECS for Mobile Satellite Communication.

UNIT V APPLICATIONS 8

GPS, Mobile satellite system for UMTS, GSM/EDGE, MOBILE IP, WLAN, Global Broadband services, ATM, GEO and Non GEO Mobile satellite systems.

TOTAL: 45 PERIODS

OUTCOMES:

- To able to design satellite link.
- To be able to design various satellite subsystems.
- To be able to design various applications in the field of mobile satellite.

REFERENCES

1. Wilbur L Pritchard, Henri G Suyderhoud, "Satellite Communication Systems Engineering", 2nd Edition, Pearson 2013.
2. Dennis Roddy "Satellite Communication", 4th Edition, Tata McGraw-Hill, 2009.
3. Timothy Pratt, Chareless Bostian, "Satellite Communications" 2nd Edition, Wiley, 2010.
4. Tri T.Ha "Digital Satellite Communications", Tata McGraw Hill, 2nd Edition, 1st Reprint 2012.
5. Ray E. Sheriff and Y. Fun Hu, "Mobile Satellite communication Networks," John Wiley & Sons, 2008.
6. Michael, J.Miller, Branka Vucetic and Les berry , "Satellite Communication: mobile and fixed Services," Kluwer Academic Publishers, 2007.
7. M.Richharia "Mobile Satellite Communications, Principles and Trends," Pearson Education, 2007.

WT7204 OPTICAL AND WIRELINE TECHNOLOGY L T P C

4 0 0 4

OBJECTIVES :

- To understand the fundamentals of wireline networks.
- To learn the concepts of optical networks.
- To give adequate exposure to the emerging technologies and their potential impact.

UNIT I RAY THEORY ANALYSIS& TRANSMISSION CHARACTERISTICS 12

Fibre Optic Guides, Light wave generation systems, systems components, optical fibers, SI, GI fibre, modes, Dispersion in fibers limitations due to dispersions, fibre loss, non liner effects.

UNIT II OPTICAL TRANSMITTERS&RECEIVERS 12

Optical Transmitters and Fibres, Basic concept, spectral distribution, semiconductor lasers, gain coefficients, modes. Transmitter design, Receive PIN and APD diodes,SNR. Switches, Coherent, homodyne and Hetro dyne keying formats, BER in synchronous and Asynchronous.

UNIT III COMPENSATION TECHNIQUES 12

Amplifiers, Basic concepts, Semiconductor laser amplifiers Raman and Brillouin-fibre amplifiers, Erbium doped-fibre and amplifiers, pumping phenomenon Dispersion Compensation Limitations, post and pre-compensation techniques, equalizing filters,SONET/SDH.

UNIT IV PASSIVE OPTICAL NETWORKS: ARCHITECTURES AND PROTOCOLS 12

PON Architectures, Network Dimensioning and operation, Power Budget, FTTx , Broadband PON: architecture, protocol and Service, Bandwidth allocation. Gigabit-Capable PON. Burst switching, Ethernet PON Architecture, 10GEPON PMD Architecture.

UNIT V WIRE LINE TECHNIQUES 12

Wire line Narrowband, XDSL, Wire line broad band, Very High Bit Rate Digital Subscriber Line (VDSL), Cable MODEM Home Networks, & VDSL Transmission Protocols. DOCSIS-Standards.

TOTAL : 60 PERIODS

OUTCOMES:

- To design the various access networks.
- To be able to design the 4G and LTE networks.
- To design broadband fiber optic networks.
- To design Hybrid wireless – optical networks.

REFERENCES

1. Gerd Keiser, "Optical Communications Essentials", 1st Reprint, Tata McGraw Hill, 2008
2. G Keiser, Optical fibre communication, system, McGraw Hill, Newyork, 2000.
3. J.M.Pitts & J.A.Schormans, Introduction to IP and ATM Design and Performance (2/e), Wiley, 2000.
4. G. P. Agarwal, Fibre optic communication system, 2nd Edition, John Wiley & b sons, New York 1997.
5. Franz and Jain, Optical communication system, Narosa Publications, New Delhi, 1995.
6. Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, "Broadband Optical Access Networks", John Wiley and Sons, New Jersey, 2011.

WT7201 ADHOC AND SENSOR NETWORKS L T P C
3 0 0 3

OBJECTIVES:

- To develop an understanding of sensor network architectures from a design and performance perspective.
- To understand the layered approach in sensor networks starting from physical layer to application layer.
- To study the WSN protocols.
- To study TinyOS and Contiki.
- To get adequate exposure to emerging technologies and their potential impact.

UNIT I MAC & ROUTING IN AD HOC NETWORKS 9

Introduction – Issues and challenges in ad hoc networks – MAC Layer Protocols for wireless ad hoc networks – Contention-Based MAC protocols – MAC Protocols Using Directional Antennas – Multiple-Channel MAC Protocols – Power-Aware MAC Protocols – Routing in Ad hoc Networks – Design Issues – Proactive, Reactive and Hybrid Routing Protocols

UNIT II TRANSPORT & QOS IN AD HOC NETWORKS 9

TCP‟s challenges and Design Issues in Ad Hoc Networks – Transport protocols for ad hoc networks – Issues and Challenges in providing QoS – MAC Layer QoS solutions – Network Layer QoS solutions – QoS Model

UNIT III MAC & ROUTING IN WIRELESS SENSOR NETWORKS 9

Introduction – Applications – Challenges – Sensor network architecture – MAC Protocols for wireless sensor networks – Low duty cycle protocols and wakeup concepts – Contention-Based protocols – Schedule-Based protocols – IEEE 802.15.4 Zig bee – Topology Control – Routing Protocols

UNIT IV TRANSPORT & QOS IN WIRELESS SENSOR NETWORKS 9

Data-Centric and Contention-Based Networking – Transport Layer and QoS in Wireless Sensor Networks – Congestion Control – In-network processing – Operating systems for wireless sensor networks – Examples

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defense against routing attacks - Secure Ad hoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course students should be able to

- Identify different issues in wireless ad hoc and sensor networks
- To analyze protocols developed for ad hoc and sensor networks
- To identify and understand security issues in ad hoc and sensor networks

REFERENCES:

1. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, Inc., 2005.
3. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.
4. Erdal Çayırcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
5. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition)”, World Scientific Publishing, 2011.
6. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010
7. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.

WT7203 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To revise the concepts of electromagnetic wave theory, Maxwell's equations, electromagnetic fields, charges, currents.
- To understand the fundamentals of applied electromagnetism by emphasizing physical and practical applications in modern communication systems.
- To instill knowledge on the EMI coupling mechanism and its mitigation techniques
- To impart comprehensive insight about the current EMC standards and about various 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 and 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.

UNIT III EMI CONTROL TECHNIQUES 9

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

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.

UNIT V EMI MEASUREMENT AND STANDARDS 9

Emi Measurements And Standards- 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 Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standardsMIL461E/462.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to apply Maxwell's equations for electromagnetic systems.
- To able to design systems to mitigate the effects of Electromagnetic Interference.
- To design systems with Electromagnetic compatibility.
- To design a EMI free system.
- To design high speed Printed Circuit board with minimum interference.
- To make our world free from unwanted electromagnetic environment.

REFERENCES:

1. V.P.Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, Newyork, 1996.
2. Henry W.Ott.,"Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.
3. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3rd Ed, Artech house, Norwood, 1986.
4. C.R.Paul,"Introduction to Electromagnetic Compatibility", John Wiley and Sons, Inc, 1992.
5. Don R.J.White Consultant Incorporate, "Handbook of EMI/EMC", Vol I-V, 1988.

WT7205 WIRELESS COMMUNICATION TECHNIQUES L T P C
4 0 0 4

OBJECTIVES:

- To understand the issues involved in mobile communication system design and analysis.
- To understand the concept of frequency reuse.
- To understand the characteristics of wireless channels.
- To acquire knowledge in different modulation schemes and its error probability in wireless system.
- To know the fundamental limits on the capacity of wireless channels.
- To understand the diversity concepts.

UNIT I THE WIRELESS CHANNEL 12

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 Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver – Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels.

UNIT II PERFORMANCE OF DIGITAL MODULATION OVER WIRELESS CHANNELS 12

Fading– Outage Probability– Average Probability of Error –– Combined Outage and Average Error Probability – Doppler Spread – Intersymbol Interference

UNIT III MULTIANTENNA COMMUNICATION 12

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

UNIT IV MULTICARRIER MODULATION 12

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Subchannels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset – Case study IEEE 802.11a

UNIT V CELLULAR CONCEPTS 12

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.

TOTAL: 60 PERIODS

OUTCOMES:

- To apply diversity techniques in wireless systems.
- To design cellular systems to achieve a given GoS (Grade of Service) in coverage and blocking probability.
- To design digital radio links considering various analytical and empirical models.
- To carry out link budget calculations.
- To be able to design frequency reuse patterns for cellular communication.

REFERENCES:

1. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Wiley Series in Telecommunications, Cambridge University Press, 2005.
2. Theodore.S. Rappaport, “Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2009.
3. Arogyaswami Paulraj, Rokit Nabar, Dhananjay Gore, “Introduction to Space-Time Wireless Communication”, 1st Edition, Cambridge University Press, 2008.
4. W.C.Y.Lee, “Mobile Cellular Telecommunications - Analog and Digital Systems”, 2nd Edition. Tata McGraw Hill, 2006.
5. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

WT7211 WIRELESS TECHNOLOGY LABORATORY L T P C
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.

LIST OF EXPERIMETNS (NS2/QUALNET/BWSIM/MATLAB)

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.
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:

1. Ability to design MAC and routing protocols in Wired and Wireless Environment using NS2/QUALNET/BWSim/Matlab.
2. To acquire the technical competence to meet out the industry expectation on the state – of the art wired / wireless technologies.
3. To acquire the ability to design WLAN/ LAN systems meeting out real time requirements.

WT7005 MULTIRATE SIGNAL PROCESSING FOR COMMUNICATION L T P C
3 0 0 3

OBJECTIVES :

- To understand discrete signals and basic signal processing - filters.
- To get exposed to various filter bank techniques.
- To understand the various applications of Multirate signal processing.

UNIT I DECIMATION AND INTERPOLATION 8

Introduction – Representation of discrete signals – Down Sampling - Up Sampling - Decimation with transversal filters – Interpolation with transversal filters.

UNIT II DECIMATION WITH POLYPHASE FILTERS 9

Interpolation with polyphase filters – Decimation and Interpolation with Rational sampling factors - Multistage implementations of decimators and interpolators.

UNIT III TWO CHANNEL FILTER BANKS 10

Analysis and synthesis filter banks – Quadrature mirror filter banks – Filter banks with perfect reconstruction – Paraunitary filter banks – Biorthogonal and linear phase filter banks – Transmuliplexer filter banks.

UNIT IV UNIFORM M-CHANNEL FIILTER BANKS 10

Filter banks with tree structure – Filter banks with parallel structure – complex modulated filter banks –cosine modulated filter banks – Transmultiplexer filter banks.

UNIT V APPLICATIONS 8

Digital Audio Systems – Sub band coding of speech and image signals – Analog Voice privacy System – Timing recovery in a digital demodulator – FM Receiver and Demodulator.

TOTAL : 45 PERIODS

OUTCOMES :

- To be able to design various filter banks.
- To be able to design speech/ audio systems related applications.

REFERENCES:

1. Fliege N J, "Multirate Digital Signal Processing", John Wiley and sons, 1994.
2. Vaidyanathan P P, "Multirate Systems and Filter Banks", Prentice Hall Inc., 1993.
3. Ifeachor E C & Jervis B.W “Digital Signal Processing” Pearson Education, 2002
4. Proakis J G and Manolakis D G, "Digital Signal Processing Principles, Algorithms and Applications", Prentice Hall of India, 2002.
5. Sanjit K Mitra, "Digital Signal Processing-A Computer Based Approach", Tata McGraw Hill, 2003.
6. Fredric J Harris “Multirate Signal Processing for Communication Systems” Pearson Education, 2009.

WT7010 WIRELESS NETWORK SECURITY L T P C
3 0 0 3

OBJECTIVE

- To understand the fundamentals of wireless security
- To configure the secured wireless home networks
- To understand the fundamental protocols involved in wireless network security.

UNIT I NUMBER THEORY AND CRYPTOGRAPHY 9

Mathematics of cryptography - integer arithmetic, modular arithmetic, linear congruence, GF (2^n), algebraic structures, primes, Euler’s phi & totient functions, Fermat’s and Euler’s theorem, primality testing, factorization, CRT, quadratic congruence, exponentiation and logarithm, elliptic curve cryptosystem, symmetric key cryptography - substitution, transposition, modern block ciphers, and its applications.

UNIT II INTEGRITY, AUTHENTICATION AND KEY MANGEMENT 9

Introduction to message integrity, hash functions and digital signature, SHA-512, MAC & MDC, HMAC, CMAC, digital signature- DSA,ECDSA, Entity authentication-passwords, challenge-response, zero-knowledge, key management-PKI, symmetric key agreement, RSA ,ElGammal, information theory, and elementary probability, complexity of algorithm.

UNIT III SECURITY PRACTICE & SYSTEM SECURITY 9

Electronic Mail Security – PGP, S/MIME, IPSec, Secure Electronic Transaction, web security considerations – SSL, TLS, IDS-password management, viruses and related threats, viruses counter measures, firewalls design principles, types of firewalls, configurations, trusted systems,

UNIT IV WIRELESS THREATS 9

Introduction to wireless technologies- history, challenges, risks, advances in wireless security, Radio Frequency –RF Terminology, interference, covert channels, and hardware. Hacking 802.11 wireless technologies- eavesdropping, jamming - wireless channel vulnerability analysis, Wi-Fi cyber crimes and awareness- countermeasures - wireless security standards wireless setup, risks and security controls.

UNIT V WIRELESS SECURITY 9

802.11i - Attacks, WPA-EAP, Attacking 802.11 Networks- Basic Types Of Attacks, Security Through Obscurity, Defeating WEP, WEP attacks, 802.11 Authentication Types, Attacking WPA-Protected 802.11, Breaking WPA, LEAP,EAP-TLS,Tunneling EAP Techniques, Hacking Attacking 802.11i wireless technologies- Hacking hotspots, client attacks resources, threats of Bluetooth-advanced attacks- layer 2 fragmentations breaking the silence, layer 2 and layer 3 resolutions.

TOTAL: 45 PERIODS

OUTCOME

Students will be able to

- Create and install a secured wireless network.
- Analyze security threats related to wireless network
- Explain the details of the secured wireless protocols for wireless networks.

REFERENCES:

1) Behrouz Forouzan, “Cryptography & Network Security”, Tata McGraw Hill, 2008.
2) Johnny Cache, Vincent Liu, “Hacking Exposed Wireless: Wireless Security secrets And Solutions” Tata McGraw Hill, 2007.
3) William Stallings, “Cryptography & Network Security – Principles and Practices”, Pearson Education, Fourth Edition, 2006.
4) Doughas R.Stinson, “Cryptography-Theory and Practice,” CRC Press,1995.
5) Wolfgang Osterhage, “Wireless Security”, CRC Press, 2011.
6) Michael E.Whitman and Herbert J.Mattord, “Principles of Information Security,” Cengage Learning, 4th Edition, 2011.

NE7080 SPACE TIME WIRELESS COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

- To acquire the knowledge on various modulation and coding schemes for space-time wireless communications.
- To understand transmission and decoding techniques associated with wireless communications.
- To understand multiple-antenna systems such as multiple-input multiple-output (MIMO) and space-time codes.

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, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

UNIT II CAPACITY OF MULTIPLE ANTENNA CHANNELS 8

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 8

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 10

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 10

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

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to design and evaluate receiver and transmitter diversity techniques.
- To be able to design and develop OFDM based MIMO systems.
- To be able to calculate capacity of MIMO systems.

REFERENCES:

1. A. Paulraj, Rohit Nabar, Dhananjay Gore., “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2003
2. Sergio Verdu “ Multi User Detection” Cambridge University Press, 1998
3. Andre Viterbi “ Principles of Spread Spectrum Techniques” Addison Wesley 1995

CU7072 COGNITIVE RADIO NETWORKS L T P C
3 0 0 3

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 Architecture.

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:

1. The student would be able to appreciate the motivation and the necessity for cognitive radio communication strategies.
2. The student would be able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
3. 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.

WT7007 RADIO FREQUENCY INTEGRATED CIRCUIT DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To introduce the electronic circuits for Amplifiers, Oscillators and radio frequency IC.
- To get exposed to microwave point to point system design.
- 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 several modern radio architectures.

UNIT I AMPLIFIERS 9

FET and bipolar transistor models **–** Two port power gains – stability – Amplifier design using S parameters – LNA – Differential amplifiers – DC biasing – Power amplifiers – general issues – efficiency, linearity etc., load pull, class A, AB and C Design – Higher class power amplifiers – linearization – distributed power amplifier.

UNIT II OSCILLATORS – RF OSCILLATORS 9

Microwave oscillators – LC – Colpitts – negative resistance – differential oscillators – frequency synthesis methods – phase locked loop analysis – oscillator phase noise.

UNIT III RADIO FREQUENCY IC 9

Introduction to RFIC – Analog and microwave design versus RFIC design – noise performance estimate – RF technology – receiver with single IF stage metallization – sheet resistance – skin effect – parasitic capacitance and inductance – current handling – metal capacitors – spiral inductors – quality factor – layouts in IC – mutual inductance – multilevel – measurement – packaging.

UNIT IV MICROWAVE POINT TO POINT SYSTEM DESIGN 9

Microwave transmission – link design – theoretical and practical aspects – fading design – protected and non protected microwave systems – link design – path calculation - spread spectrum microwave system – compatibility – safety coordinate systems – Datum's & GPS – Receiver design – receiver architecture – dynamic range – frequency conversion and filtering – examples of practical receivers – FM broad cast, Digital cellular – Millimeter wave point to point, Direct conversion GSM receiver.

UNIT V TRANSMISSION LINE EQUIPMENT 9

Digital microwave radio – fiber optic equipment – wireline equipment – cabling grounding – Power battery backup – GPS antenna – reliability issues – cell site selection – microwave repeater site selection – microwave site and path survey – microwave antenna mounting – measurement of RF fields – source emissions – power level and radiation pattern – microwave installation measurements and testing.

TOTAL : 45 PERIODS

OUTCOMES :

- To be able to design Amplifiers, Oscillators and radio frequency IC.
- To be able to design microwave point to point system.

REFERENCES:

1. David Pozar, "Microwave and RF Design of Wireless Systems", John Wiley, 2001.
2. Harvey Lehpamer, "Transmission System Design Handbook for Wireless Networks", Artech House, 2002.
3. John Rogers and Calvin Plett, "Radio Frequency Integrated Circuit Design", Artech House, 2002.
4. Stephan A Mass, "Non-Linear Microwave and RF circuits", Artech House, Second Edition.1988.
5. Ferri Losee, "RF Systems, Components and Circuits handbook", Artech house, 2002.
6. Larson LE, "RF and Microwave Circuit for Wireless Applications", Artech House, 1997.

NE7081 VLSI DESIGN TECHNIQUES L T P C
3 0 0 3

OBJECTIVE

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

UNIT I MOS TRANSISTOR PRINCIPLES 9

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits and Device modelling. Characteristics of CMOS inverter, Scaling

principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore's constant, Logical Effort.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic .Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NOR array logic.

UNIT III SEQUENTIAL LOGIC CIRCUITS 9

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits

UNIT IV DESIGNING ARITHMETIC BUILDING BLOCKS & TESTING 9

Datapath circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing- Testers, Text fixtures and test programs- Logic verification- - Manufacturing test – Design for testability – Boundary scan.

UNIT V IMPLEMENTATION STRATEGIES 9

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures.

TOTAL: 45 PERIODS

OUTCOMES

- At the end of the course students will be in a position to understand the basics of VLSI design, testing and different FPGA architecture.

REFERENCES:

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated circuits: A design perspective". Second Edition, Prentice Hall of India, 2003.
2. N.Weste, K.Eshraghian, "Principles of CMOS VLSI DESIGN", A system Perspective, second edition,Addision Wesley 1993
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, 1997
5. R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", Prentice Hall of India, 2005.

WT7008 SPREAD SPECTRUM COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

- To understand the basics of spread spectrum communication systems.
- To understand the way in which spread spectrum is applied to CDMA.
- To understand the performance of spread spectrum techniques.

UNIT I PERFORMANCE CHARACTERIZATION OF DIGITAL DATA TRANSMISSION 9

Detection of binary signals in AWGN - Quadrature multiplexed signalling schemes - Signalling through band limited channels - Equalization of digital data transmission system - Realization imperfections - Degradations in performance. Communication in the presence of pulse noise jamming - Low probability detection scheme - Direct Sequence Spread Spectrum (DSSS) and Frequency Hop Spread Spectrum Systems and examples of Spread Spectrum Systems.

UNIT II SPREAD SPECTRUM SYSTEMS 9

Direct sequence spread spectrum methods employing BPSK, QPSK and MSK - Frequency Hop spread spectrum methods - Coherent slow frequency Hop technique - Non coherent slow and fast frequency Hop spread spectrum techniques - Hybrid DS/FH spread spectrum - Complex envelope representation of spread spectrum systems.

UNIT III BINARY SHIFT REGISTER SEQUENCES FOR SPREAD SPECTRUM SYSTEMS 9

Definition - PN sequence generator fundamentals - Maximal length sequences - Properties, Power spectrum and Polynomial tables for maximal length sequences - Gold codes - Rapid Acquisition systems - Non-linear code generators.

UNIT IV SYNCHRONIZATION OF SPREAD SPECTRUM SYSTEMS 9

Optimal tracking of wideband signals - Early-late tracking loops - Code tracking loops for FHSS - Optimum synchronization techniques - Multiple dwell and sequential detectors - Synchronization using a matched filter - Synchronization by estimating the received spreading code.

UNIT V PERFORMANCE OF SPREAD SPECTRUM SYSTEM 9

SS Systems communications models - Performance without coding under AWGN and different jamming environments - spread spectrum systems performances with forward error correction - Block coding - Convolutional coding and specific error correcting codes - Inter leaving - Random coding bounds.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to arrive at detailed specifications of the spread spectrum systems.
- To design the spread spectrum based systems for CDMA.
- To be able to evaluate the performance of spread spectrum based systems.

REFERENCES

1. Ziemer R E and Peterson R L, "Digital Communication and Spread Spectrum Systems", Macmillan Publishing Co., 1985.
2. Dixon R C, "Spread Spectrum Systems", Wiley Interscience, 1976.
3. Holms J K, "Coherent Spread Spectrum Systems", Wiley Interscience, 1982.

NE7073 BROADBAND ACCESS TECHNOLOGIES L T P C
3 0 0 3

OBJECTIVE

- To give fundamental concepts related to broadband access technologies.
- To understand the current and emerging wired and wireless access technologies.
- To acquire knowledge about cable modems and fiber access technologies.
- To have an exposure to different systems standards for next generation broadband access networks.

UNIT I REVIEW OF ACCESS TECHNOLOGIES 5

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT II DIGITAL SUBSCRIBER LINES 10

Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.

UNIT III CABLE MODEM 10

Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

UNIT IV FIBER ACCESS TECHNOLOGIES 10

Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.

UNIT V BROAD BAND WIRELESS 10

Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000.

TOTAL : 45 PERIODS

OUTCOMES

- To able to design systems meeting out the requirements of the recent standards.
- To meet out the industry requirements for man power in next generation networks.
- To be able to contribute towards the enhancement of the existing wireless technologies.

REFERENCES:

1. Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999.
2. Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and Cable Modems”, John Wiley & Sons, 2000.
3. Walter J Woralski, “ADSL and DSL Technologies”, McGraw Hill Computer Communication Series, Second Edition Oct 2001.
4. William Webb, “Introduction to Wireless Local Loop Broadband and Narrow Band System”, Mobile Communication Series, Artech House Publishers, Second Edition 2000.
5. Martin P. Clarke, “Wireless Access Network: Fixed Wireless Access and WLL Network Design and Operation”, John Wiley & Sons 2000.
6. Dennis J. Rauschmayer, “ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines, Macmillan Technology Series, 1998.

WT7003 MICRO ELECTRO MECHANICAL SYSTEM FOR WIRELESS COMMUNICATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the concepts of micro electromechanical devices.
- To know the design concepts of micro sensors and micro actuators.
- To make the student familiar with the mechanical and the electrostatic design and the associated system issues.
- To introduce the student to the different MEMS applications, the design basics, the design tools and the performance issues

UNIT I FUNDAMENTALS & SWITCHES 9

RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation.

UNIT II TUNNABLE MEMS 9

MEMS inductors and capacitors. Micromachined inductor. Effect of inductor layout. Modeling and design issues of planar inductor. Gap tuning and area tuning capacitors. Dielectric tunable capacitors.

UNIT III FILTERS 9

Micromachined RF filters. Modeling of mechanical filters. Electrostatic comb drive. Micromechanical filters using comb drives. Electrostatic coupled beam structures.

UNIT IV PERFORMANCE ANALYSIS 9

MEMS phase shifters. Types. Limitations. Switched delay lines. Micro machined transmission lines. Co planar lines. Micro machined directional coupler and mixer.

UNIT V MICROMACHINED ANTENNA 9

Micro machined antennas. Microstrip antennas – design parameters. Micromachining to improve performance. Reconfigurable antennas.

TOTAL : 45 PERIODS

OUTCOMES:

- The student would be able to demonstrate an understanding of the different aspects of microsystem design.
- Students will able to design different type of MEMS based devices, circuits and subsystems.
- The student would be capable of applying his knowledge and design tools and will be well practiced in design skills.

REFERENCES

1. H.J.D.Santos, RF MEMS Circuit Design for Wireless Communications, Artech House, 2002.
2. G.M.Rebeiz , RF MEMS Theory , Design and Technology, wiley , 2003.
3. Stephen D Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2001.
4. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, 1997.
5. V.K.Varadan etal, RF MEMS and their Applications, Wiley,2003.
6. Gregory Kovacs, “Micromechanised Transducers Source Book”, WCB McGraw Hill, Boston, 1998.
7. M H Bao, “Micromechanical Transducers, Pressure Sensors, Accelerometers and Gyroscopes” Elsevier, Newyork, 2000.

WT7002 GLOBAL POSITIONING SYSTEMS L T P C
3 0 0 3

OBJECTIVES :

- To know the fundamentals of coordinate systems.
- To understand the basic design factors for GPS.
- To know the dynamics of satellite.
- To get exposed to the environmental factors involved in the design of GPS.

UNIT I GPS FUNDAMENTALS 9

History of GPS – BC-4 System – HIRAN – NNSS – NAVSTAR GLONASS and GNSS Systems – GPS Constellation – Space Segment – Control Segment – User Segment – Single and Dual Frequency – Point – Relative – Differential GPS – Static and Kinematic Positioning – 2D and 3D – reporting Anti Spoofing (AS); Selective Availability (SA) – DOP Factors.

UNIT II CO-ORDINATE SYSTEM AND SATELLITE MOTION 9

Coordinate Systems – Geo Centric Coordinate System – Conventional Terrestrial Reference System – Orbit Description – Keplerian Orbit – Kepler Elements – Satellite Visibility – Topocentric Motion – Disturbed Satellite Motion – Perturbed Motion – Disturbing Accelerations - Perturbed

Orbit – Time Systems – Astronomical Time System – Atomic Time – GPS Time – Need for Coordination – Link to Earth Rotation – Time and Earth Motion Services.

UNIT III TRACKING TECHNIQUES 9

C/A code; P-code; Y-code; L1, L2 Carrier frequencies – Code Pseudo Ranges – Carries Phases – Pseudo Ranges – Satellite Signal Signature – Navigation Messages and Formats – Undifferenced and Differenced Range Models – Delta Ranges – Signal Processing and Processing Techniques – Tracking Networks – Ephemerides – Data Combination: Narrow Lane; Wide Lane – OTF Ambiguity.

UNIT IV ATMOSPHERIC EFFECTS 9

Propagation Media – Multipath – Antenna Phase Centre – Atmosphere in brief – Elements of Wave Propagation – Ionospheric Effects on GPS Observations – Code Delay – Phase Advances – Integer Bias – Clock Error – Cycle Slip – Noise-Bias – Blunders – Tropospheric Effects on GPS Oberservables – Multipath Effect – Antenna Phase Centre Problems and Correction.

UNIT V APPLICATION 9

Iner Disciplinary Applications – Crystal Dynamics – Gravity Field Mapping – Atmospheric Occulation – Surveying – Geophysics – Air borne GPS – Ground Transportation – Space borne GPS – Metrological and Climate Research using GPS.

TOTAL : 45 PERIODS

OUTCOMES :

- To be able to design GPS

REFERENCES:

1. B.Hoffman - Wellenhof, H.Lichtenegger and J.Collins, "GPS: Theory and Practice", 4th revised edition, Springer, Wein, New york,1997
2. A.Leick, "GPS Satellites Surveying", 2nd edition, John Wiley & Sons, NewYork,1995
3. B.Parkinson, J.Spilker, Jr.(Eds), "GPS: Theory and Applications", Vol.I & Vol.II, AIAA, 370 L'Enfant Promenade SW, Washington, DC 20024, 1996
4. A.Kleusberg and P.Teunisen(Eds), “GPS for Geodesy”, Springer-Verlag, Berlin,1996
5. L.Adams, "The GPS - A Shared National Asset”, Chair, National Academy Press, Washington, DC, 1995

NE7078 INFORMATION THEORY AND CODING L T P C
3 0 0 3

OBJECTIVES :

- To understand the concepts of Information theory and Coding.
- To understand the fundamental limits prescribed by the information theory.
- To learn the various coding schemes in detail.

UNIT I QUANTITATIVE STUDY OF INFORMATION 9

Basic inequalities, Entropy, Kullback-Leibler distance, Mutual information, Bounds on entropy, Fisher information, Cramer Rao inequality, Second law of thermodynamics, Sufficient statistic, 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 equipartition, 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 design and implement various coding schemes.
- To be able to apply coding techniques to information sources like video, audio and so on.

REFERENCES:

1. Thomas Cover, Joy Thomas, “Elements of Information Theory “, Wiley, 2005.
2. David Mackay, “Information Theory, Interference & Learning Algorithms”, Cambridge University Press, 1st edition, 2002.

WT7004	MODELING AND SIMULATION OF WIRELESS COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the aspect of simulation and modeling.
- To understand random signals and process
- To get exposed to simulation methods for wireless systems
- To know modeling procedures for various channels.

UNIT I INTRODUCTION 9

Role of Simulation: Examples of complexity - multidisciplinary aspects of simulation - models - deterministic and stochastic simulations; Simulation methodology - aspects of methodology - performance estimation; Fundamental Concepts and Techniques: Sampling - quantizing - reconstruction and interpolation - simulation sampling frequency - low pass simulation models for band pass – low pass complex envelope for bandpass signals - linear bandpass systems - multicarrier signals - nonlinear and time - varying systems.

UNIT II GENERATING AND PROCESSING RANDOM SIGNALS 9

Stationary and Ergodic Processes: Uniform random number generators - mapping uniform RVs to an arbitrary PDF - generating uncorrelated Gaussian random numbers - generating correlated Gaussian random numbers - PN sequence generators; Establishing a PDF and a PSD Post Processing: Basic graphical techniques - estimation - coding.

UNIT III METHODOLOGY FOR SIMULATING A WIRELESS SYSTEM 9

Monte Carlo Simulation Fundamental Concepts: Applications and integration - two Monte Carlo examples; Semi Analytic Techniques System: Level simplifications and sampling rate considerations - overall methodology; Modeling and Simulation of Nonlinearities: Introduction - modeling and simulation of memory less nonlinearities - modeling and simulation of nonlinearities with memory - techniques for solving nonlinear differential equations. Prerequisite : Basic knowledge of C programming, signals and systems, digital communication and digital signal processing.

UNIT IV MODELING AND SIMULATION OF TIME-VARYING SYSTEMS 9

Introduction: Models for LTV systems - random process models - simulation models for LTV systems; Wired and guided wave - radio channels - multipath fading channels - modeling multipath fading channels; Random process models - simulation methodology; Discrete Channel Models: Discrete memory less channel models - Markov models for discrete channels with memory-example HMMs - Gilbert and Fritchman models - estimation of Markov model parameters.

UNIT V EFFICIENT SIMULATION TECHNIQUES 9

Tail Extrapolation: PDF estimators- importance sampling; Case study of a cellular radio system; Cellular radio system - simulation methodology - modeling co-channel interference - two example simulations; A code-division multiple access system - FDM system with a nonlinear satellite transponder - preprocessors for CDMA application.

TOTAL : 45 PERIODS

OUTCOMES :

- To be able to design various models for wireless communication
- To be able to simulate various channels
- To apply for various wireless communication technologies.

REFERENCES

1. William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport and Kurt L. Kosbar "Principles of Communication Systems Simulation with Wireless Applications", Prentice Hall, Upper Saddle River, 2003.
2. M. C. Jeruchim, Philip Balaban and K.Sam shanmugam. "Simulation of Communication Systems", Plenum Press, 2007.
3. M. Law and W. David Kelton , "Simulation Modelling and Analysis", McGraw Hill, 2008.
4. K. Hayes, "Modelling and Analysis of Computer Communication Networks", Plenum Press, 1984.
5. Banks, J. S. Carson, Nelson and D. M. Nicol, "Discrete Event System Simulation", 4th Edition, Prentice Hall of India, 2005.

MM7351 MULTIMEDIA COMPRESSION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
  To understand the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To appreciate the use of compression in multimedia processing applications
- To understand and implement compression standards in detail

UNIT I FUNDAMENTALS OF COMPRESSION 9

Introduction To multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression Algorithms - Elements of Information Theory – Error Free Compression – Lossy Compression

UNIT II TEXT COMPRESSION 9

Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT III IMAGE COMPRESSION 9

Image Compression: Fundamentals –– Compression Standards – JPEG Standard – Sub-band coding – Wavelet Based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT IV AUDIO COMPRESSION 9

Audio compression Techniques – μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.

UNIT V VIDEO COMPRESSION 9

Video compression techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – DVI real time compression – Current Trends in Compression standards.

TOTAL :45 PERIODS

OUTCOMES:

Upon Completion of the course, the students should be able to

- Implement basic compression algorithmsFamiliar with the use of MATLAB and its equivalent open source environments
- Design and implement some basic compression standards
- Critically analyze different approaches of compression algorithms in multimedia related mini projects.

REFERENCES

1. Khalid Sayood: Introduction to Data Compression", Morgan Kauffman Harcourt India, Third Edition, 2010.
2. David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlog, New York, 2006.
3. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals", CRC Press, 2003.
4. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, 2009.

NE7251 REAL TIME EMBEDDED SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basics of embedded system, architecture of PIC microcontroller and ARM processor.
- To understand the RTOS concepts like scheduling and memory management related to the embedded system.
- To learn the protocols of embedded wireless application.
- To understand concepts involved in the design of hardware and software components for an embedded system**.**

UNIT I INTRODUCTION 12

Real Time System – Embedded Systems – Architecture of Embedded System - Simple Programming for Embedded System – Process of Embedded System Development - Pervasive Computing – Information Access Devices – Smart Cards – Microcontrollers – ARM Processor - Real time Microcontrollers – Low power embedded systems, microcontrollers & RF**.**

UNIT II EMBEDDED/REAL TIME OPERATING SYSTEM 9

Operating System Concepts: Processes, Threads, Interrupts, Events - Real Time Scheduling Algorithms - Memory Management – Overview of Operating Systems for Embedded, Real Time, Handheld Devices – Target Image Creation – Programming in Linux, RTLinux, VxWorks, uC/Os overview.

UNIT III CONNECTIVITY 9

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

UNIT IV REAL TIME UML 6

Requirements Analysis – Object Identification Strategies – Object Behaviour – Real Time Design Patterns.

UNIT V SOFTWARE DEVELOPMENT AND CASE STUDY 9

Concurrency – Exceptions – Tools – Debugging Techniques – Optimization – Case Studies - Interfacing Digital Camera with USB port and Data Compressor.

TOTAL: 45 PERIODS

OUTCOMES:

- To be able to make a choice a suitable embedded processor for a given application.
- To be able to design the hardware and software for the embedded system.
- To be able to design and develop the real time kernel/operating system functions, task control block structure and analyze different task states.
- To be able to implement different types of inter task communication and synchronization techniques.

REFERENCES:

1. R.J.A.Buhr, D.L.Bailey, “An Introduction to Real-Time Systems”, Prentice-Hall International,1999.
2. David E-Simon, “An Embedded Software Primer”, Pearson Education, 2007.
3. C.M.Krishna, Kang G.Shin, “Real Time Systems”, Mc-Graw Hill, 1997.
4. B.P.Douglass, “Real Time UML", 2nd Edition, Addison-Wesley 2000.
5. Dr.K.V.K.K.Prasad, “Embedded/Real Time Systems: Concepts, Design and Programming”,DreamTech Press, Black Book, 2005.
6. R.Barnett, L.O.Cull, S.Cox, “Embedded C Programming and the Microchip PIC”,
7. Thomason Learning, 2004.
8. Wayne Wolf, “Computers as Components - Principles of Embedded Computer System Design”, Mergen Kaufmann Publisher, 2006.
9. Sriram V Iyer, Pankaj Gupta, “Embedded Real Time Systems Programming”, Tata Mc-Graw Hill, 2004.

WT7001 FREE SPACE OPTICAL COMMUNICATION L T P C

3 0 0 3

OBJECTIVE

- To understand the concepts of free space optical communication
- To know the challenges involved in free space communication
- To give adequate exposure to the emerging technologies and their potential impact.

UNIT I FUNDAMENTALS OF FSO TECHNOLOGY 9

Introduction – Maxwell's Equations – Electromagnetic wave propagation in free space-alternate bandwidth technologies – Fiber Vs FSO- Fiber Access – Overview of FSO Optical Transmitters – Receivers – Subsystems – Pointing, Acquisition and Tracking – Line of sight analysis.

UNIT II FSO NETWORKS 9

The Role of FSO in the network–factors affecting FSO–line of sight(LOS)–selecting transmission wave integration of FSO in Optical networks – installation of FSO systems – moving towards edge – and residential areas.

UNIT III LONG DISTANCE FSO COMMUNICATION 9

The FSO model – Applications – System descriptions and design – Introduction to Laser Satellite Communications – Characteristics, Modulation Techniques and Radiation effects – Laser Sources.

UNIT IV OPTICAL COMPONENTS FOR FSO 9

Optical waveguides – Optical Filters, Couplers, Amplifiers, Switches, Antennas, Interconnecting Equipments, and etc – Optical integrated circuits – semiconductor integrated optic devices.

UNIT V OPTICAL SIGNAL PROCESSING 9

Analog and Discrete systems – Noise and Stochastic processes – Filters – Power spectra estimation – Ambiguity function, Wigner distribution function and triple correlations.

TOTAL: 45 PERIODS

OUTCOME

- To develop a mathematical model for optical sources
- Should be able to design and analyze free space optical transmitters and receivers.
- To be able to carry out power-bandwidth budget calculations
- To solve issues related to loss, bandwidth and cross talk and non-linearity

REFERENCES

1) Heinz, Phd. Willebrand, "Free Space Optics," Sams, 1st Ed., 2001.
2) Morris Katzman, "Laser Satellite Communication," Prentice Hall Inc., New York, 1991

WT7009 ULTRA WIDEBAND COMMUNICATION L T P C
3 0 0 3

OBJECTIVE

- To understand the basics principles behind the UWB concepts.
- To enable the student to understand the all areas of design and implementation of UWB.

UNIT I INTRODUCTION TO ULTRA-WIDEBAND 9

Introduction, UWB Modulation Options - UWB Signaling Techniques - Data Mapping - Spectral Characteristics - Data Mapping and Transceiver Complexity - Modulation Performances in Practical Conditions

UNIT II ULTRA-WIDEBAND PULSE SHAPER DESIGN 9

Transmit Spectrum and Pulse Shaper - FIR Digital Pulse Design - Optimal UWB Single Pulse Design - Optimal UWB Orthogonal Pulse Design.

UNIT III ULTRA-WIDEBAND CHANNEL MODELING 9

Principles and Background of UWB Multipath Propagation Channel Modeling -Channel Sounding Techniques - UWB Statistical-Based Channel Modeling -Impact of UWB Channel on System Design - Potential Benefits of MIMO.

UNIT IV ANTENNA DESIGN CONSIDERATIONS 9

System Model - UWB Receiver Related Issues - TH-IR-UWB Receiver Options. Multiple-Access Interference Mitigation at the Receiver Side - Multiple-Access Interference Mitigation at the Transmitter Side. Effect of NBI in UWB Systems - Avoiding NBI - Canceling NBI.

UNIT V MULTIBAND OFDM SYSTEM 9

Multiband Pulsed-OFDM UWB system. Medium Access Protocols - Network Applications. Multiple Access in UWB Sensor Systems - UWB Sensor Network Case Study -System Description-UWEN – Implementation - Location System - Position Calculation Methods. The 802.15.4 MAC Standard - Advanced MAC Design for Low-Bit-Rate UWB Networks

TOTAL: 45 PERIODS

OUTCOME

- The student should be able to develop a comprehensive overview of UWB system design.
- The student would be able to design transmit and receive antenna

REFERENCES

1) Huseyin Arsian, Zin Ning Chen, “Ultra-Wide band Wireless Communication” Wiley, 2006.
2) Homayoun Nikcobar and Ramjee Prasas” Introduction to Ultra Wideband for Wireless Communications” Springer, 2009.
3) Jeffrey H.Reed, “An Introduction to Ultra Wideband Communication Systems” Prentice Hall PTR, 2005.
4) Kayimiery siwiak and Debra mekown, “Ultra-Wideband Radio Technology”, John Willey & Sons 2004.

WT7006 NETWORK ROUTING PROTOCOLS L T P C
3 0 0 3

OBJECTIVES

- Create in-depth awareness of circuit switching network routing and routing in packet switching network.
- Should be able identify the capabilities, addressing and routing of high speed networks such as ATM networks.
- Should be able to analyze Mobile Communication networks and mobility managements.
- Ability to apply RTOS concepts for solving multi task applications.

UNIT I INTRODUCTION 9

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT II INTERNET ROUTING INTERIOR PROTOCOL 9

Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT III ROUTING IN OPTICAL WDM NETWORKS 9

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting-Benefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE NETWORKS 9

Mobile - IP Networks - Macro-mobility Protocols, Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access, Internet Infrastructure (HAWAII).

UNIT V AD HOC NETWORKS 9

Mobile Ad –Hoc Networks - Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

TOTAL: 45 PERIODS

OUTCOMES

- Explain various communication architectures and protocols used in circuit switched and packet switched networks.
- Analyze Mobile Networks, simulate switching techniques and QoS.
- The student should be able to apply the correct routing algorithm on a network depending on the type the and the condition of the network.

REFERENCES:

1. William Stallings, 'High speed networks and Internets Performance and Quality of Service', II nd Edition, Pearson Education Asia. Reprint India 2002.
2. M. Steen Strub, 'Routing in Communication network, Prentice –Hall International, New york, 1995.
3. S. Keshav, 'An engineering approach to computer networking' Addison Wesley 1999.
4. William Stallings, 'High speed Networks TCP/IP and ATM Design Principles, Prentice Hall, New York, 1995
5. C.E Perkins, 'Ad Hoc Networking', Addison – Wesley, 2001
6. Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, "A Survey of mobility Management in Next generation All IP- Based Wireless Systems", IEEE Wireless Communications, pp 16-27, 2004.
7. A.T Campbell et al., "Comparison of IP Micro mobility Protocols," IEEE Wireless Communications, pp 72-82, 2002.
8. Jochen H.Schiller, "Mobile Communication", 2nd Edition, Pearson Ed, 2014.

NE7074 COMPUTATIONAL INTELLIGENCE L T P C
3 0 0 3

OBJECTIVES:

- To provide the basic concepts in computational intelligence
- To give an exposure to neural network learning techniques and architectures
- To provide a good understanding of fuzzy concepts and models
- To provide an exposure to different optimization techniques.

UNIT I INTRODUCTION TO COMPUTATIONAL INTELLIGENCE 9

Evolution of Computing - Constituents - From Conventional AI to Computational Intelligence - Machine Learning Basics

UNIT II 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 - Advances in Neural networks –SVM

UNIT III 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- Introduction to Fuzzy models

UNIT IV NEURO-FUZZY MODELING 9

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

UNIT V OPTIMIZATION ALGORITHMS 9

Heuristic search and optimization techniques – Random search- Introduction to Genetic Algorithms (GA) -Applications of GA – Social Algorithms

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to design systems based on neural network architecture
- To implement fuzzy models and work on fuzzy tool box.
- To design a suitable optimization algorithm for a given application.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India, 2003.
2. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall, 1995.
3. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn., 2003.
4. Mitchell Melanie, “An Introduction to Genetic Algorithm”, Prentice Hall, 1998.
5. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley, 1997.
6. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB”, Springer, 2007.
7. S.N.Sivanandam · S.N.Deepa, “ Introduction to Genetic Algorithms”, Springer, 2007.
8. Jacek M. Zurada, “Introduction to Artificial Neural Systems”, PWS Publishers, 1992.

NE7077	GAME THEORY FOR WIRELESS COMMUNICATION AND NETWORKING	L	T	P	C
		3	0	0	3

OBECTIVES:

- To give an overview of a broad range of models that is studied in game theory
- To understand a range of mathematical models of conflict and co-operation between two or more agents
- To discuss the main concepts in the game theory and to explain the classes of 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 design 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.
6. Prajit K.Dutta, "Strategies and Games: Theory and Practice", MIT Press, 1999.

AP7252 DIGITAL IMAGE PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To provide an introduction to basic concepts and methodologies for digital image processing.
- To develop engineering skills and intuitive understanding of the most important concepts, techniques and algorithms for digital image processing.
- To understand the general processes of image acquisition, storage, enhancement, segmentation, representation and description.
- To implement filtering and enhancement algorithms for monochrome as well as color images.
- To appreciate the challenges and understand the principles and applications of visual pattern recognition.

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Elements of digital image processing systems, Digital Camera working principles, Elements of visual perception, brightness, contrast, hue, saturation, Mach Band effect, Image sampling, Quantization, Dither, Two dimensional mathematical preliminaries.

UNIT II IMAGE TRANSFORMS 9

1D DFT, 2D transforms - DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Wavelet transform.

UNIT III IMAGE ENHANCEMENT AND RESTORATION 9

Spatial domain filtering, intensity transformations, contrast stretching, histogram equalization, smoothing filters, sharpening filters, noise distributions, mean filters, order statistics filters. Image restoration - degradation model, Unconstrained and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations-spatial transformations, Gray-Level interpolation.

UNIT IV IMAGE SEGMENTATION AND MORPHOLOGY 9

Image segmentation - Edge detection, Edge linking and boundary detection, Region growing, Region splitting and Merging, Image Recognition - Patterns and pattern classes, Matching by minimum distance classifier, Matching by correlation, Morphological Image Processing - Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

UNIT V IMAGE COMPRESSION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Block Truncation Coding, Transform coding, JPEG, MPEG.

TOTAL: 45 PERIODS

OUTCOMES:

- Develop an overview of the field of image processing.
- Analyze and implement the fundamental algorithms
- Gain experience in applying image processing algorithms to real problems

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, " Digital Image Processing", Pearson Education, Inc., Second Edition, 2004
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2002.
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins," Digital Image Processing using MATLAB", Pearson Education, Inc., 2004.
4. William K. Pratt, " Digital Image Processing", John Wiley, New York, 2002.
5. S. Sridhar, " Digital Image Processing", Oxford University Press.
6. Milan Sonka et al, "Image Processing, Analysis and Machine Vision", Brookes/Cole, Vikas Publishing House, 2nd edition, 1999;
7. Sid Ahmed, M.A., " Image Processing Theory, Algorithms and Architectures", McGrawHill, 1995.

CU7251 WIRELESS TRANSCEIVER DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the student to understand the intricacies of RF system design using behavior models of the subsystems present in the transceivers

UNIT I FUNDAMENTALS OF SYSTEM DESIGN 9

Linear systems and transformation, Non-linear system representation, Noise and Random process, elements of Digital base band system: Sampling, jitter, modulation techniques, pulse shaping, error probability detection,

UNIT II RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS 9

Superheterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture

UNIT III RECEIVER SYSTEM ANALYSIS AND DESIGN 9

Sensitivity and noise figure of receiver, intermodulation characteristics, single tone desensitization, adjacent channel selectivity and blocking characteristics, receiver dynamic range and AGC system, system design and performance evaluation

UNIT IV TRANSMITTER SYSTEM ANALYSIS AND DESIGN 9

Transmission power and spectrum, modulation accuracy, adjacent and alternate channel power, noise emission.

UNIT V CASE STUDY 9

Multimode and multiband superheterodyne transceiver: selection of frequency plan, receiver system and transmitter system design - Direct conversion transceiver: receiver system and transmitter system design.

TOTAL: 45 PERIODS

OUTCOMES:

1. The student would be able to demonstrate an understanding of the basic principles of RF system design.
2. The student would have enhanced knowledge on the abnormalities present in the transceiver architectures and would be able to utilize their models in the system performance estimation.

REFERENCES

1. Qizheng Gu, “RF System Design of Transceivers for Wireless Communications”, Springer, 2005
2. K P Pun, J E D Franca and C A Leme, “Circuit Design For Wireless Communications – Improved Techniques for Image Rejection in Wideband Quadrature Receivers”, Springer, 2003.
3. Kai Chang , RF and Microwave Wireless Systems, John Wiley, 2000

CU7151 ADVANCED RADIATION SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

- To enhance the students knowledge in the area of various antenna design and to make them understand their radiation mechanism.
- To impart knowledge about the state of art in antenna technology.

UNIT I ANTENNA FUNDAMENTALS 9

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell’s equations - Antenna fundamental parameters - Radiation integrals - Radiation from surface and line current distributions – dipole, monopole, loop antenna; Mobile phone antenna-base station, hand set antenna; Image; Induction ,reciprocity theorem, Balance to unbalance transformer, Review of Antenna Measurements.

UNIT II ANTENNA ARRAYS 9

One Dimensional Arrays: Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Linear array synthesis techniques – Binomial and Chebyshev distributions; Two dimensional uniform arrays;smart antennas,switched beam and adaptive arrays, Mutual Coupling in Finite Arrays.

UNIT III RADIATION FROM APERTURES 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.

UNIT IV MICROSTRIP ANTENNA 9

Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch, Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Reconfiguration Mechanisms; Computer Aided Design of Microstrip Antennas, Microstrip Reflectarray Antennas.

UNIT V MODERN ANTENNAS 9

PIFA – Vivaldi Antennas - UWB Antennas - Antennas in Medicine – Leaky Wave Antennas – Plasma Antennas – Wearable Antennas – RFID Antennas - Automotive antennas, Reconfigurable antennas - Meta materials

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Describe the fundamentals to recent techniques in antenna technology.
- Design and assess the performance of various antennas.

REFERENCES

1. Balanis.A, “Antenna Theory Analysis and Design”, 3rd Edition, John Wiley and Sons, New York, 1982.
2. Frank B. Gross, “Frontiers in Antennas”, Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, “Modern Antennas”, II Edition, Springer Publications, 2007.
4. Krauss.J.D, “Antennas”, II edition, John Wiley and sons, New York, 1997.
5. I.J. Bahl and P. Bhartia,” Microstrip Antennas”, Artech House,Inc.,1980
6. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, 2nd edition, John Wiley& Sons Inc.,1998.
7. Jim R. James,P.S.Hall ,"Handbook of Microstrip Antennas"IEE Electromagnetic wave series 28, Volume 2,1989

CU7071 ADVANCED WIRELESS COMMUNICATION TECHNIQUES L T P C

3 0 0 3

OBJECTIVES:

1. To enable the student to understand the evolving paradigm of cooperative and green wireless communication concepts and the challenges and trade-offs involved in such networks.
2. To enable the student to understand the different power saving strategies and energy efficient signal, system and network design.
3. To expose the student to the energy saving techniques adopted in existing wireless components, protocols and networks and the evolution of green future wireless communication technologies.

UNIT I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks ; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

UNIT II COOPERATIVE TECHNIQUES 9

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations ; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi-point transmission in LTE-Advanced.

UNIT III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Distributed space-time block codes ; Collaborative relaying in downlink cellular systems ; Radio resource optimization; Adaptive resource allocation ; Cross-layer scheduling design for cooperative wireless two-way relay networks ; Network coding in relay-based networks.

UNIT IV GREEN RADIO NETWORKS 9

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations , Power-management for base stations in smart grid environment , Cooperative multicell processing techniques for energy-efficient cellular wireless communications.

UNIT V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks ; Energy performance in TDD-CDMA multihop cellular networks ; Resource allocation for green communication in relay-based cellular networks ; Green Radio Test-Beds and Standardization Activities.

TOTAL : 45 PERIODS

OUTCOMES:

- The student would be able to appreciate the necessity and the design aspects of cooperative and green wireless communication.
- 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 green engineering solutions in a global, economic, environmental and societal context.

REFERENCES

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , “Cooperative Cellular Wireless Networks”, Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), “Green Radio Communication Networks”, Cambridge University Press, 2012.
3. F. Richard Yu, Yu, Zhang and Victor C. M. Leung “Green Communications and Networking”, CRC press, 2012.
4. Mazin Al Noor, “Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access”, GRIN Verlag, 2012.
5. Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, “Handbook of Green Information and Communication Systems”, Academic Press, 2012.
6. Ramjee Prasad and Shingo Ohmori, Dina Simunic, “Towards Green ICT”, River Publishers, 2010.
7. Jinsong Wu, Sundeep Rangan and Honggang Zhang, “Green Communications: Theoretical Fundamentals, Algorithms and Applications”, CRC Press, 2012.

MM7011 MOBILE AND PERVASIVE COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES :

- To understand the basics of Mobile computing and Personal computing.
- To learn the role of wireless networks in Mobile Computing and Pervasive Computing.
- To study about the underlying wireless networks.
- To understand the architectures of mobile and pervasive applications.
- To become familiar with the pervasive devices and mobile computing platforms.

UNIT I INTRODUCTION 9

Differences between Mobile Communication and Mobile Computing – Contexts and Names – Functions – Applications and Services – New Applications – Making Legacy Applications Mobile Enabled – Design Considerations – Integration of Wireless and Wired Networks – Standards Bodies – Pervasive Computing – Basics and Vision – Principles of Pervasive Computing – Categories of Pervasive Devices

UNIT II 3G AND 4G CELLULAR NETWORKS 9

Migration to 3G Networks – IMT 2000 and UMTS – UMTS Architecture – User Equipment – Radio Network Subsystem – UTRAN – Node B – RNC functions – USIM – Protocol Stack – CS and PS Domains – IMS Architecture – Handover – 3.5G and 3.9G a brief discussion – 4G LAN and Cellular Networks – LTE – Control Plane – NAS and RRC – User Plane – PDCP, RLC and MAC – WiMax IEEE 802.16d/e – WiMax Internetworking with 3GPP

UNIT III SENSOR AND MESH NETWORKS 9

Sensor Networks – Role in Pervasive Computing – In Network Processing and Data Dissemination – Sensor Databases – Data Management in Wireless Mobile Environments – Wireless Mesh Networks – Architecture – Mesh Routers – Mesh Clients – Routing – Cross Layer Approach – Security Aspects of Various Layers in WMN – Applications of Sensor and Mesh networks

UNIT IV CONTEXT AWARE COMPUTING 9

Adaptability – Mechanisms for Adaptation - Functionality and Data – Transcoding – Location Aware Computing – Location Representation – Localization Techniques – Triangulation and Scene Analysis – Delaunay Triangulation and Voronoi graphs – Types of Context – Role of Mobile Middleware – Adaptation and Agents – Service Discovery Middleware

UNIT V APPLICATION DEVELOPMENT 9

Three tier architecture - Model View Controller Architecture - Memory Management – Information Access Devices – PDAs and Smart Phones – Smart Cards and Embedded Controls – J2ME – Programming for CLDC – GUI in MIDP – Application Development ON Android and iPhone.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the student should be able to,

- To deploy 3G networks.
- To develop suitable algorithms for 4G networks.
- To use sensor and mesh networks to develop mobile computing environment.
- To develop mobile computing applications based on the paradigm of context aware computing.

REFERENCES:

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, “Mobile Computing: Technology, Applications and Service Creation”, Second Edition, Tata McGraw Hill, 2010.
2. Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley, 2010.

3. Pei Zheng and Lionel M Li, „Smart Phone & Next Generation Mobile Computing", Morgan Kaufmann Publishers, 2006.
4. Frank Adelstein, "Fundamentals of Mobile and Pervasive Computing", TMH, 2005
5. Jochen Burthardt et al, "Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Pearson Education, 2003
6. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufmann Publishers, 2004
7. Uwe Hansmaan et al, „Principles of Mobile Computing", Springer, 2003
8. Reto Meier, "Professional Android 2 Application Development", Wrox Wiley, 2010.
9. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", Wiley, 2009.

CP7083 INTERNET OF THINGS IN THE CLOUD L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of Internet of Things
- To get an idea of some of the application areas where Internet of Things can be applied
- To understand the middleware for Internet of Things
- To understand the concepts of Web of Things
- To understand the concepts of Cloud of Things with emphasis on Mobile cloud computing
- To understand the IOT protocols

UNIT I INTRODUCTION 10

Definitions and Functional Requirements –Motivation – Architecture - Web 3.0 View of IoT– Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit Approach for End-user Participation in the Internet of Things. Middleware for IoT: Overview – Communication middleware for IoT –IoT Information Security

UNIT II IOT PROTOCOLS 8

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – KNX – Zigbee Architecture – Network layer – APS layer – Security

UNIT III WEB OF THINGS 10

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture

UNIT IV INTEGRATED 9

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things - Network Dynamics: Population Models – Information Cascades - Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small-World Phenomenon

UNIT V APPLICATIONS 8

The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments - Resource Management in the Internet of Things: Clustering, Synchronisation and Software Agents. Applications - Smart Grid – Electrical Vehicle Charging

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify and design the new models for market strategic interaction
- Design business intelligence and information security for WoB
- Analyze various protocols for IoT
- Design a middleware for IoT
- Analyze and design different models for network dynamics

REFERENCES:

1. The Internet of Things in the Cloud: A Middleware Perspective - Honbo Zhou – CRC Press – 2012
2. Architecting the Internet of Things - Dieter Uckelmann; Mark Harrison; Florian Michahelles-(Eds.) – Springer – 2011
3. Networks, Crowds, and Markets: Reasoning About a Highly Connected World - David Easley and Jon Kleinberg, Cambridge University Press - 2010
4. The Internet of Things: Applications to the Smart Grid and Building Automation by -Olivier Hersent, Omar Elloumi and David Boswarthick - Wiley -2012
5. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012

IF7075 MOBILE APPLICATION DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To learn the characteristics of mobile applications.
- To understand the intricacies of UI required by mobile applications.
- To study about the design aspects of mobile application.
- To learn development of mobile applications.

UNIT I INTRODUCTION 9

Mobile Applications – Characteristics and Benefits – Application Model – Infrastructure and Managing Resources – Mobile Software Engineering – Frameworks and Tools – Mobile devices Profiles.

UNIT II USER INTERFACE 9

Generic UI Development – VUIs and Mobile Applications – Text to Speech techniques – Designing the right UI – Multimodal and Multichannel UI – Gesture based UIs – Screen Elements and Layouts – Voice XML – Java API.

UNIT III APPLICATION DESIGN 9

Memory Management – Design patterns for limited memory – Work flow for Application Development – Techniques for composing Applications – Dynamic Linking – Plug ins and rules of thumb for using DLLs – Concurrency and Resource Management – Look and feel.

UNIT IV APPLICATION DEVELOPMENT 9

Intents and Services – Storing and Retrieving data – Communication via the Web – Notification and Alarms – Graphics and Multimedia – Telephony – Location based services – Packaging and Deployment – Security and Hacking.

UNIT V TOOLS **9**

Google Android Platform – Eclipse Simulator – Android Application Architecture – Event based programming – Apple iPhone Platform – UI tool kit interfaces – Event handling and Graphics services – Layer Animation.

TOTAL:45 PERIODS

OUTCOMES:

Upon Completion of the course, the students should be able

- To design and implement the user interfaces for mobile applications.
- To design the mobile applications that is aware of the resource constraints of mobile devices.
- To develop advanced mobile applications that accesses the databases and the web.
- To develop useful mobile applications in the current scenario using Google Android and Eclipse simulator.

REFERENCES:

1. Zigurd Mednieks, Laird Dornin, G, Blake Meike and Masumi Nakamura, “Programming Android”, O‟Reilly, 2011.
2. Reto Meier, Wrox Wiley, “Professional Android 2 Application Development”, 2010.
3. Alasdair Allan, “iPhone Programming”, O‟Reilly, 2010.
4. Wei-Meng Lee, “Beginning iPhone SDK Programming with Objective-C”, Wrox Wiley, 2010.
5. Stefan Poslad, “Ubiquitous Computing: Smart Devices, Environments and interactions”, Wiley, 2009.