FRANCIS XAVIER ENGINEERING COLLEGE
AUTONOMOUS INSTITUTION
ACCREDITED BY NBA
ISO 9001:2015 Certified | DST-FIST Supported Institution
Recognized under Section 2(f) & 12(B) of the UGC Act, 1956
Vannarpettai, Tirunelveli - 627003, Tamil Nadu

CURRICULUM & SYLLABUS

M.E – Communication Systems

Regulations 2019

VISION OF THE DEPARTMENT

To develop Electronics and Communication Engineers by permeating with proficient morals, to be recognized as an adroit engineer worldwide and to strive endlessly for excellence to meet the confronts of our modern society by equipping them with changing technologies, professionalism, creativity research, employability, analytical, practical skills and to excel as a successful entrepreneur

MISSION OF THE DEPARTMENT

- To provide excellence through effective and qualitative teaching-learning process that equips the students with adequate knowledge and to transform the students' lives by nurturing the human values to serve as a precious resource for Electronics and Communication Engineering and nation.
- To enhance the problem solving and lifelong learning skills that will enable by edifying the students to pursue higher studies and career in research.
- To create students with effective communication skills, the abilities to lead ethical values in order to fulfill the social needs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 – Meet Market Demands : Graduates will become a successful engineer to meet the demand driven needs of industries/technical profession

PEO 2 – Core Competence: Graduates will demonstrate core competence in mathematical, scientific and basic engineering fundamentals necessary to formulate, analyze and solve engineering problems and/or also to pursue advanced study or research

PEO 3 – Design and Analysis: Graduates will demonstrate good breadth of knowledge in core areas of Information Technology and related engineering so as to comprehend engineering trade-offs, analyze, design, and synthesize data and technical concepts to create novel designs in solving the real life problems

PEO 4 – Professional Responsibility: Graduates will demonstrate professional responsibility by offering a wide spectrum of consultancy and testing services by addressing social, cultural, economic, sustainability, and environmental considerations in the solution of real world engineering problems

PEO5 – Life-long Learning: Graduates will engage themselves in life-long learning through independent study and by participating in professional activities or continuing education

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. **PSO_a –** An ability to analyze a problem, design algorithm, identify and define the computing requirements appropriate to its solution and implement the same in emerging technology environments like cloud computing, embedded products and real-time systems..
2. **PSO_b –** Knowledge of data and its management techniques for data acquisition, big data, handling of data etc. and enabling students in solving problems using these techniques of data analytics like pattern recognition, knowledge discovery.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES(PEO)	PROGRAMME OUTCOMES (PO)											
	A	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**J**	**k**	**l**
PEO 1				H				L	L	M	M	L
PEO 2	H	H	L	L								M
PEO 3			H			L						H
PEO 4			H		L	M	H	L				
PEO 5												H

MAPPING OF PROGRAMME SPECIFIC OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following Table

PROGRAMME SPECIFIC OBJECTIVES(PEO)	PROGRAMME OUTCOMES (PO)											
	A	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**J**	**k**	**l**
PSO_a	H	M			H				M	M		
PSO_b				H			H	H			H	

Contribution L: Low / Reasonable M: Medium / Significant H:High / Strong

M.E COMMUNICATION SYSTEMS

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

S. No	CATEGORY	CREDITS PER SEMESTER				TOTAL CREDIT	CREDITS IN %
		I	II	III	IV		
2	ES	**4**				**4**	**6%**
3	PC	**15**	**11**			**26**	**37%**
4	PE	**3**	**9**	**9**		**21**	**30%**
5	EEC		**1**	**6**	**12**	**19**	**27%**
TOTAL		**22**	**21**	**15**	**12**	**70**	**100%**

SUMMARY OF CREDIT DISTRIBUTION

ES - Engineering Sciences

PC - Professional Core

PE - Professional Elective

EEC - Employability Enhancement Course

M.E COMMUNICATION SYSTEMS

REGULATIONS 2019

CHOICE BASED CREDIT SYSTEM

I – IV SEMESTERS CURRICULA AND SYLLABI

FIRST SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19MA1256	Applied Mathematics For Communication Engineers	ES	3	1	0	4	4
19CU1601	Advanced Radiation Systems	PC	3	0	0	3	3
19CU1602	Advanced Digital Communication Techniques	PC	3	1	0	4	4
19CU1603	Signal Processing and Baseband Techniques	PC	3	0	0	3	3
19CU1604	Advanced Wireless Communication Techniques	PC	3	0	0	3	3
	Professional Elective I	PE	3	0	0	3	3
19CU1611	Wireless Communication Laboratory	PC	0	0	4	2	4
		TOTAL	**18**	**2**	**4**	**22**	**24**

SECOND SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19CU2601	Advanced Wireless Networks	PC	3	0	0	3	3
19CU2602	MIC and RF System Design	PC	3	0	0	3	3
19CU2603	Millimeter Wave Communication	PC	3	0	0	3	3
	Professional Elective II	PE	3	0	0	3	3
	Professional Elective III	PE	3	0	0	3	3
	Professional Elective IV	PE	3	0	0	3	3
19CU2611	RF and Optical Microwave Laboratory	PC	0	0	4	2	4
19CU2901	Term Paper Writing and Seminar	EEC	0	0	2	1	2
		TOTAL	**18**	**0**	**6**	**21**	**24**

THIRD SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
	Professional Elective V	PE	3	0	0	3	3
	Professional Elective VI	PE	3	0	0	3	3
	Professional Elective VII	PE	3	0	0	3	3
19CU3911	Project Work Phase I	EEC	0	0	12	6	12

TOTAL	**9**	**0**	**12**	**15**	**21**

FOURTH SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19CU4911	Project Work Phase II	EEC	0	0	24	12	24
		TOTAL	**0**	**0**	**24**	**12**	**24**

L - Lecture	**T-Tutorial**	**P- Practical**	**H- Hours**	**C-Credits**

Code No.	**Course**	**L**	**T**	**P**	**C**
PROFESSIONAL ELECTIVES					
PROFESSIONAL ELECTIVE I					
19CU1701	Wireless Transceiver Design	3	0	0	3
19CU1702	Radar and Navigational Aids	3	0	0	3
19CU1703	Advanced Techniques In Image Processing	3	0	0	3
19VL1703	Advanced Microprocessors and Microcontrollers	3	0	0	3
PROFESSIONAL ELECTIVE II					
19CU2701	Communication Network Security	3	0	0	3
19CU2702	OFDM Systems	3	0	0	3
19CU2703	High Speed Switching Architectures	3	0	0	3
19VL2703	DSP Processor Architecture and Programming	3	0	0	3
PROFESSIONAL ELECTIVE III					
19CU2704	Wireless Sensor Networks	3	0	0	3
19CU2705	Advanced Microwave Communication	3	0	0	3
19CU2706	Cognitive Radio Networks	3	0	0	3
19CU2707	Electromagnetic Interference and Compatibility	3	0	0	3
PROFESSIONAL ELECTIVE IV					
19CU2708	Mobile Adhoc Sensor Networks	3	0	0	3
19CU2709	Network Routing Algorithms	3	0	0	3
19CU2710	RF System Design	3	0	0	3

Code No.	Course	L	T	P	C
19VL2708	MEMS and NEMS	3	0	0	3
PROFESSIONAL ELECTIVE V					
19VL3701	Reconfigurable architectures	3	0	0	3
19CU3701	Soft Computing Techniques	3	0	0	3
19CU3702	Video Surveillance Systems	3	0	0	3
19CU3703	Internet of Things	3	0	0	3
PROFESSIONAL ELECTIVE VI					
19CU3704	Software Defined Radio	3	0	0	3
19CU3705	Pattern Recognition And Machine Learning	3	0	0	3
19CU3706	Space Time Wireless Communication	3	0	0	3
19VL3704	Network on Chip	3	0	0	3
PROFESSIONAL ELECTIVE VII					
19CU3707	Ultra Wideband Communication	3	0	0	3
19CU3708	Network Management	3	0	0	3
19CU3709	Network Processors	3	0	0	3
19VL3707	Hardware – Software Co-Design	3	0	0	3

SEMESTER –I

Code No.	Course	Category	L	T	P	C	H
19MA1256	Applied Mathematics For Communication Engineers	BS	3	1	0	4	4
19CU1601	Advanced Radiation Systems	PC	3	0	0	3	3
19CU1602	Advanced Digital Communication Techniques	PC	3	1	0	4	4
19CU1603	Signal Processing and Baseband Techniques	PC	3	0	0	3	3
19CU1604	Advanced Wireless Communication Engineering	PC	3	0	0	3	3
	Professional Elective I	PE	3	0	0	3	3
19CU1611	Wireless Communication Laboratory		0	0	4	2	4
		TOTAL	**18**	**2**	**4**	**22**	**24**

19MA1256 APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS LTPC 3 1 0 4

Course Objectives:

- To demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in communication engineering.
- To identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools

Course Outcomes:

After completing this course, students should demonstrate competency in the following skills:

Concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors.

- Apply various methods in linear algebra to solve system of linear equations.
- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Numerical solution of differential equations by single and multistep methods.
- Computation of probability, random variables and their associated distributions, correlations and regression.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.
- Using discrete time Markov chains to model com

UNIT I LINEAR ALGEBRA **12**

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization - Generalized eigenvectors – Canonical forms – Singular value decomposition and applications - Pseudo inverse – Least square approximations

UNIT II LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method -Transportation problems - Assignment models

UNIT III NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Runge - Kutta method of fourth order for system of IVPs - Numerical stability of Runge - Kutta method - Adams - Bashforth multistep method - Shooting method, BVP : Finite difference method and collocation method.

UNIT IV PROBABILITY AND RANDOM VARIABLES **12**

Probability –Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT V QUEUEING MODELS **12**

Poisson Process – Markovian queues – Single and multi - server models – Little‟s formula Steady state analysis.

Total :**60 Periods**

REFERENCES:

1. Bronson, R. and Costa, G. B., “Linear Algebra”, 2nd Edition, Academic Press, 2007.

2. Burden, R. C. and Faires, J. D., "Numerical Analysis ", 9th Edition, Cengage Learning, 2016.

3. Gross, D., Shortle, J.F., Thompson, J. M. and Harris, C. M., "Fundamentals of Queueing Theory “, 4th Edition, Wiley, 2014.

4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‟s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

5. Sastry, S. S., "Introductory Methods of Numerical Analysis ", 5th Edition, PHI Learning, 2015.

6. Taha H.A., “Operations Research: An Introduction”, 9th Edition, Pearson Education Asia, New

19CU1601 ADVANCED RADIATION SYSTEMS L T P C 3 0 0 3

Course Objectives

- To understand antenna radiation and its parameters.
- To enhance the student knowledge in the area of various antenna design.
- To design mono pole, dipole and patch antenna and to impart the knowledge about modern antennas.

Course Outcomes

1. Ability to understand antenna concepts
2. Ability to design antenna for various applications
3. Knowledge of modern antenna design

UNIT I ANTENNA FUNDAMENTALS

Antenna Parameters - radiation pattern, HPBW,FNBW, gain and directivity, polarization, radiation resistance, Input impedance , Radiation from surface and line current distributions – dipole, monopole, Image theory; Induction, reciprocity theorem, BALUN, Introduction to numerical techniques

UNIT II RADIATION FROM APERTURE ANTENNA

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

UNIT III ANTENNA ARRAYS

Introduction-General structure of phased array, linear array, phased array, frequency scanned arrays, beam forming, MEMS technology in phased arrays-Retro directive and self-phased arrays-Binomial array

UNIT IV MICRO STRIP ANTENNA

Radiation mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch ,input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of micro strip array antenna.

UNIT V SPECIAL ANTENNAS AND MEASUREMENTS

Mobile phone antenna,base station, hand set antenna, UWB antenna, Antenna for automobiles, Broadband antenna, antenna factor, Gain, impedance and radiation pattern measurements, Test sites and anechoic chamber.

Total: 45 Periods

REFERENCES

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 1982.
2. Hubregt.J.Visser “Antenna Theory and Applications” 1st Edition, John Wiley & Sons Ltd,New York,2012
3. S.Drabowitch et.al., ”Modern Antennas”, 2nd Edition Springer science business Media,Inc.2005
4. Xavier Begaud, “Ultra Wide Band Antennas” , 1st Edition, ISTE Ltd and John Wiley & Sons Ltd, New York,2013
5. Zhijun Zhang” Antenna Design for Mobile Devices” 1st Edition, John Wiley & Sons (Asia) Ltd, New York,2011
6. Krauss.J.D, “Antennas”, II edition, John Wiley and sons, New York, 1997

7. Microstrip Patch Antennas (Second Edition) , Kai Fong Lee, Kwai Man Luk, Hau Wah Lai , 2nd edition ,world scientific publishing company Pte limited, 2018..

19CU1602 ADVANCED DIGITAL COMMUNICATION TECHNIQUES L T P C 3 1 0 4

Course Objectives:

- To understand the basics of signal-space analysis and digital transmission.
- To understand the coherent and noncoherent receivers and its impact on different channel characteristics.
- To understand the different Equalizers
- To understand the different block coded and convolutional coded digital communication systems.
- To understand the basics of Multicarrier and Multiuser Communications.

Course Outcomes:

1. Upon Completion of the course, the students will be able to:
2. Develop the ability to understand the concepts of signal space analysis for coherent and non-coherent receivers.
3. Conceptually appreciate different Equalization techniques
4. Possess knowledge on different block codes and convolutional codes.
5. Comprehend the generation of OFDM signals and the techniques of multiuser detection.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION 9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherentreceivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partiallycoherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization-Bit synchronization.

UNIT II EQUALIZATION TECHNIQUES 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon‟s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrumcommunication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay;Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation anddemodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

Total: 45 Periods

REFERENCES:

1. Bernard Sklar, "Digital Communications", second edition, Pearson Education, 2001.
2. John G. Proakis, "Digital Communication", Fifth Edition, McGraw Hill Publication,2008.
3. M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection", Prentice Hall of India, New Delhi, 1995.
4. Richard Van Nee &Ramjee Prasad, "OFDM for Multimedia Communications" Artech House Publication, 2001.
5. Stephen G. Wilson, "Digital Modulation and Coding", First Indian Reprint, Pearson Education, 2003.
6. Simon Haykin, "Digital communications", John Wiley and sons, 1998.
7. Theodore S.Rappaport, „Wireless Communications", 2nd edition, Pearson Education, 2002.

19CU1603 SIGNAL PROCESSING AND BASEBAND TECHNIQUES L T P C 3 0 0 3

Course 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.

Course Outcomes

1. 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.
2. 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.

3. The student would be in a position to apply his knowledge for designing a baseband system addressing the channel impairments.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, 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, NeymanPeason, 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

REFERENCES:

1. Monson H. Hayes, ‗Statistical Digital Signal Processing and Modeling‖, John Wiley and Sons, Inc, Singapore, 2002

2. John G. Proakis., ‗Digital Communication‘, 4 th edition, McGraw Hill Publication, 2001.

3. John J. Proakis, Dimitris G. Manolakis, : Digital Signal Processing‘, Pearson Education, 2002.

4. Bernard Sklar and Pabitra Kumar Roy, Digital Communications: Fundamentals & Applications, 2/E, Pearson Education India, 2009

5. John G. Proakis, MasoudSalehi, ―Communication Systems Engineering‖, Prentice Hall, 1994.

6. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw a. -Hill, 2000.

19CU1604 ADVANCED WIRELESS COMMUNICATION TECHNIQUES L T P C 3 0 0 3

Course Objectives:

- 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.
- To enable the student to understand the different power saving strategies and energy efficient signal, system and network design.
- 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.

Course Outcomes

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

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 multi cell 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

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

6.. Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press 2005.

19CU1611 WIRELESS COMMUNICATION LABORATORY L T P C 0 0 4 2

Course Objectives

- To acquire knowledge on Transmission line and S- parameter estimation of microwave devices
- To introduce the basics of Microstrip Patch Antenna and its analysis.
- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms

Course Outcomes

1. Measure and analyze various transmission line parameters.
2. Design Microstrip patch antennas
3. Implement the adaptive filtering algorithms
4. To generate and detect digital communication signals of various modulation techniques using MATLAB.
5. Evaluate cellular mobile communication technology and propagation model.

LIST OF EXPERIMENTS USING NETWORK ANALYZER:

1. Measurement of transmission line parameters
2. S-parameter estimation of Microwave devices.
3. Design and testing of a Microstrip coupler.
4. Characteristics of Microstrip patch antenna

LIST OF EXPERIMENTS USING APPROPRIATE SIMULATION TOOLS:

1. Generation & detection of binary digital modulation techniques.
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS
3. Digital Filter Design
4. Performance evaluation of simulated CDMA system
5. Channel equalizer design(LMS,RLS)
6. Antenna Radiation Pattern measurement

Total: 45 Periods

SECOND SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
19CU2601	Advanced Wireless Networks	PC	3	0	0	3	3
19CU2602	MIC and RF System Design	PC	3	0	0	3	3
19CU2603	Millimeter Wave Communication	PC	3	0	0	3	3
	Professional Elective II	PE	3	0	0	3	3
	Professional Elective III	PE	3	0	0	3	3
	Professional Elective IV	PE	3	0	0	3	3
19CU2611	RF and Optical Microwave Laboratory	PC	0	0	4	2	4
19CU2901	Term Paper Writing and Seminar	EEC	0	0	2	1	2
		TOTAL	**18**	**0**	**6**	**21**	**24**

19CU2601 ADVANCED WIRELESS NETWORKS L T P C 3 0 0 3

Course Objectives:

- To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- To study about wireless IP architecture, Packet Data Protocol and LTE network architecture.
- To study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- To study about mobility management, cellular network, and micro cellular networks.

Course Outcomes:

- Familiar with the latest 4G networks and LTE
- Understand about the wireless IP architecture and LTE network architecture.

- Familiar with the adaptive link layer and network layer graphs and protocol.
- Understand about the mobility management and cellular network.
- Understand about the wireless sensor network architecture and its concept.

UNIT I INTRODUCTION 9

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTEA - Wireless Standards. Network Model-Network Connectivity-Wireless Network Design with Small World Properties

UNIT II WIRELESS IP NETWORK ARCHITECTURES 9

3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain – LTE network Architecture - Roaming Architecture- Protocol Architecture- Bearer Establishment Procedure - Inter-Working with other RATs.

UNIT III ADAPTIVE LINK AND NETWORK LAYER 9

Link Layer Capacity of Adaptive Air Interfaces-Adaptive Transmission in Ad Hoc Networks Adaptive Hybrid ARQ Schemes for Wireless Links-Stochastic Learning Link Layer Protocol Infrared Link Access Protocol-Graphs and Routing Protocols-Graph Theory-Routing with Topology Aggregation-Network and Aggregation Models

UNIT IV MOBILITY MANAGEMENT 9

Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution Mobility Prediction in Pico- and Micro-Cellular Networks

UNIT V QUALITY OF SERVICE 9

QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearer sand QoSin LTE networks.

Total : 45 Periods

TEXT BOOKS:

1. Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, “Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach”, John Wiley & Sons, 2014.

2. Crosspoint Boulevard, “Wireless and Mobile All-IP Networks”, Wiley Publication, 2005.

REFERENCES:

1. Jyh-Cheng Chen and Tao Zhang, “IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols”, John Wiley & Sons, Inc. Publication,2006.

2. Minoru Etoh, “Next Generation Mobile Systems3G and Beyond,” Wiley Publications,2005.

3. Stefania Sesia, Issam Toufik and Matthew Baker, “LTE – The UMTS Long Term Evolution From Theory to Practice”, John Wiley & Sons, Inc. Publication, Second Edition, 2011.

4. Savo Glisic," advanced wireless networks-technology and business models", Third Edition, John Wiley & Sons, Ltd, 2016

5. Savo Glisic,"Advanced Wireless Networks-4G Technologies", John Wiley & Sons, Ltd,2006

19CU2602 MIC AND RF SYSTEM DESIGN L T P C 3 0 0 3

Course Objectives

- To enhance the students' knowledge in the area of planar microwave engineering and to make them understand the intricacies in the design of microwave circuits.
- To learn RF design and circuit board components

Course Outcomes

- Able to understand various RF issues.
- Able to gain knowledge of impedance transformation.
- To be able to analyze RF circuits.
- Describe the fundamentals to recent techniques in MIC technology.
- Independently design and assess the performance of various planar configurations

UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 9

CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match, Single ended and differential schemes.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

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

UNIT IV RF FILTER, OSILLATOR, MIXER 9

Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers - phase locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.

UNIT V MIC COMPONENTS 9

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.

Total: 45 Periods

Text Book:

1. B.Razavi, "RF Microelectronics", Pearson Education, 1997.

REFERENCES:

1. Ingo Wolff," Coplanar Microwave Integrated circuits", John Wiley and sons, New Jersey, 2006.
2. T. Lee,"Design of CMOS RF Integrated Circuits", Cambridge, 2004.
3. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, 2006.
4. Samuel Y.Liao , Microwave Devices and Circuits, Pearson Education, 2012.
5. Gupta K.C. and Amarjit Singh, ―Microwave Integrated Circuits‖, John Wiley, New York, 1975.
6. C. Gentili, ―Microwave Amplifiers and Oscillators‖, North Oxford Academic, 1986.

19CU2603 MILLIMETER WAVE COMMUNICATION L T P C 3 0 0 3

Course Objectives

- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To know the antenna design at Millimeter wave frequencies**.**

Course Outcomes:

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

- Discuss satellite navigation and global positioning system
- Outline deep space networks and inter planetary missions

UNIT I INTRODUCTION TO MILLIMETER WAVE COMMUNICATIONS 9

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

UNIT II MM WAVE DEVICES AND CIRCUITS 9

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC‟s and DAC‟s.

UNIT III MM WAVE COMMUNICATION SYSTEMS 9

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

UNIT IV MM WAVE MIMO SYSTEMS 9

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

UNIT V ANTENNAS FOR MM WAVE SYSTEMS 9

Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Deviceto Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL PERIODS : : 45

REFERENCES:

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

3. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

19CU2901 TERM PAPER WRITING AND SEMINAR L T P C 0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the author’s contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.

8. Preparing conclusions based on the reading of all the papers.

9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried out,

Activity	**Instructions**	**Submission week**	**Evaluation**
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being	4th week	**6%** (the list of standard papers and reason for selection)

	considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and Compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5% (clarity)**
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

19CU2611 RF AND OPTICAL MICROWAVE LABORATORY L T P C 0 0 4 2

Course Objective:

- Understand the working principle of optical sources, detector, fibers and microwave components
- Develop understanding of simple optical communication link.
- Learn about the characteristics and measurements in optical fiber
- Know about the behavior of microwave components.
- Practice microwave measurement procedures

Course Outcomes

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

1. Analyze the performance of simple optical link.
2. Test microwave and optical components.
3. Analyze the mode characteristics of fiber
4. Analyze the radiation of pattern of antenna

MICROWAVE EXPERIMENTS

1. Reflex klystron or Gunn diode characteristics and basic microwave parameter measurement such as VSWR, frequency, wavelength.

2. Directional Coupler Characteristics.

3. Radiation Pattern of Horn Antenna.

4. S-parameter Measurement of the following microwave components (Isolator, Circulator, E plane Tee, H Plane Tee, Magic Tee)

5. Attenuation and Power Measurement

OPTICAL NETWORK EXPERIMENTS:

1.Comparison of WDM Routing and Wavelength Assignment Algorithms Using Simulation

2. Characterization and Comparison of Direct and External Modulation Schemes Using Simulation

3. Characterization of linear and non-linear behaviour of SMF, DSF and NZDSF Using Simulation

4. Characterization and Comparison of Optical Multiplexing techniques Using Simulation

5. Characterization and Comparison of Optical Filters Using Simulation

6. Characterization and Comparison of Optical Amplifiers Using Simulation

Total: 45 Periods

THIRD SEMESTER							
Code No.	**Course**	**Category**	**L**	**T**	**P**	**C**	**H**
	Professional Elective V		3	0	0	3	3
	Professional Elective VI		3	0	0	3	3
	Professional Elective VII		3	0	0	3	3
19CU3911	Project Work Phase I		0	0	12	6	12
		TOTAL	**9**	**0**	**12**	**15**	**21**

PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE I					
19CU1701	Wireless Transceiver Design	3	0	0	3
19CU1702	Radar and Navigational Aids,	3	0	0	3
19CU1703	Advanced Techniques In Image Processing	3	0	0	3
19VL1703	Advanced Microprocessors and Microcontrollers	3	0	0	3

19CU1701 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

Course Outcomes:

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

1. Design RF system for a given specification
2. Discuss the abnormalities present in the transceiver architectures
3. Estimate the system performance utilizing the models.

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 periods: 45

REFERENCES:

1. QizhengGu, ―RF System Design of Transceivers for Wireless Communications‖, Springer, 2005

2. K P Pun, J E D Franca and C ALeme, ―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

19CU1702 RADAR AND NAVIGATIONAL AIDS L T P C 3 0 0 3

Course Objectives

- To enable the student to understand the basic principles of radar operation and the different types of radars an applications.
- To enable the student to understand the different systems involved in radar configuration, the signal processing aspects to accurately detect and interpret signals and the antenna systems for signal capture.
- To enable the student to understand the role of radar systems as navigational and landing aid**.**

Course Outcomes:

1. The student would demonstrate an understanding of the basic principles of radar design.
2. The student would be able to identify suitable navigation systems and their usage for a given application scenario.

3. The student would be familiar with the use of navigational systems for estimating and measuring the parameters and analyzing and interpreting them

UNIT I RANGE EQUATION AND TYPES OF RADAR 9

Basic Radar, Radar equation, Radar parameters, Block diagram, Radar frequencies. Types of Radar: CW, Doppler, MTI, FMCW, Pulsed, Tracking Radar. DSP in Radar (MTD1).

UNIT II RADAR SYSTEM CONCEPTS 9

Different type of Noise, Noise figure, LNA. False alarm & Missed detection, Radar cross section, TR, ATR, Types of Displays -Color CRT, Bright displays, synthetic video displays, A scope, PPI**.**

UNIT III SIGNAL PROCESSING 9

Detection of radar signals in Noise and clutter, detection of non-fluctuating target in noise, Matched filter, Matched filter response to delayed Doppler shifted signals, Radar measurements. Doppler Processing, Linear FM Pulse Compression, Passive System: Digital compression, SAW pulse compression. Signal processing in Antenna arrays**.**

UNIT IV RADIO NAVIGATION AND LANDING AIDS 9

General principles, Radio compass (NDB), ADF, VOR, DME., Hyperbolic Navigation DECCA,OMEGA, LORAN, Mechanics of Landing: Instrument Landing System, Microwave Landing System.

UNIT V SATELLITE NAVIGATION AND HYBRID NAVIGATION SYSTEM 9

Basics of Satellite Navigation, Introduction to Global Positioning System., System Description, Basic principles, position, velocity determination, Signal structure- DGPS, Integration of GPS & INS.

Total : 45 Periods

References

1. M.I.Skolnik ,―Introduction to Radar Systems‖, Tata McGraw Hill 2006.
2. Myron Kyton and W.R.Fried ―Avionics Navigation Systems‖ John Wiley &Sons 1997.

3. Nagaraja ―Elements of Electronic Navigation‖ Tata McGraw Hill, 2nd ed, 2000.

4. Albert Helfrick. D, ‗Principles of Avionics', Avionics communications Inc., 2004

5. Nathansan, ―Radar design principles-Signal processing and environment‖, 2/e, PHI, 2007.

6. Hofmann-Wellenhof, Hlichlinegger and J.Collins, ―GPS Theory and Practice‖, 5/e SpringerInternational Edition, 2007.

7. Roger J.Sullivan, ―Radar foundations for Imaging and advanced concepts‖, PHI,2004.

19CU1703 ADVANCED TECHNIQUES IN IMAGE PROCESSING L T P C 3 0 0 3

Course Objectives

1. To understand the image fundamentals.
2. To understand the various image segmentation techniques.
3. To extract features for image analysis.
4. To introduce the concepts of image registration and image fusion.
5. To illustrate 3D image visualization.

Course Outcomes

: Upon Completion of the course, the students will be able to

1. Explain the fundamentals digital image processing.
2. Describe image various segmentation and feature extraction techniques for image analysis.
3. Discuss the concepts of image registration and fusion.
4. Explain 3D image visualization.

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing.

UNIT II SEGMENTATION 9

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

UNIT III FEATURE EXTRACTION 9

First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV REGISTRATION AND IMAGE FUSION 9

Registration - Preprocessing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, wavelet based fusion -region based fusion.

UNIT V 3D IMAGE VISUALIZATION 9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

Total: 45 Periods

References:

1. ArdeshirGoshtasby, " 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications",John Wiley and Sons,2005.
2. Anil K. Jain, Fundamentals of Digital Image Processing', Pearson Education, Inc., 2002.
3. John C.Russ, "The Image Processing Handbook", CRC Press,2007.
4. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press,2008.
5. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson,Education, Inc.,Second Edition, 2004.
6. Rick S.Blum, Zheng Liu, "Multisensor image fusion and its Applications", Taylor& Francis,2006.

19VL1703 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS L T P C 3 0 0 3

Course Objectives

1. To study 80386 and Pentium processor.
2. To understand CISC and RISC Architectures.
3. To Learn ARM processor.

Course Outcomes

1. Discuss 80386 and Pentium Processor.
2. Introduction to RISC architectures.
3. Discuss the register and memory management system of ARM processor.
4. Outline ARM instruction set and addressing modes.
5. Explain PIC microcontroller and motorola 68HC11 microcontroller.

UNIT I 80386 AND PENTIUM PROCESSOR 9

80386 PROCESSOR: Basic programming model – Memory organization – Data types – Instruction set - Addressing mode – Address translation – Interrupts –PENTIUM PROCESSOR: Introduction to Pentium processor architecture – Special Pentium Registers – Pentium Memory Management – Introduction to Pentium pro processor – Pentium Pro Special Features.

UNIT II CISC and RISC Architecture 9

Introduction to RISC architectures: RISC Versus CISC – RISC Case studies: MIPS R4000 – SPARC – Intel i860 - IBM RS/6000.

UNIT III ARM PROCESSOR 9

ARM Programmer"s Model – Registers – Processor Modes – State of the processor – Condition Flags – ARM Pipelines – Exception Vector Table – ARM Processor Families – Typical 3 stage pipelined ARM organization–Introduction to ARM Memory Management Unit.

UNIT IV ARM ADDRESSING MODES AND INSTRUCTION SET 9

ARM Addressing Modes – ARM Instruction Set Overview – Thumb Instruction Set Overview – LPC210X ARM Processor Features.

UNIT V PIC MICROCONTROLLER AND MOTOROLA 68HC11 MICROCONTROLLER 9

Instruction set, addressing modes – operating modes- Interrupt system- RTC-Serial Communication Interface – A/D Converter PWM and UART. MOTOROLA: CPU Architecture – Instruction set – interrupts- Timers- I 2C Interfacing –UART- A/D Converter – PWM

Total: 45 Periods

References:

1. Andrew Sloss, "ARM System Developers Guide", Morgan Kaufmann Publishers, 2005.
2. Barry B Brey, "The Intel Microprocessor, Pentium and Pentium Pro Processor, Architecture Programming and Interfacing", Prentice Hall of India, 2002.
3. Daniel Tabak, "Advanced Microprocessors", McGraw Hill Inc., 1995.
4. David E Simon "An Embedded Software Primer", Pearson Education, 2007.
5. Gene .H.Miller ." Micro Computer Engineering ," Pearson Education , 2003.
6. Intel, "Microprocessors, Vol-I &Vol-II", Intel Corporation, USA, 1992.
7. John .B.Peatman , " Design with PIC Microcontroller , Prentice hall, 1997.
8. Mohammed Rafiquzzaman, "Microprocessors and Microcomputer Based System Design", Universal Book Stall, New Delhi, 1990.
9. Steve Furber, "ARM System-on-Chip Architecture", Pearson Education, 2005 "ARM7 TDMI Technical Reference Manual", ARM Ltd., UK, 2004 6.

PROFESSIONAL ELECTIVE II					
19CU2701	Communication Network Security	3	0	0	3
19CU2702	OFDM Systems	3	0	0	3
19CU2703	High Speed Switching Architectures	3	0	0	3
19VL2703	DSP Processor Architecture and Programming	3	0	0	3

19CU2701 COMMUNICATION NETWORK SECURITY L T P C 3 0 0 3

Course Objectives

- To make the student understand the importance and goals of communication network and information security and introduce him to the different types of attacks.
- To expose the student to the different approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.
- To enable the student to appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.

Course Outcomes

1. To demonstrate an understanding of the ways in which communication network security.
2.To understand the basic principles of security algorithm design.
3.To understand the concept of authentication and key management.
4.To understand the concept of security.
5.To study the concept of wireless network security.

UNIT I INTRODUCTION ON SECURITY 9

Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability. Security services and mechanisms, Techniques: Cryptography, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers- Steganography- Revision on Mathematics for Cryptography.

UNIT II SYMMETRIC & ASYMMETRIC KEY ALGORITHMS 9

Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, principle of asymmetric key algorithms, RSA Cryptosystem

UNIT III INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT 9

Message Integrity, Hash functions: SHA 512, Whirlpool, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

UNIT IV NETWORK SECURITY, FIREWALLS AND WEB SECURITY 9

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security

associations, Key Management. E-mail security: PGP, MIME,S/MIME. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature

UNIT V WIRELESS NETWORK SECURITY 9 Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for Broadband networks: Secure Ad hoc Network, Secure Sensor Networks

Total: 45 Periods

REFERENCES:

1. Behrouz A. Forouzan ,"Cryptography and Network security"McGraw- Hill, 2011
2. William Stallings,"Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India,New Delhi, 2002.
3. Atul Kahate ,"Cryptography and Network security", 2nd Edition, Tata McGraw-Hill, 2008.
4. R.K.Nichols and P.C. Lekkas ,"Wireless Security: Models , threats and Solutions", McGraw-Hill, 2001.
5. H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, Feb. 2004.
6. Securing Ad Hoc Networks, IEEE Network Magazine, vol. 13, no. 6, pp. 24-30, December 1999.

19CU2702 OFDM SYSTEMS L T P C 3 0 0 3

Course Objectives

- To learn the concepts of OFDM and channel models
- To have a knowledge of the basics of OFDM and Synchronization error
- To study the signal processing and channel estimation aspects of OFDM
- To understand the interleaving and coding techniques in OFDM
- To understand the peak power problem and the methods of reducing it.

Course Outcomes

- Understanding of application of OFDM for communication systems.
- Knowledge of various techniques and aspects of OFDM.
- Discussion about design and simulation of modulation and coding techniques using software
- Learn the problems in OFDM and Hybrid OFDM.

UNIT I BASEBAND DATA TRANSMISSION 9

Baseband PAM –One Shot Minimum Distance Receiver –Minimum Distance Sequence Detection — M-arysignaling scheme-shaping of the transmitted signal spectrum-Noise in Baseband System -

Coherent and Non coherent Technique, Orthogonal Modulation – OFDM modulation and Demodulation –Multidimensional Modulation-Modulation with Memory.

UNIT II BAND-LIMITED CHANNELS 9

Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel Models: Fading Dispersive channel, Time and Frequency Selective, Rayleigh channel, karhunen- Loeve Expansion; Diversity Technique: Space, polarization, path, angle, Time and frequency, Diversity Combining Technique'

UNIT III EQUALIZATION 9

Optimal Zero-Forcing Equalization- Generalized Equalization Methods- Fractionally Spaced Equalizer –Transversal Filter Equalizer –ISI and Channel Capacity –Constrained –complexity Equalizers – Adaptive Linear Equalizer – Adaptive DFE.

UNIT IV DETECTION 9

Detection of a Single Real-Valued Symbol- Detection of a Signal Vector –Known Signals in Gausian Noise –ML Sequence Detection with the Viterbi Algorithm – A Posteriori Probability Detection with BCJR- Symbol Error Probability for MLSD – incoherent Detection –Shot Noise Signal with known Intensity.Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection.

UNIT V FUNDAMENTALS OF ESTIMATION THEORY 9

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

REFERENCE(S)

1. John R Barry, Edward Lee and David G. Messerschmitt, Digital Communication, Springer,2008.
2. John G. Proakis, Digital Communications, McGraw –Hill International Edition, 2009.
3. Simon Haykin, Communication Systems, PHI, 2008.
4. BemardSklar, Digital Communications: Fundamentals and Applications, Prentice Hall, 2001.
5. Bikash Kumar Dey, Digital Communication, NPTEL courseware 2008
6. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques:Signaling and detection, Prentice Hall India, N. Delhi, 1995.
7. Bernard C. Levy, Principles of Signal Detection and Parameter Estimation, Springer, 2008.

19CU2703 HIGH SPEED SWITCHING ARCHITECTURES L T P C

3 0 0 3

Course Objectives

- To enable the student to understand the basics of switching technologies and their implementation LANs, ATM networks and IP networks.
- To enable the student to understand the different switching architectures and queuing strategies and their impact on the blocking performances.
- To expose the student to the advances in packet switching architectures and IP addressing and switching solutions and approaches to exploit and integrate the best features of different architectures for high speed switching.

Course Outcomes

1.The student would be able to identify suitable switch architectures for a specified networking scenario and demonstrate its blocking performance.

2.The student would be in a position to apply his knowledge of switching technologies, architectures and buffering strategies for designing high speed communication networks and analyse their performance

UNIT I LAN SWITCHING TECHNOLOGY 9

Switching Concepts - LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs.

UNIT II ATM SWITCHING ARCHITECTURES 9

Blocking networks - basic - and- enhanced banyan networks, Sorting networks - merge sorting, Rearrangable networks - full-and- partial connection networks, Non blocking networks - Recursive network construction, Comparison of non-blocking network, Switching with deflection routing - Shuffle switch, Tandem banyan switch.

UNIT III QUEUES IN ATM SWITCHES 9

Internal Queuing -Input, output and shared queuing, multiple queuing networks – Combined Input, output and shared queuing - Performance analysis of Queued switches.

UNIT IV PACKET SWITCHING ARCHITECTURES 9

Architectures of Internet Switches and Routers- Bufferless and buffered Crossbar switches, Multistage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars.

UNIT V IP SWITCHING 9

Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Ipv6 over ATM.

Total: 45 Periods

References:

1. AchillePattavina, ―Switching Theory: Architectures and performance in Broadband ATM networks ",John Wiley & Sons Ltd, New York. 1998

2. Rich Siefert, Jim Edwards, ―The All New Switch Book – The Complete Guide to LAN Switching Technology‖, Wiley Publishing, Inc., Second Edition, 2008.

3. Elhanany M. Hamdi, ―High Performance Packet Switching architectures‖, Springer Publications, 2007.

4. Christopher Y Metz, ―Switching protocols & Architectures‖, McGraw - Hill Professional Publishing, NewYork.1998.

5. Rainer Handel, Manfred N Huber, Stefan Schroder, ―ATM Networks - Concepts Protocols, Applications‖, 3rd Edition, Addison Wesley, New York. 1999.

19VL2703 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING L T P C 3 0 0 3

Course Objectives

The objective of this course is to provide in-depth knowledge on

- Digital Signal Processor basics
- Third generation DSP Architecture and programming skills
- Advanced DSP architectures and some applications.

Course Outcomes

Students should be able to:

- Become Digital Signal Processor specialized engineer
- DSP based System Developer

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II TMS320C5X PROCESSOR 9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III TMS320C6X PROCESSOR 9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ADSP PROCESSORS 9

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

UNIT V ADVANCED PROCESSORS 9

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

TOTAL: 45 PERIODS

References:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012

2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.

3. Rulph Chassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, A John Wiley & Sons, Inc., Publication, 2005

4. User guides Texas Instrumentation, Analog Devices, Motorola.

PROFESSIONAL ELECTIVE III					
19CU2704	Wireless Sensor Networks	3	0	0	3
19CU2705	Advanced Microwave Communication	3	0	0	3
19CU2706	Cognitive Radio Networks	3	0	0	3
19CU2707	Electromagnetic Interference and Compatibility	3	0	0	3

19CU2704 WIRELESS SENSOR NETWORKS L T P C 3 0 0 3

Course Objectives

- To enable the student to understand the role of sensors and the networking of sensed data for different applications.
- To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario.
- To enable the student to understand the challenges in synchronization and localization of sensor nodes, topology management for effective and sustained communication, data management and security aspects.

Course Outcomes

1. To understand the concept of Wireless Sensor Network.
2. To understand the concept of Architecture.

3. To know the concept of MAC and Routing
4. To understand the concept of infrastructure establishment control.
5. To design the data management system.

UNIT I OVERVIEW OF WIRELESS SENSOR NETWORKS 9

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks.

UNIT II ARCHITECTURES 9

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Considerations

UNIT III MAC AND ROUTING 9

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V DATA MANAGEMENT and SECIRUTY 9

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

Total: 45 Periods

Text Book:

1. Ian F. Akyildiz, Mehmet Can Vuran, ― Wireless Sensor Networks, John Wiley, 2010

References:

1. Yingshu Li, My T. Thai,Weili Wu, ― Wireless Sensor Networks and Applications‖ Springer 2008
2. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.
3. Feng Zhao & Leonidas J. Guibas, ―Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

4. KazemSohraby, Daniel Minoli, &TaiebZnati, ―Wireless Sensor Networks-s Technology, Protocols, And Applications, John Wiley, 2007.

5. Anna Hac, ―Wireless Sensor Network Designs‖, John Wiley, 2003.

19CU2705 ADVANCED MICROWAVE COMMUNICATION L T P C 3 0 0 3

Course Objectives

- To enable the student to understand the basic principles of microwave amplifiers and oscillators,
- passive component characteristics, resonators and filters, antennas and microwave radio link
- characterization.

Course Outcomes

- The student would be able to design a microwave system taking into account the path losses and
- fading channel characteristics, carry out measurements and interpret results obtained

UNIT I MICROWAVE AMPLIFIERS AND OSCILLATORS 9

Klystron Amplifier – Reflex Klystron Amplifier –Travelling wave tube Amplifier – Magnetron Oscillator and Modulator-Varactor diode – Solid State Broad band Amplifiers – diode detector and mixer-- YIG tuned Oscillators– Comb generators. GUNN, Tunnel IMPATT diode oscillators.

UNIT II MICROWAVE PASSIVE COMPONENTS 9

Scattering parameters-S-Matrix – Attenuator –Phase shifters – T Junctions – Hybrid T Junctions – Directional couplers – Isolater, Properties of ferrite devices – YIG devices—Step recovery Diodes– Gyrator – Circulator – Scattering parameter measurement.

UNIT III MICROWAVE RESONATORS AND FILTERS 9

Review of resonant circuits – principle of Microwave resonators – field analysis of cavity resonators – Characteristics of filters –YIG tuned filters – Filter and resonant applications – SRD Frequency multipliers and frequency Discriminators.

UNIT IV MICROWAVE ANTENNAS 9

Characteristics of Microwave Antennas – Half Wave Dipole –Array – Horn –Paraboloidal Reflector – feeds – Lens and slot Antennas – Leaky and surface wave Antennas – Broad band Antennas – Micro strip Antennas – Antenna measurements.

UNIT V MICROWAVE RADIO SYSTEM 9

Types of propagation – Line of sight transmission – Radio horizon – Broadband Microwave Surveillance Receivers—ELINT and Electronic support measures--Microwave links- Repeaters – Diversity – frequency and space diversity systems – Fading – System gain and path losses – Noise and Absorption in Microwave links.

Total : 45 Periods

REFERENCES:

1. Roddy.D., ―Microwave Technology‖ Reston Publications.1986.
2. Chatterjee R. ―Microwave Engineering ―East West Press. 1988.
3. Rizzi.P.‖Microwave Engineering Passive circuits‖. Prentice Hall.1987
4. Tomasi.W ―Advanced Electronic communication systems ―Prentice Hall.1987.
5. Clock.P.N. ―Microwave Principles and Systems‖ Prentice Hall.1986.
6. Combes, Graffewil and Sauterean ―Microwave Components, Devices and Active
7. Circuits‖. John wiley.1987.
8. Annapurana Das.Sisir.K.Das, Microwave Engineering‖ Tata McGraw Hill, 2000.

19CU2706 COGNITIVE RADIO NETWORKS L T P C 3 0 0 3

COURSE OBJECTIVES:

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

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.

UNIT I SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE 9

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

UNIT II COGNITIVE RADIOS AND ITS ARCHITECTURE 9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases,

Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architechture.

UNIT III SPECTRUM SENSING AND IDENTIFICATION 9

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

UNIT IV USER COOPERATIVE COMMUNICATIONS 9

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

UNIT V INFORMATION THEORETICAL LIMITS ON CR NETWORKS 9

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

Total : 45 Periods

REFERENCES:

1. Alexander M. Wyglinski, MaziarNekovee, 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, ShantidevMohanty, ― NeXt generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks, May 2006.

7. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, "Cognitive Radio-An Enabler for Internet of things", River Publishers, 2017

19CU2707 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C 3 0 0 3

Course Objectives

The basics of EMI

1. EMI sources.
2. EMI problems.
3. Solution methods in PCB.
4. Measurements techniques for emission.

Course Outcomes

1. Identify Standards
2. Understand various coupling mechanism
3. Discuss EMI mitigation techniques
4. Analyse Various standards and regulations
5. Compare EMI test methods

UNIT I BASIC THEORY 9

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

UNIT II COUPLING MECHANISM 9

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT III EMI MITIGATION TECHNIQUES 9

Working principle of Shielding and Murphy‟s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT IV STANDARD AND REGULATION 9

Need for Standards, Generic/General Standards for Residential and Industrial environment, BasicStandards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.

UNIT V EMI TEST METHODS AND INSTRUMENTATION 9

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

REFERENCES:

1. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3 Ed, Artech house, Norwood, 1986.
2. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006.
3. Daryl Gerke and William Kimmel, "EDN"s Designer"s Guide to Electromagnetic Compatibility",Elsevier Science & Technology Books, 2002
4. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.
5. Electromagnetic Compatibility by Norman Violette ,Published by Springer, 2013
6. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork,2009
7. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2001.
8. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

PROFESSIONAL ELECTIVE IV					
19CU2708	Mobile Adhoc Sensor Networks	3	0	0	3
19CU2709	Network Routing Algorithms	3	0	0	3
19CU2710	RF System Design	3	0	0	3
19VL2708	MEMS and NEMS	3	0	0	3

19CU2708 MOBILE ADHOC SENSOR NETWORKS L T P C 3 0 0 3

Course Objectives

• To study characteristics, vulnerabilities and challenges of ad hoc networks.

• To explore issues and challenges in designing MAC and TCP Protocols in the context of AdHoc networks.

• To understand adaptation of the routing protocols in mobile networks.

• To explore issues and challenges variety of attacks and threats over different layer.

• To evaluate the performance of MAC, routing protocols in MANETs.

Course Outcomes

1. Ability to identify the various challenges and vulnerabilities in MANET.
2. Obtain an awareness cyber-attacks and threads in mobile networks.

3. Understand and recognize the architectures, designing MAC, TCP, IP and security protocols.
4. Analyze the solutions for covering the security principles of wireless networks.
5. Apply in-depth knowledge of wireless communications principles, systems, and networks to the solution of wireless engineering problems.

UNIT I WIRELESS LAN, PAN, WAN AND MAN 9

Characteristics of wireless channel - Fundamentals of WLANs - IEEE 802.11 standard – HIPERLAN – WLL - Wireless ATM - IEEE 802.16 standard – HIPERACCESS- AdHoc Wireless Internet.

UNIT II MAC AND ROUTING PROTOCOLS 9

MAC: Design issues - Goals and classification - Contention–based MAC protocols: MACAW, DPRMA, DPSMA.MAC protocols using directional antenna- Routing protocols: AODV, DSR, ZRP, LAR, CHGSR, FSR and power-aware routing protocols.

UNIT III TRANSPORT LAYER AND SECURITY PROTOCOLS 9

Transport layer Protocol: Design issues - Goals and classification - TCP over AdHoc wireless Networks – Security - Security requirements - Issues and challenges in security provisioning - Network security attacks - Security routing.

UNIT IV ENERGY MANAGEMENT 9

Need - Classification of battery management schemes - Transmission power management schemes - System power management schemes. Wireless Sensor Networks: Architecture - Data dissemination - Date gathering - MAC protocols - Location discovery - Quality of a sensor network.

UNIT V PERFORMANCE ANALYSIS 9

ABR beaconing - Performance parameters - Route-discovery time - End-to-end delay performance - Communication throughput performance - Packet loss performance - Route reconfiguration/repairtime - TCP/IP based applications.

Total: 45 Periods

References:

1. C.Siva Ram Murthy and B.S.Manoj, “AdHoc Wireless Networks: Architectures and protocols”, Prentice Hall PTR, 2007
2. C.K.Toh. , “AdHoc Mobile Wireless Networks: Protocols and Systems”, Prentice Hall PTR, 2008
3. Mohammad Ilyas, “The Handbook of AdHoc Wireless Networks”, CRC press, 2002
4. Charles E. Perkins, “AdHoc Networking”, Addison – Wesley, 2008
5. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic, “Mobile AdHoc Networking”, Wiley – IEEE press, 2004
6. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.

19CU2709 NETWORK ROUTING ALGORITHMS L T P C 3 0 0 3

Course Objectives

- To expose the students to the layered architecture for communication networks and the specific functionality of the network layer.
- To enable the student to understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network.
- To enable the student to understand the different routing algorithms existing and their performance characteristics.

Course Outcomes

- To understand the ISO OSI architecture l and functions of each layer in detail.
- To gain knowledge on various internet routing protocols.
- To gain knowledge on various routing algorithms in optical WDM's.
- Given the network and user requirements and the type of channel over which the mobile IP network has to operate, the student would be in a position to apply his knowledge for identifying a suitable routing algorithm, implementing it and analyzing its performance.
- The student would also be able to design a new algorithm or modify an existing algorithm to satisfy the evolving demands in the mobile Ad-Hoc network and by the user 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 9

Interior protocol : 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 - IP NETWORKS 9

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 MOBILE AD –HOC NETWORKS 9

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

References:

1. A.T Campbell et al., ― Comparison of IP Micromobility Protocols, IEEE Wireless Communications Feb.2002, pp 72-82.
2. C.E Perkins, "Ad Hoc Networking", Addison – Wesley, 2001.
3. C.Siva Rama Murthy and Mohan Gurusamy, "WDM Optical Networks – Concepts, Design and Algorithms", Prentice Hall of India Pvt. Ltd, New Delhi –2002.
4. Ian F. Akyildiz, Jiang Xie and ShantidevMohanty, "A Survey of mobility Management in Next generation All IP- Based Wireless Systems", IEEE Wireless Communications Aug.2004, pp 16-27.
5. M. Steen Strub, "Routing in Communication network", Prentice Hall International, Newyork,1995.
6. S. Keshav, "An engineering approach to computer networking", Addison Wesley 1999.
7. William Stallings, "High speed Networks TCP/IP and ATM Design Principles", Prentice Hall, New York, 1995.
8. William Stallings, "High speed networks and Internets Performance and Quality of Service", II Edition, Pearson Education Asia. Reprint India 2002.

19CU2710 RF SYSTEM DESIGN L T P C 3 0 0 3

Course Objective

- To understand the fundamentals of RF design and Microwave integrated circuits
- To understand the various components of RF system for Wireless Communications.
- To know the basic techniques needed for analysis of RF systems.

Course Outcomes

- Capability to design RF circuits.
- To be able to analyze RF circuits

UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS, ARCHITECTURES 9

CMOS , Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers**:** Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation

and enhancement , High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match , Single ended and Differential schemes.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

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

UNIT IV RF FILTER,OSCILLATOR AND MIXER 9

Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phase locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.

UNIT V MIC COMPONENTS 9

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.

Total: 45 Periods

References:

1.Razavi, "RF Microelectronics", Pearson Education, 1997.

2.Ingo Wolff," Coplanar Microwave Integrated circuits", John Wiley and sons, New Jersey, 2006.

3.T. Lee,"Design of CMOS RF Integrated Circuits", Cambridge, 2004.

19VL2708 MEMS AND NEMS L T P C 3 0 0 3

Course Objectives

- To introduce the concepts of micro electromechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

Course Outcomes

1. At the end of this course, the student should be able to:
2. Discuss micro sensors
3. Explain micro actuators
4. Outline nano systems and Quantum mechanics

UNIT I OVERVIEW 9

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of

MEMS and NEMS, MEMS and NEMS – Applications, Devices and structures. Materials for MEMS:Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES 9

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wetetching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials

UNIT III MICRO SENSORS 9

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor.

UNIT IV MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

TOTAL: 45 PERIODS

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006.
2. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.
3. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001
4. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.
5. Tai Ran Hsu ,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.

PROFESSIONAL ELECTIVE V					
19VL3701	Reconfigurable architectures	3	0	0	3
19CU3701	Soft Computing Techniques	3	0	0	3
19CU3702	Video Surveillance Systems	3	0	0	3
19CU3703	Internet of Things	3	0	0	3

19VL3701 RECONFIGURABLE ARCHITECTURES L T P C 3 0 0 3

Course Objectives:

The students should be made to:

- Understand concept of reconfigurable systems
- Learn programmed FPGAs
- Study flexibility on routing

Course Outcomes

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

- Compare FPGA routing architectures
- Discuss FPGA applications
- Explain high level synthesis

UNIT I INTRODUCTION 9

Domain-specific processors, Application specific processors, Reconfigurable Computing Systems – Evolution of reconfigurable systems – Characteristics of RCS advantages and issues. Fundamental concepts& Design steps –classification of reconfigurable architecture-fine, coarse grain & hybrid architectures – Examples

UNIT II FPGA TECHNOLOGIES & ARCHITECTURE 9

Technology trends- Programming technology- SRAM programmed FPGAs, antifuse programmed FPGAs, erasable programmable logic devices. Alternative FPGA architectures: Mux Vs LUT based logic blocks – CLB Vs LAB Vs Slices- Fast carry chains- Embedded RAMs- FPGA Vs ASIC design styles.

UNIT III ROUTING FOR FPGAS 9

General Strategy for routing in FPGAs- routing for row-based FPGAs – segmented channel routing, definitions- Algorithm for I segment and K segment routing – Routing for symmetrical FPGAs, Flexibility of FPGA Routing Architectures: FPGA architectural flexibility on Routability- Effect of switch block flexibility on routability - Tradeoffs in flexibility of S and C blocks

UNIT IV HIGH LEVEL DESIGN 9

FPGA Design style: Technology independent optimization- technology mapping- Placement. Highlevel synthesis of reconfigurable hardware, high- level languages, Design tools: Simulation (cyclebased, event driven based) – Synthesis (logic/HDL vs physically aware) – timing analysis (static vs dynamic)- verification physical design tools.

UNIT V APPLICATION DEVELOPMENT WITH FPGAS 9

Case Studies of FPGA Applications–System on a Programmable Chip (SoPC) Designs.

TOTAL : 45 PERIODS

REFERENCES:

1. Christophe Bobda, "Introduction to Reconfigurable Computing –Architectures, Algorithms and Applications", Springer, 2010.

2. Clive "Max" Maxfield, "The Design Warrior"s Guide to FPGAs: Devices, Tools And Flows", Newnes, Elsevier, 2006.

3. Jorgen Staunstrup, Wayne Wlf, "Hardware/Software Co- Design: Priciples and practice", Kluwer Academic Pub, 1997.

4. Maya B. Gokhale and Paul S. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer, 2005.

5. Russell tessier and Wayne Burleson "Reconfigurable Computing for Digital Signal Processing: A Survey" Journal of VLSI Signal processing 28,p7-27,2001.

6. Stephen M. Trimberger, "field – programmable Gate Array Technology" Springer,2007.

7. Stephen D. broen, Robert J. Francis, Jonathan Rose, Zvonko G. Vranesic," Fieldprogrammable Gate Arrays", Kluwer Academic Pubnlishers, 1992.

8. Scott Hauck and Andre Dehon (Eds.), "Reconfigurable Computing –The Theory and Practice of FPGA-Based Computation", Elsevier / Morgan Kaufmann, 2008

19CU3701 SOFT COMPUTING TECHNIQUES L T P C 3 0 0 3

OBJECTIVES

To know the basics of artificial neural networks

1. To provide adequate knowledge about feed forward /feedback neural networks
2. To apply the concept of fuzzy logic in various systems.
3. To have the idea about genetic algorithm
4. To provide adequate knowledge about the applications of Soft Computing.

OUTCOMES:

1. Knowledge on concepts of soft computational techniques.
2. Able to apply soft computational techniques to solve various problems.
3 .Motivate to solve research oriented problems

UNIT I ARTIFICIAL NEURAL NETWORK 9

Introduction-Basic concepts of Neural Network-Model of an Artificial Neuron-Characteristics of Neural Network-Learning Methods-Back propagation Network Architecture-Back propagation Learning-Counter Propagation Network-Hopfield/Recurrent Network-Adaptive Resonance Theory

UNIT II FUZZY LOGIC 9

Basic concepts of Fuzzy Logic-Fuzzy Sets and Crisp Sets-Fuzzy Set Theory and Operations-Properties of Fuzzy Sets-Fuzzy and Crisp relations, Fuzzy to Crisp Conversion-Membership Functions-Interference in Fuzzy Logic-Fuzzy if-then Rules, Fuzzy implications and Fuzzy Algorithms, Fuzzification & Defuzzification-Fuzzy Controller

UNIT III NEURO-FUZZY MODELLING 9

ANFIS Architecture-Classification and Regression Trees-Data Clustering algorithms-Rulebase Structure Identification.

UNIT IV GENETIC ALGORITHMS 9

Basic concepts-Working Principle-Inheritance Operators-Cross Over-Inversion & Deletion-Mutation Operator-Generation Cycle.

UNIT V APPLICATIONS OF SOFTCOMPUTING 9

Genetic Algorithm Application- Bagley and Adaptive Game-Playing Program- Greg Viols Fuzzy Cruise Controller-Air Conditioner Controller-Application of Back Propagation Neural Network

Total: 45 Periods

REFERENCES

1. George J. Klir and Bo Yuan, „Fuzzy Sets and Fuzzy Logic Theory and Applications“, Printice Hall of India, 2002

2. J.S.R.Jang,C.T.Sun and E.Mizutani,"Neuro-Fuzzy and Soft Computing",PHI,2004, Pearson Education 2004.

3. LaureneFausett,”Fundamentals of Neural Networks: Architectures, Algorithms and Applications”, Pearson Education India, 2006.

4. S.Rajasekaran and G.A.V.Pai."Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2010.

5. Timothy J Ross, “Fuzzy logic with Engineering Applications”, John Wiley and Sons, 2009.

6. Zimmermann H.J."Fuzzy Set Theory and Its Application" Springer International

19CU3702 VIDEO SURVEILLANCE SYSTEMS L T P C 3 0 0 3

Course Objective

1. The purpose of this course is to provide an insight to the fundamental theory and techniques for efficient representation, processing of video signals and the applications of digital video.
2. This course covers essential topics including motion analysis and video tracking.
3. This provides a formal problem formulation for video tracking and typical challenges that make video tracking difficult.
4. Also it discusses current and emerging applications of video tracking.
5. Also covers video processing applications on such diverse topics as video surveillance, face tracking and recognition from video, motion tracking in medical videos, and using video to assist speech recognition.

Course Outcomes

1. Apply motion segmentation and video tracking
2. Video tracking algorithms for intelligent surveillance and medical applications
3. Analyze different background subtraction techniques for different scenario
4. Examine the ideas behind intelligent surveillance and medical applications
5. Analyze to choose right sensor for the right job

UNIT I DIGITAL VIDEO OVERVIEW 9

Analog vs Digital, Analog to Digital, Worldwide Video Standards (NTSC, PAL, SECAM), Interlaced and Progressive Scan, Resolution, Color models in video- YUV,YIQ,YCbCr, Motion Analysis- Motion estimation (Pixel based and block matching based), motion compensation.

UNIT II DIGITAL VIDEO HARDWARE 9

How cameras work, Refraction, optics, F- Stop, Shutter speed, Depth of field, Digital image sensors- CCD vs CMOS, Manual, auto focus, power requirements, Day and night cameras, Infra-red and thermal technologies, Indoor/ Outdoor cameras, Fixed/PTZ/ Moving cameras, CCTV

UNIT III MOTION SEGMENTATION 9

Background subtraction, Identifying region of interest in image sequences, Challenges, background subtraction using color or feature, Pixel level processing, Region level Processing. Frame level processing

UNIT IV VIDEO TRACKING 9

Design of Video Tracker- Challenges- Main Components- Single Target Tracking- Multiple Target Tracking- Interactive vs automated target tracking-

UNIT V BEHAVIOUR ANALYSIS OF INDIVIDUALS 9

Learning based behavior analysis- SVM learning- Behaviour analysis of human groups- People count and crowd density estimation Applications –surveillance- Architecture of Automated video surveillance system- Components of knight multi camera surveillance system medical

Total: 45 Periods

REFERENCES

1. Essential Guide to Video Processing by Al Bovik, Academic Press, 2009
2. Digital Video Surveillance and security by Anthony C Caputo, Elsevier Inc, 2010
3. Video Tracking – Theory and Practice by Emilio Maggio, Andrea Cavallaro, John Wiley and Sons pvt Ltd, 2011
4. Automated Multi camera Video Surveillance Algorithms and Practice, Omar Javed, Mubarak Shah, Springer, 2008 Intelligent Surveillance Systems by HuihuanQian, Xinyu Wu, YangshengXu, Springer, 2011.

19CU3703 INTERNET OF THINGS L T P C 3 0 0 3

Course Objectives:

To understand the fundamentals of Internet of Things

- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario

Course Outcomes

Upon completion of the course, the student should be able to:

1. Analyze various protocols for IoT
2. Develop web services to access/control IoT devices.
3. Design a portable IoT using Rasperry Pi
4. Deploy an IoT application and connect to the cloud.
5. Analyze applications of IoT in real time scenario

UNIT I INTRODUCTION TO IoT 9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II IoT ARCHITECTURE 9

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT III IoT PROTOCOLS 9

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO 9

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS 9

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

Total: 45 Periods

References

1. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011

3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012

4. Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

PROFESSIONAL ELECTIVE VI					
19CU3704	Software Defined Radio	3	0	0	3
19CU3705	Pattern Recognition And Machine Learning	3	0	0	3
19CU3706	Space Time Wireless Communication	3	0	0	3
19VL3704	Network on Chip	3	0	0	3

19CU3704 SOFTWARE DEFINED RADIO L T P C 3 0 0 3

Course Objectives: The students should be made to:

- Understand radio frequency implementation
- Learn multi rate signal processing and digital generation of signals

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

1. Design data converters
2. Evaluate smart antennas
3. Discuss digital hardware and software choices

UNIT I INTRODUCTION & CASE STUDIES 9

Introduction to software Radio concepts: Need for software Radios, Definition of software Radio, Characteristics and Benefits. Design Principles. Case studies: SPEAK easy, JTRS, SDR-3000.

UNIT II RADIO FREQUENCY IMPLEMENTATION 9

The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.

UNIT III MULTI RATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS. 9

Sample rate conversion principles. Digital filter Banks. Timing recovery in Digital Receivers using Multi rate Digital filters. Approaches to Direct Digital Synthesis. Analysis of spurious signal Band pass signal generation, Generation of Random sequences.

UNIT IV DATA CONVERTERS AND SMART ANTENNAS 9

Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas- Hardware implementation of Smart Antennas.

UNIT V DIGITAL HARDWARE AND SOFTWARE CHOICES 9

DSP Processors, FPGA, ASIC s. Tradeoffs, Object oriented programming, Object Brokers, GNU Radio-USRP.

Total : 45 Periods

References:

1. Jeffrey H.Reed, "Software Radio: A Modern Approach to Radio Engineering, Prentice Hall,2002.

2. Joseph Mitola, "Software Radio Architecture: Object Oriented Approaches to Wireless System Engineering", Wiley-Inter science; I Edition 2000,ISBN:0471384925

3. Radio, G. N. U. "The gnu software radio." Available from World Wide Web: https://gnuradio. org (2007).

4. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, "Cognitive Radio-An Enabler for Internet of things", River Publishers, 2017.

19CU3705 PATTERN RECOGNITION AND MACHINE LEARNING L T P C 3 0 0 3

Course Objectives:

- Study the fundamental of pattern classifier.
- To know about various clustering concepts.
- To originate the various structural pattern recognition and feature extraction.
- To understand the basic of concept learning and decision trees
- To explore recent advances in pattern recognition.

Course Objectives

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

- Classify the data and identify the patterns.
- Utilize the given data set to extract and select features for Pattern recognition.
  Describe the decision tree and concept learning.
- Discuss on recent advances in pattern recognition

UNIT I PATTERN CLASSIFIER 9

Overview of Pattern recognition – Discriminant functions – Supervised learning –Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier.

UNIT II CLUSTERING 9

Clustering for unsupervised learning and classification -Clustering concept – C-means algorithm – Hierarchical clustering procedures -Graph theoretic approach to pattern clustering -Validity of clusters.

UNIT III FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION 9 KL Transforms – Feature selection through functional approximation – Binary selection -Elements of formal grammars - Syntactic description - Stochastic grammars –Structural representation.

UNIT IV INTRODUCTION, CONCEPT LEARNING AND DECISION TREES 9

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

UNIT V EVOLUTIONARY AND GRAPHICAL MODELS 9

– Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process , Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

Total: 45 Periods

REFERENCES:

1. Duda R.O., and Hart.P.E., Pattern Classification and Scene Analysis, Wiley, New York, 1973.

2. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.

3. NarasimhaMurty M and Susheela Devi V, "Pattern Recognition – An Algorithmic Approach", Springer, Universities Press, 2011

4. Robert J.Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley &Sons Inc., New York, 2007.

5. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (Indian Edition), 2013.

6. Tou and Gonzalez, Pattern Recognition Principles, Wesley Publication Company, London

19CU3706 SPACE TIME WIRELESS COMMUNICATION L T P C 3 0 0 3

Course 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.

Outcomes:

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

UNIT I MULTIPLE ANTENNA PROPAGATION AND ST CHANNELCHARACTERIZATION 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 9

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

UNIT III SPATIAL DIVERSITY 9

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

UNIT IV MULTIPLE ANTENNA CODING AND RECEIVERS 9

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

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

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

Total: 45 Periods

REFERENCES:

1. Andre Viterbi " Principles of Spread Spectrum Techniques" Addison Wesley 1995

2. Jafarkhani, Hamid. Space-time coding: Theory and Practice. Cambridge University Press, 2005.

3. Paulraj, RohitNabar, Dhananjay Gore., "Introduction to Space Time Wireless Communication Systems", Cambridge University Press, 2003

4. Sergio Verdu" Multi User Detection" Cambridge University Press, 1998

19VL3704 NETWORK ON CHIP L T P C 3 0 0 3

Course Objectives

1. To understand the fundamentals of 3D NOC.
2. To impart knowledge about testing and energy issues in NOC.
3. To understand the router architectures in 3D NOC.

Course Outcomes

1. The ability to understand the need for 3D NOC.

2. The ability to know the concepts used in testing and reduction of power in NOC.
3. The ability to learn the architecture and working of routers in 3D NOC

UNIT I INTRODUCTION TO THREE DIMENSIONAL NOC 9

Three-Dimensional Networks-on-Chips Architectures.–Resource Allocation for QoSOn-Chip Communication–Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-onChip.

UNIT II TEST AND FAULT TOLERANCE OF NOC 9

Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-onChips-Test and Fault Tolerance for Networks-on-Chip Infrastructures- Monitoring Services for Networks-on-Chips.

UNIT III ENERGY AND POWER ISSUES OF NOC 9

Energy and Power Issues in Networks-on-Chips-The CHAIN works Tool Suite: A Complete Industrial Design Flow for Networks-on-Chips

UNIT IV MICRO-ARCHITECTURE OF NOC ROUTER 9

Baseline NoC Architecture – MICRO-Architecture Exploration ViChaR: A Dynamic Virtual Channel Regulator for NoC Routers- RoCo: The Row-Column Decoupled Router – A Gracefully Degrading and Energy-Efficient Modular Router Architecture for On-Chip Networks. Exploring Fault Tolerant Networks-on-Chip Architectures.

UNIT V DimDE ROUTER FOR 3D NOC 9

A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures Digest of Additional NoC MACRO-Architectural Research.

Total: 45 Hours

References

1. ChrysostomosNicopoulos, Vijaykrishnan Narayanan, Chita R.Das, Networks-on- Chip Architectures AHolistic Design Exploration, Springer,2009.
2. Fayezgebali, Haythamelmiligi, HqhahedWatheq E1-Kharashi, Networks-on-Chips theory and practice, CRC press, 2009.
3. Axel Jantsch ,HannuTenhunen,Networkson Chip, Publisher: Springer; Soft cover reprint of hardcover 1st ed. 2003 edition (November 5, 2010).
4. Giovanni De Micheli , Luca Benini, Networkson Chips: Technology and Tools (Systems on Silicon), Publisher: Morgan Kaufmann; 1 edition (August 3, 2006).
5. Jose Flich ,DavideBertozzi ,Designing Network On-Chip Architectures in the Nanoscale Era, (Chapman Hall/CRC Computational Science), Publisher: Chapman and Hall/CRC; 1 edition (December 18,2010).

PROFESSIONAL ELECTIVE VII					
19CU3707	Ultra Wideband Communication	3	0	0	3
19CU3708	Network Management	3	0	0	3
19CU3709	Network Processors	3	0	0	3
19VL3707	Hardware – Software Co-Design	3	0	0	3

19CU3707 ULTRA WIDEBAND COMMUNICATION L T P C 3 0 0 3

Course Objectives

• To give fundamental concepts related to Ultra wide band

• To understand the channel model and signal processing for UWB.

• To acquire knowledge about UWB antennas and regulations

Course Outcomes

1. The student would be able to understand UWB technologies
2. Ability to assess the performance of UWB channels
3. The student would be able to design UWB antenna for various applications

UNIT I INTRODUCTION TO UWB 9

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

UNIT II UWB TECHNOLOGIES AND CHANNEL MODELS 9

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

UNIT III UWB SIGNAL PROCESSING 9

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

UNIT IV UWB ANTENNAS 9

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

UNIT V UWB APPLICATIONS AND REGULATIONS 9

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

Total: 45 Hours

References

1.Homayoun Nikookar and Ramjee Prasad, "Introduction to Ultra Wideband for Wireless Communications"1st Edition, Springer Science & Business Media B.V. 2010.

2.Thomas Kaiser, FengZheng "Ultra Wideband Systems with MIMO", 1st Edition, John Wiley & Sons Ltd, New York, 2010

3.W. Pam Siriwongpairat and K. J. Ray Liu, "Ultra-Wideband Communications Systems: Multiband OFDM approach" John Wiley and IEEE press, New York 2008.

19CU3708 NETWORK MANAGEMENT L T P C 3 0 0 3

Course Objectives

- To appreciate the need for interoperable network management as a typical distributed application
- To familiarize concepts and terminology associated with SNMP
- To be aware of current trends in network management technologies

Course Outcomes

After the completion of this course, students will be able to

1. Diagnose problems and make minor repairs to computer networks using appropriate diagnostics software b
2. Demonstrate how to correctly maintain LAN computer systems
3. Maintain the network by performing routine maintenance tasks
4. Apply network management tools

UNIT I OSI NETWORK MANAGEMENT 9

OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS

UNIT II BROADBAND NETWORK MANAGEMENT 9

Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network reference model, Integrated local Management Interface. ATM Management Information base, Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital Exchange Interface Management

UNIT III SIMPLE NETWORK MANAGEMENT PROTOCOL 9

SNMPv1 Network Management: Communication and Functional Models. The SNMP Communication Model, Functional model. SNMP Management SNMPv2: Major Changes in SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base,SNMPv2 Protocol, Compatibility With SNMPv1.Configuration management, Fault management, Performance management, Event Correlation Techniques 168 security management, Accounting management, Report Management, Policy Based Management, Services Level Management

UNIT IV NETWORK MANAGEMENT SYSTEMS 9

Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Commercial Network management Systems, System Management and Enterprise Management Solutions

UNIT V WEB-BASED MANAGEMENT 9

NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network

Total 45 Periods

References

1. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi, 1999
2. Mani Subramanian, "Network Management - Principles and Practice", Pearson Education, Second edition, 2010.
3. Mani Subramanian, "Network Management Principles and Practice", Addison Wesley, Second edition, 2010
4. Mark Burges, "Principles of Network System Administration", Wiley, 2000.
5. Salah Aiidarons and Thomas Plevayk, "Telecommunications Network Technologies and Implementations", Eastern Economy Edition IEEE press, New Delhi, 1998
6. Stephen Morris, "Network Management, MIBs and MPLS - Principles

19CU3709 NETWORK PROCESSORS L T P C 3 0 0 3

Course Objectives

- Learn network processors
- Study commercial network processors
- Understand network processor architecture

Course Outcomes

Discuss network processor architecture

1. Compare different programming
2. Explain IOS technologies

UNIT I INTRODUCTION 9

Traditional protocol processing Systems – Network processing Hardware – Basic Packet Processing Algorithms and data Structures - Packet processing functions – Protocol Software – Hardware Architectures for Protocol processing – Classification and Forwarding – Switching Fabrics

UNIT II NETWORK PROCESSOR TECHNOLOGY 9

Network Processors: Motivation and purpose - Complexity of Network Processor Design – Network Processor Architectures architectural variety, architectural characteristics Peripheral Chips supporting Network Processors: Storage processors, Classification Processors, Search Engines, Switch Fabrics, Traffic Managers.

UNIT III COMMERCIAL NETWORK PROCESSORS 9

Multi-Chip Pipeline, Augmented RISC processor, Embedded Processor plus Coprocessors, Pipelilne of Flomogeneous processors. Configurable Instruction set processors – Pipeline of Electrogeneous processors – Extensive and Diverse processors – Flexible RISC plus Coprocessors – Scalability issues – Design Tradeoffs and consequences

UNIT IV NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING 9

Architecture: Intel Network Processor: Multi headed Architecture Overview – Features- Embedded EISC processor - Packet Processor Hardware – Memory interfaces – System and Control Interface Components – Bus Interface. Programming Software Development Kit-IXP Instruction set – register formats – Micro Engine Programming – Intra thread and Inter-thread communication– thread synchronization – developing sample applications – control plane – ARM programming

UNIT V IOS TECHNOLOGIES 9

CISCO COS – Connectivity and scalability – high availability – IP routing – IP services – IPV6 – Mobile IP – MPLS – IP Multicast 0 Manageability – QoS – Security – Switching – Layer VPN2

Total: 45 Hours

References

1. Douglas E.Comer "Networks Systems Design using Network Processors" Prentice Hall JaN. 2003
2. Erik, J.Johnson and Aaron R.Kunze, "IXP2400/2806 Programming: The Microengine Coding Grade" Intel Press.
3. Hill Carlson, "Intel Internet Exchange Architecture & Applications a Practical Guide to Intel‟s network Processors" Intel press. www.cisco.com
4. Panas C. Lekkas, "Network Processors: Architectures, Protocols and Paradigms Telecom Engineering)", McGraw Hill, Professional, 2003.
5. Patrick Crowley, MaEranklin, H. Hadminglu, PZ Onfryk, "Network Processor Design, Issues and Practices Vol-1" Morgan Kaufman, 2002.
6. Patrick Crowley, M a Frankliln, H. Hadimioglyum PZ Onufryk, Network Processor Design, Issues and Prentices vol.II, Morgan Kaufman, 2003.
7. Ran Giladi, Network Processors: Architecture, Programming, and Implementation, Morgan Kauffmann, 2008.

19VL3707 HARDWARE AND SOFTWARE CO DESIGN L T P C 3 0 0 3

Course Objectives

1. The students will learn various design steps starting from system specifications to hardware/software implementation and will experience process optimization while considering various design decisions.
2. Students will gain design experience with project/case studies using contemporary high level methods and tools.

Course Outcomes

1. To outline and apply design methodologies
2. To appreciate the fundamental building blocks of the using hardware and software co design and related implementation and testing environments and techniques and their inter-relationships
3. To modern hardware/software tools for building prototypes
4. To demonstrate practical competence in these areas.
5. Analyze various verification methods

UNIT I SYSTEM SPECIFICATION AND MODELLING 9

Embedded Systems , Hardware/Software Co-Design , Co-Design for System Specification and Modeling , Co-Design for Heterogeneous Implementation - Processor Synthesis , Single Processor Architectures with one ASIC, Single-Processor Architectures with many ASICs, Multi Processor Architectures , Comparison of Co-Design Approaches , Models of Computation ,Requirements for Embedded System Specification .

UNIT II HARDWARE/SOFTWARE PARTITIONING 9

The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization, HW/SW Partitioning based on Heuristic Scheduling, HW/SW Partitioning based on Genetic Algorithms.

UNIT III HARDWARE/SOFTWARE CO-SYNTHESIS 9

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation,Distributed System Co-Synthesis

UNIT IV PROTOTYPING AND EMULATION 9

Introduction, Prototyping and Emulation Techniques, Prototyping and Emulation Environments,Future Developments in Emulation and Prototyping ,Target Architecture- Architecture Specialization Techniques, System Communication Infrastructure, Target Architectures and Application System Classes, Architectures for Control-Dominated Systems, Architectures for Data Dominated Systems, Mixed Systems and Less Specialized Systems

UNIT V DESIGN SPECIFICATION AND VERIFICATION 9

Concurrency, Coordinating Concurrent Computations, Interfacing Components, Verification, Languages for System-Level Specification and Design System-Level Specification, Design Representation for System Level Synthesis, System Level Specification Languages, Heterogeneous Specification and Multi-Language Co-simulation

TOTAL : 45 PERIODS

REFERENCES:

1. Ralf Niemann , “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer Academic Pub, 1998.

2. Jorgen Staunstrup , Wayne Wolf ,”Hardware/Software Co-Design: Principles and Practice” , Kluwer Academic Pub,1997.

3. Giovanni De Micheli , Rolf Ernst Morgon,” Reading in Hardware/Software Co-Design “ Kaufmann Publishers,2001.