K.L.N. COLLEGE OF ENGINEERING

Pottapalayam, Sivagangai District

(An Autonomous Institution Affiliated to Anna University, Chennai)

CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM

(REGULATIONS 2020)

I to IV Semester

M.E. Communication Systems

Department of Electronics and Communication Engineering

VISION OF THE INSTITUTION

To become a Centre of Excellence in Technical Education and Research in producing Competent and Ethical professionals to the society.

MISSION OF THE INSTITUTION

To impart Value and Need based curriculum to the students with enriched skill development in the field of Engineering, Technology, Management and Entrepreneurship and to nurture their character with social concern and to pursue their career in the areas of Research and Industry.

VISION OF THE DEPARTMENT

To promote as a center of excellence in educational and research activities related to electronics and communication engineering and its allied areas.

MISSION OF THE DEPARTMENT

To create educational and research environment to meet ever changing and ever demanding needs of electronics and communication industry along with IT and other interdisciplinary fields.

To mould the students to become ethically upright and recognized as responsible engineers.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To provide students with strong fundamental concepts and also advanced techniques and tools to build various communication systems.
- To enable graduates to attain successful professional careers by applying their engineering skills in communication system design to meet out the challenges in industries and academia.
- To engage graduates in lifelong learning, adapt emerging technology and pursue research for the development of innovative products.

PROGRAM OUTCOMES (POs):

The Graduate Attributes of PG programmes of the NBA are as following:

1. Scholarship of Knowledge

Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

2. Critical Thinking

Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

3. Problem Solving

Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

4. Research Skill

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

5. Usage of modern tools

Create, select, learn 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.

6. Collaborative and Multidisciplinary work

Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

7. Project Management and Finance

Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8. Communication

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. Life-long Learning

Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

10. Ethical Practices and Social Responsibility

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

11. Independent and Reflective Learning

Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

PROGRAMME SPECIFIC OBJECTIVES (PSOs)

- To inculcate the ability in graduates to design and analyze the subsystems such as RF, Signal Processing, Modern communication systems and networks.
- To enhance problem solving skills in communication systems design using latest hardware and software tools.
- To apply communication engineering principles and practices for developing products for scientific and business applications.

CATEGORY OF COURSES

1) **Foundation Courses (FC) Courses**

2) **Professional Core (PC) Courses** include the core courses relevant to the chosen programme of study.
3) **Employability Enhancement Courses (EEC)** includes Project Work and/or Internship, Seminar, Professional Practices, Case Study and Industrial/Practical Training.
4) **Professional Elective (PE) Courses** include the elective courses relevant to the chosen programme of study.
5) **Open Elective (OE) Courses**

6) **Audit Courses (AC)** are mandatory courses include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.

Structure of Curriculum

S.NO.	CATEGORY	NUMBER OF CREDITS				
		I SEM	II SEM	III SEM	IV SEM	TOTAL
1.	Foundation Courses (FC)	4				4
2.	Professional Core (PC)	14	8	3		25
3.	Employability Enhancement Course (EEC)		2	6	12	20
4.	Professional Electives (PE)	3	12	3		18
5.	Open Elective (OE)			3		3
6.	Audit Course (AC)	0	0			0
Credits per Semester		21	22	15	12	70
					Total Credits	70

CURRICULAM AND SYLLABUS

SEMESTER - I

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MA102	Applied Mathematics for Communication Engineers	FC	4	4	0	0	4
2.	20CU101	Advanced Radiation Systems	PC	3	3	0	0	3
3.	20CU102	Modern Digital Communication Techniques	PC	3	3	0	0	3
4.	20CU103	Advanced Digital Signal Processing	PC	4	3	1	0	4
5.		Professional Elective - I	PE	3	3	0	0	3
6.	20RM101	Research Methodology and IPR	PC	2	2	0	0	2
7.		Audit Course – 1	AC	2	2	0	0	0
PRACTICAL								
8.	20CU1L1	Advanced Communication Systems Laboratory	PC	4	0	0	4	2
			TOTAL	**25**	**20**	**1**	**4**	**21**

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20CU201	Advanced Wireless Communication Systems	PC	3	3	0	0	3
2.	20CU202	MIC and RF System Design	PC	3	3	0	0	3
3.		Professional Elective - II	PE	3	3	0	0	3
4.		Professional Elective - III	PE	3	3	0	0	3
5.		Professional Elective - IV	PE	3	3	0	0	3
6.		Professional Elective - V	PE	3	3	0	0	3
7.		Audit Course – 2	AC	2	2	0	0	0
PRACTICALS								
8.	20CU2L1	RF System Design Laboratory	PC	4	0	0	4	2
9.	20CU2L2	Mini Project with Seminar	EEC	2	0	0	2	2
			TOTAL	**26**	**20**	**0**	**6**	**22**

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20CU301	Millimeter Wave Communication	PC	3	3	0	0	3
2.		Professional Elective - VI	PE	3	3	0	0	3
3.		Open Elective	OE	3	3	0	0	3
PRACTICAL								
4.	20CU3L1	Project Work Phase - I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	20CU4L1	Project Work Phase - II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 70

FOUNDATION COURSE (FC)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20MA102	Applied Mathematics for Communication Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU101	Advanced Radiation Systems	PC	3	3	0	0	3
2.	20CU102	Modern Digital Communication Techniques	PC	3	3	0	0	3
3.	20CU103	Advanced Digital Signal Processing	PC	4	3	1	0	4
4.	20RM101	Research Methodology and IPR	PC	2	2	0	0	2
5.	20CU1L1	Advanced Communication Systems Laboratory	PC	4	0	0	4	2
6.	20CU201	Advanced Wireless Communication Systems	PC	3	3	0	0	3
7.	20CU202	MIC and RF System Design	PC	3	3	0	0	3
8.	20CU2L1	RF System Design Laboratory	PC	4	0	0	4	2
9.	20CU301	Millimeter Wave Communication	PC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU2L2	Mini Project with Seminar	EEC	2	0	0	2	2
2.	20CU3L1	Project Work Phase - I	EEC	12	0	0	12	6
3.	20CU4L1	Project Work Phase - II	EEC	24	0	0	24	12

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE – 1

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU1E1	Optical Networks	PE	3	3	0	0	3
2.	20CU1E2	RADAR Signal Processing	PE	3	3	0	0	3
3.	20CU1E3	Analog and Mixed Mode VLSI Design	PE	3	3	0	0	3
4.	20CU1E4	Real Time Embedded Systems	PE	3	3	0	0	3
5.	20CU1E5	Markov Chain and Queuing System	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – 2

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU2E1	Communication Network Modeling and Simulation	PE	3	3	0	0	3
2.	20CU2E2	Digital Communication Receivers	PE	3	3	0	0	3
3.	20CU2E3	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3
4.	20CU2E4	VLSI for Wireless Communication	PE	3	3	0	0	3
5.	20CU2E5	Cognitive Radio Networks	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – 3

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU3E1	Advanced Antenna Design	PE	3	3	0	0	3
2.	20CU3E2	Advanced Digital Image Processing	PE	3	3	0	0	3
3.	20CU3E3	Speech Processing and Synthesis	PE	3	3	0	0	3
4.	20CU3E4	Advanced Wireless Networks	PE	3	3	0	0	3
5.	20CU3E5	Fundamentals of 5G Mobile Networks	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – 4

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU4E1	Wavelet Transforms and its Applications	PE	3	3	0	0	3
2.	20CU4E2	Software Defined Radio	PE	3	3	0	0	3
3.	20CU4E3	Space Time Wireless Communication	PE	3	3	0	0	3
4.	20CU4E4	Pattern Recognition and Machine Learning	PE	3	3	0	0	3
5.	20CU4E5	Virtual Reality Systems	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – 5

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU5E1	Network Routing Algorithms	PE	3	3	0	0	3
2.	20CU5E2	Machine Learning in Communication Networks	PE	3	3	0	0	3
3.	20CU5E3	Multimedia Compression Techniques	PE	3	3	0	0	3
4.	20CU5E4	Ultra Wide Band Communication	PE	3	3	0	0	3
5.	20CU5E5	Smart Antennas for 5G Communications	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – 6

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20CU6E1	Soft Computing Techniques and Applications	PE	3	3	0	0	3
2.	20CU6E2	Network Processors	PE	3	3	0	0	3
3.	20CU6E3	Network Management Systems and Techniques	PE	3	3	0	0	3
4.	20CU6E4	Communication Network Security	PE	3	3	0	0	3
5.	20CU6E5	High Performance Switching Architectures	PE	3	3	0	0	3

OPEN ELECTIVE (OE)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20OEP31	Business Analytics	OE	3	3	0	0	3
2.	20OEP32	Industrial Safety	OE	3	3	0	0	3
3.	20OEP33	Operations Research	OE	3	3	0	0	3
4.	20OEP34	Cost Management of Engineering Projects	OE	3	3	0	0	3
5.	20OEP35	Composite Materials	OE	3	3	0	0	3
6.	20OEP36	Waste to Energy	OE	3	3	0	0	3

AUDIT COURSE (AC)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20AC101	English for Research Paper Writing	AC	2	2	0	0	0
2.	20AC102	Disaster Management	AC	2	2	0	0	0
3.	20AC103	Sanskrit for Technical Knowledge	AC	2	2	0	0	0
4.	20AC104	Value Education	AC	2	2	0	0	0
5.	20AC105	Constitution of India	AC	2	2	0	0	0
6.	20AC106	Pedagogy Studies	AC	2	2	0	0	0
7.	20AC107	Stress Management by Yoga	AC	2	2	0	0	0
8.	20AC108	Personality Development through Life Enlightenment Skills	AC	2	2	0	0	0

SEMESTER COURSE WISE PO MAPPING

		SUBJECTS	Programme Outcomes									
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
FIRST YEAR	SEMESTER - I	Applied Mathematics for Communication Engineers	3	3	2	1	1	-	-	-	1	-	-
		Advanced Radiation Systems	3	3	2	2	2	2	1	-	2	2	2
		Modern Digital Communication Techniques	3	2	1	1	2	2	-	-	2	2	-
		Advanced Digital Signal Processing	3	3	3	3	3	1	1	1	2	1	2
		Research Methodology and IPR	3	2	2	2	3	2	1	1	2	1	1
		Advanced Communication Systems Laboratory	3	3	1	1	2	2	1	-	3	1	1
	SEMESTER – II	Advanced Wireless Communication Systems	3	3	2	2	2	2	1	-	2	2	2
		MIC and RF System Design	2	2	3	3	2	2	1	1	3	2	-
		RF System Design Laboratory	3	3	3	3	3	3	3	3	3	2	2
		Mini Project with Seminar	3	3	3	2	1	2	1	2	3	2	1
SECOND YEAR	SEMESTER – III	Millimeter Wave Communication	3	3	2	2	2	2	1	-	2	2	2
		Project Work Phase – I	3	3	3	3	3	3	3	2	3	3	3
	SEMESTER – IV	**Project Work Phase – II**	3	3	3	3	3	3	3	2	3	3	3

		SUBJECTS	Programme Outcomes									
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
FIRST & SECOND YEAR	PROFESSIONAL ELECTIVES	Optical Networks	3	2	2	1	2	1	-	-	2	1	1
		RADAR Signal Processing	2	1	3	3	3	2	-	1	2	1	-
		Analog and Mixed Mode VLSI Design	3	3	3	1	3	1	-	-	2	2	2
		Real Time Embedded Systems	3	3	3	3	3	2	2	2	3	2	2
		Markov Chain and Queuing System	2	2	3	3	3	2	1	2	3	2	2
		Communication Network Modeling and Simulation	3	2	1	1	2	2	-	-	2	1	-
		Digital Communication Receivers	2	2	3	3	2	2	1	2	2	2	1
		Electromagnetic Interference and Compatibility	3	3	2	3	2	1	-	-	2	1	1
		VLSI for Wireless Communication	1	2	3	3	3	2	1	2	2	2	1
		Cognitive Radio Networks	3	2	2	1	2	1	-	-	3	1	1
		Advanced Antenna Design	2	2	3	3	2	2	1	1	3	2	-
		Advanced Digital Image Processing	2	3	3	3	3	2	1	2	2	2	1
		Speech Processing and Synthesis	3	3	3	3	3	2	1	2	3	3	2
		Advanced Wireless Networks	1	1	1	2	2	2	1	-	2	1	1
		Fundamentals of 5G Mobile Networks	3	3	3	2	3	1	1	-	2	1	1
		Wavelet Transforms and its Applications	2	3	3	3	3	2	1	2	3	2	-
		Software Defined Radio	3	1	1	1	2	2	-	1	2	1	-
		Space Time Wireless Communication	2	2	3	3	3	2	1	2	3	2	2

		SUBJECTS	Programme Outcomes									
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
FIRST & SECOND YEAR	PROFESSIONAL ELECTIVES	Pattern Recognition and Machine Learning	2	1	3	3	3	2	-	1	2	1	-
		Virtual Reality Systems	2	3	3	3	3	2	1	2	2	2	1
		Network Routing Algorithms	3	2	1	1	2	2	-	-	2	1	-
		Machine Learning in Communication Networks	3	2	1	1	2	2	-	-	2	1	-
		Multimedia Compression Techniques	3	3	2	2	3	2	1	2	3	2	2
		Ultra Wide Band Communication	3	3	3	2	3	1	1	-	2	1	1
		Smart Antennas for 5G Communications	3	3	3	2	3	1	1	-	2	1	1
		Soft Computing Techniques and Applications	3	3	2	3	2	2	1	1	2	1	1
		Network Processors	1	1	1	1	2	1	-	-	1	1	1
		Network Management Systems and Techniques	1	1	1	2	2	2	1	-	2	1	1
		Communication Network Security	3	2	2	3	2	2	1	1	3	2	1
		High Performance Switching Architectures	3	3	3	3	3	3	2	3	3	2	2
THIRD SEMESTER	OPEN ELECTIVES	Business Analytics	3	3	3	3	3	1	2	2	2	2	1
		Industrial Safety	3	2	1	1	3	2	2	1	2	1	1
		Operations Research	2	2	2	2	2	1	1	1	1	1	1
		Cost Management of Engineering Projects	3	2	1	1	3	2	2	1	2	1	1
		Composite Materials	3	3	1	1	2	2	1	1	2	1	1
		Waste to Energy	3	3	3	3	3	1	2	2	2	2	1

SCHEDULING OF COURSES

Semester	Theory						Laboratory / Project		
I (21)	20MA102 Applied Mathematics for Communication Engineers (4)	20CU101 Advanced Radiation Systems (3)	20CU102 Modern Digital Communication Techniques (3)	20CU103 Advanced Digital Signal Processing (4)	Professional Elective – I (3)	20RM101 Research Methodology and IPR (2)	20CU1L1 Advanced Communication Systems Laboratory (2)	---	Audit Course - 1
II (22)	20CU201 Advanced Wireless Communication Systems (3)	20CU202 MIC and RF System Design (3)	Professional Elective – II (3)	Professional Elective – III (3)	Professional Elective – IV (3)	Professional Elective – V (3)	20CU2L1 RF System Design Laboratory (2)	20CU2L2 Mini Project with Seminar (2)	Audit Course - 2
III (15)	20CU301 Millimeter Wave Communication (3)	Professional Elective – VI (3)	Open Elective (3)	---	---	---	20CU3L1 Project Work Phase – I (6)	---	---
IV (12)	---	---	---	---	---	---	20CU4L1 Project Work Phase – II (12)	---	---

Total Number of credits to be earned for the award of degree: 70

20MA102 APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVES:

The primary objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in communication engineering.

UNIT I LINEAR ALGEBRA 12

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

UNIT II LINEAR PROGRAMMING 12

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

UNIT III NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Initial value problems - single step methods: Picard's method - taylor's series - 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 and orthogonal collocation method – Laplace Equations

UNIT IV NON LINEAR PROGRAMMING 12

KUHN-TUCKER condition - Elimination methods, Quadratic interpolation - Direct search method - Random search method - Steepest descent method - Conjugate Gradient method

UNIT V QUEUEING MODELS 12

Poisson Process – Markovian queues – Single and multi - server models – Little‟s formula - Machine interference model – Steady state analysis – Self service queue.

TOTAL: 60 PERIODS

Course Outcomes (COs):

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

CO1 **:** Concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors.

CO2 **:** Apply various methods in linear algebra to solve system of linear equations.

CO3 **:** 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.

CO4 : Numerical solution of differential equations by single and multistep methods.

CO5 : Determine the optimum values of Non-linear programming problems using KKT method

CO6 : Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.

REFERENCES:

1. Gilbert Strang, "Introduction to Linear Algebra" 3rd Edition, Wellesely, Cambridge Press, 2003.
2. Bronson, R. and Costa, G. B., "Linear Algebra", 2nd Edition, Academic Press, 2007.
3. Burden, R. C. and Faires, J. D., "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
4. Gross, D., Shortle, J.F., Thompson, J. M. and Harris, C. M., "Fundamentals of Queueing Theory", 4th Edition, Wiley, 2014.
5. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education Asia, 8th Edition, 2015.
6. Sastry, S. S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
7. Taha H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education Asia, New Delhi, 2016.
8. K.V.Mittal, "Theory of Optimization", Wiley Eastern Limited, New Delhi,1988.

20CU101 **ADVANCED RADIATION SYSTEMS**

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the fundamental principles of antenna and to apply them to the design and analysis of antenna systems. Students will learn how to characterize antennas and how to use antennas. Different types of antennas and their applications will be introduced, with focus on linear wire antennas, loop antennas, microstrip patch antennas, antenna arrays, and the design considerations of using antennas in wireless communication systems.

UNIT I ANTENNA FUNDAMENTALS **9**

Wave equations, radiation pattern, HPBW,FNBW, gain and directivity, polarization, equivalent circuit, radiation resistance, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Antenna parameters, Image theory; Induction, reciprocity theorem, Balance to unbalance transformer, Introduction to numerical techniques.

UNIT II RADIATION FROM APERTURES 9

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

UNIT III ARRAYS 9

Introduction-General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beamforming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self phased arrays.

UNIT IV MICRO STRIP ANTENNA 9

Radiation mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of microstrip array antenna.

UNIT V SPECIAL ANTENNAS AND MEASUREMENTS 9

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Impart knowledge about the state of art in antenna technology.

CO2 : Describe the fundamentals to recent techniques in antenna technology.

CO3 : Understand the antenna radiation and its parameters.

CO4 : Design of monopole, dipole and patch antenna and to impart the knowledge about modern antennas.

CO5 : Design and assess the performance of various antennas.

CO6 : Knowledge of modern antenna design for various applications.

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.

20CU102 MODERN DIGITAL COMMUNICATION TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

The primary objectives are understood the basics signal-space analysis and digital transmission, coherent and noncoherent receivers and its impact on different channel characteristics and equalizers.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION 9

Coherent receivers – Optimum receivers in WGN – IQ modulation and demodulation – Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent 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 spectrum communication – 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 and demodulation 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

Course Outcomes (COs):

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

CO1 **:** Develop the ability to understand the concepts of signal space analysis for coherent and non-coherent receivers.

CO2 **:** Conceptually appreciate different Equalization techniques.

CO3 **:** Possess knowledge on different block codes and convolutional codes.

CO4 **:** Comprehend the generation of OFDM signals and the techniques of multiuser detection.

CO5 **:** Understand the different block coded and convolutional coded digital communication systems.

CO6 **:** Understand the basics of Multicarrier and Multiuser Communications.

REFERENCES:

1. Bernard Sklar, “Digital Communications”, Second edition, Pearson Education, 2001.
2. John G. Proakis, “Digital Communication”, Fifth Edition, Mc Graw 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 and 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”, Second edition, Pearson Education, 2002.

20CU103 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	1	0	4

OBJECTIVES:

This subject focuses on mathematical description and modeling of discrete time random signals with important theorems and algorithms. Also the student can learn relevant figures of merit such as power, energy, bias and consistency and familiar with estimation, prediction and filtering techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6

Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Auto-correlation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records,Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

UNIT II SPECTRUM ESTIMATION 9+6

Bias and Consistency of estimators - Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.

UNIT III LINEAR ESTIMATION AND PREDICTION 9+6

Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.

UNIT IV ADAPTIVE FILTERS 9+6

Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING 9+6

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.

TOTAL 45 + 30: 75 PERIODS

Course Outcomes (COs):

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

CO1 : Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.

CO2 : State Parseval's theorem, W-K theorem, principle of orthogonality, spectral factorization theorem, Widrow-Hoff LMS algorithm and Shannon's sampling theorem, and define linear prediction, linear estimation, sample auto-correlation, periodogram, bias and consistency.

CO3 : Explain various noise types, Yule-Walker algorithm, parametric and non-parametric methods, Wiener and Kalman filtering, LMS and RMS algorithms, Levinson Durbin algorithm, adaptive noise cancellation and adaptive echo cancellation, speed verses convergence issues, channel equalization, sampling rate change, subband coding and wavelet transform.

CO4 : Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval's theorem, W-K theorem and normal equations.

CO5 : Design AR, MA, ARMA models, Weiner filter, anti aliasing and anti imaging filters, and develop FIR adaptive filter and polyphase filter structures.

CO6 : Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006.
3. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.
4. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ, 1986.
5. S. Kay, "Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ, 1988.
6. Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.

20RM101 **RESEARCH METHODOLOGY AND IPR**

L	T	P	C
2	0	0	2

OBJECTIVES:

To give an overview of the research methodology and explain the technique of defining a research problem and to explain the functions of the literature review in research. This course can explain the art of interpretation and the art of writing research reports. Also it explains various forms of the intellectual property, its relevance and business impact in the changing global business environment.

UNIT I INTRODUCTION TO RESEARCH METHODOLOGY 6

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations. Effective literature studies, approaches, analysis, Plagiarism, Research ethics.

UNIT II EFFECTIVE TECHNICAL WRITING 6

How to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III INTELLECTUAL PROPERTY AND INTERNATIONAL SCENARIO 6

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

UNIT IV PATENT RIGHTS 6

Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

UNIT V NEW DEVELOPMENTS IN IPR 6

Administration of Patent System, New developments in IPR, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand research problem formulation.

CO2 **:** Analyze research related information.

CO3 **:** Follow research ethics.

CO4 : Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CO5 : Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

CO6 : Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

REFERENCES:

1. S.Melville and W.Goddard, "Research Methodology: An Introduction for Science and Engineering Students", Juta & Co. Ltd., 1996.
2. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", Third Edition, SAGE Publications Ltd., 2010.
3. Debora J. Halbert, "Resisting Intellectual Property (RIPE Series in Global Political Economy)", Taylor & Francis Ltd., 2006.
4. W.H.Mayall, "Industrial Design for Engineers", London Iliffe Books Ltd. 1967.
5. Benjamin W. Niebel, "Product Design and Process Engineering", McGraw-Hill Inc., US, 1974.
6. Morris Asimow, "An Introduction To Design", Prentice-Hall, Inc. First Edition, 1962.
7. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Law & Business, 2012.
8. T. Ramappa, "Intellectual Property Rights Under WTO: Tasks Before India", A H Wheeler Publishing Co. Ltd., 2002.

20CU1L1 **ADVANCED COMMUNICATION SYSTEMS LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVES:

This course introduces the basics of microstrip patch antenna and its analysis. This study can measure the performance of digital communication systems and provide a comprehensive knowledge of wireless communication with the design of digital filter and it's adaptive filtering algorithms.

LIST OF EXPERIMENTS

USE NETWORK ANALYSER:

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.

USE APPROPRIATE SIMULATION TOOLS:

1. Generation and 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: 60 PERIODS

Course Outcomes (COs):

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

CO1 **:** Acquire knowledge on Transmission line and S- parameter estimation of microwave devices.

CO2 **:** Measure and analyze various transmission line parameters.

CO3 **:** Design Microstrip patch antennas.

CO4 **:** Implement the adaptive filtering algorithms.

CO5 **:** Generate and detect digital communication signals of various modulation techniques using MATLAB.

CO6 **:** Evaluate cellular mobile communication technology and propagation model.

20CU201 ADVANCED WIRELESS COMMUNICATIONS SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the concepts of MIMO diversity and spatial multiplexing. This can useful to learn Massive MIMO system and millimeter wave communication.

UNIT I INFORMATION THEORETIC ASPECTS OF MIMO 10

Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels, Erogodic and outage capacity, capacity bounds and influence of channel properties on the capacity.

UNIT II MIMO DIVERSITY AND SPATIAL MULTIPLEXING 10

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

UNIT III MASSIVE MIMO SYSTEM 9

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

UNIT IV MILLIMETER WAVE COMMUNICATION 8

Spectrum regulation, Channel propagation, Hardware technology for mmWave systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

UNIT V SOFTWARE DEFINED RADIO AND COGNITIVE RADIO 8

SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self controlling system, Ontology based cognitive radio.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Describe and categorize various wireless MIMO channel models.

CO2 : Analyze the performance of various MIMO channel models.

CO3 : Prioritize different spatial diversity techniques.

CO4 : Explain various ST coding techniques and design optimum receivers for MIMO systems.

CO5 : Analyze and evaluate advanced signal processing techniques for wireless communications.

CO6 : Demonstrate software defined radio and cognitive radio.

REFERENCES:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press, 2005.
3. Mischa Dohler and Jose F. Monserrat Afif Osseiran "5G Mobile and Wireless Communication Technology", Cambridge University Press, 2016.
4. Mieczyslaw M Kokar and Lezek Lechowicz, "Cognitive Radio Interoperability through Waveform Reconfiguration" ARTECH House, 2016.

20CU202 MIC AND RF SYSTEM DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the fundamental principles of the design of RF circuits and its analysis. Also, it can describe about the design of microstrip lines for a given set of parameters.

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

Course Outcomes (COs):

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

CO1 : Understand the fundamentals of RF design and Microwave integrated circuits.

CO2 : Understand the various components of RF system for Wireless Communications.

CO3 : Know the basic techniques needed for the analysis of RF systems.

CO4 : Describe the various types of microstrip line components.

CO5 : Analyze the performance of microstrip lines using different methods.

CO6 : Design lumped elements for a given set of parameters.

REFERENCES:

1. B.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.

20CU2L1 RF SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

This course aims to provide students with the technological skills needed in the design and engineering of modern Microwave systems and subsystems. This course focuses on the design and simulation of passive and active devices for microwave applications.

LIST OF EXPERIMENTS

(ADS/IE3D/HFSS or any similar/ equivalent tool may be used for the design)

1. Measurement of S parameters for (a) Inductor (b) Capacitor (c) impedance matching circuits, filters using network analyzer
2. Design of λ/2, λ/4 microstrip transmission line.
3. Design of microstrip inductor and capacitor.
4. Design of impedance matching network.
5. Design of low pass, high pass, band pass and band stop filter at RF.
6. Design and characterization of microstrip patch antennas.
7. Design and characterization of LNA.
8. Design and characterization of Mixer.
9. Design and characterization of VCO.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

- Network analyzer Equipment - 1.5 GHz (Minimum) – 1 No
- ADS/IE3D/HFSS or any similar / equivalent Electromagnetic Simulation tool for Design experiments – 10 User license
- Desktop PC"s for hosting Electromagnetic simulation tool – 10 Numbers
- Inductor, Capacitor, matching circuits, filters capable of operating at 500 MHz or above

Course Outcomes (COs):

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

CO1 **:** Verify the basic principles and design aspects involved in high frequency communication systems components.

CO2 **:** Expose the student to different high frequency components and conduct the experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts.

CO3 **:** Apply knowledge to identify a suitable architecture and systematically design an RF system.

CO4 **:** Comprehensively record and report the measured data, and would be capable of analyzing, interpreting the experimentally measured data and produce the meaningful conclusions.

CO5 **:** Design and develop RF components using microstrip technology.

CO6 **:** Design and develop microstrip filters.

20CU301 **MILLIMETER WAVE COMMUNICATION**

L	T	P	C
3	0	0	3

OBJECTIVES:

The primary focus of this course is to introduce the design characteristics of millimeter wave communications, guiding structures and interconnects at millimeter-wave frequencies. Also, it focuses on the design of millimeter-wave fields, meta-surface antennas and low-profile antennas.

UNIT I INTRODUCTION **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, Device to Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand the fundamentals of Millimeter wave devices and circuits.

CO2 **:** Understand the various components of Millimeter wave communications system.

CO3 : Design antenna for Millimeter wave frequencies.

CO4 : Understand the modulation techniques in Millimeter Wave Communication.

CO5 : Extend the knowledge gained through the wireless communication course to MIMO scenario and identify its challenges and issues.

CO6 : Apply the fundamental concepts of multicarrier communication to design of LTE systems.

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 and Murdock, "Millimeter Wave Wireless Communication”, Prentice Hall, 2014.
3. Xiang, W; Zheng, K; Shen, X.S; “5G Mobile Communications”, Springer, 2016.

20CU1E1 **OPTICAL NETWORKS**

L	T	P	C
3	0	0	3

OBJECTIVES:

This subject focuses on optical system components like optical amplifiers and wavelength converters. The study of recent developments in optical network architectures, packet switching, network design perspectives, different optical network management techniques and functions.

UNIT I INTRODUCTION TO OPTICAL NETWORKS 9

Telecommunications Networks Architecture, Services, circuit switching and packet switching, Optical Networks: Multiplexing Techniques, Second generation Optical Networks, Optical Packet Switching, Transmission Basics: Wavelength, frequencies, and channel spacing, Wavelength standards, Optical power and loss, Network Evolution, Nonlinear Effects: Self-phase Modulation, Cross-phase Modulation, Four Wave mixing, Solitons. Components: Couplers, Isolators and Circulators, Multiplexers and Filters, Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Converters.

UNIT II TRANSMISSION SYSTEM ENGINEERING 9

System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Crosstalk, Dispersion, Wavelength Stabilization, Overall Design Considerations. Optical Internets: Migration to IP optical networking, IP and Optical backbone, IP Routing table, MPLS and optical cross connect table, Protocol stack Alternatives, Internetworking SS7 and Legacy Transport, Internet transport network protocol stack.

UNIT III SONET, SDH AND OPTICAL TRANSPORT NETWORKS (OTNS) 9

SONET and SDH: SONET multiplexing hierarchy, Frame structure, Functional Component, problem detection, concatenation. Architecture of Optical Transport Networks (OTNs): Digital wrapper, in-band and out-of band control signalling, Importance of Multiplexing and multiplexing hierarchies, SONET multiplexing hierarchies, SDH multiplexing hierarchies, New Optical Transport, OTN layered Model, Generic Framing Procedure (GFP).

UNIT IV WDM, NETWORK TOPOLOGIES, MPLS AND OPTICAL NETWORKS 9

WDM operation, Dense Wavelength Division Multiplexing (DWDM), Erbium-doped Fiber (EDF), WDM amplifiers, Add-Drop Multiplexers, Wavelength Continuity Property, Higher dispersion for DWDM, Tunable DWDM Lasers.

UNIT V NETWORK TOPOLOGIES AND PROTECTION SCHEMES 9

Robust networks, Line and path protection switching, Types of topology, Point to point topology, bi-directional line-switched ring (BLSR), meshed topology, Passive optical networks, Metro optical networks 28 MPLS and Optical Networks: IS label switching, Forwarding equivalence class (FEC), Types of MPLS nodes, Label distribution and binding, label swapping and traffic forwarding, MPLS support of Virtual Private Networks (VPN), MPLS traffic engineering, Multi protocol Lambda switching (MPIS).

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Interpret functions of various optical network components.

CO2 : Analyze broadcast-and-select and wavelength routing networks.

CO3 : Compare different optical network architectures.

CO4 : Explain photonic packet switching concepts and access networks.

CO5 : Analyze different network management functions.

CO6 : Assess and Evaluate optical networks.

REFERENCES:

1. Rajiv Ramaswami and Kumar Sivarajan, "Optical Networks – Practical Perspective", 3rd Edition, Morgan - Kaufmann Publishers.
2. Optical Networks, Third Generation Transport Systems, Uyless Black, Pearson.

20CU1E2 **RADAR SIGNAL PROCESSING**

L	T	P	C
3	0	0	3

OBJECTIVES:

The students could understand the basic principles of radar operation and the different types of radars and their applications. They can able 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. Also, they become familiar with conventional applications of radar and with new techniques currently being researched and implemented.

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), Radar measurements.

UNIT II RADAR SYSTEM CONCEPTS 9

Scattering and RCS, RCS models, propagation, antennas, receivers, Different type of Noise, Noise figure, False alarm & Missed detection, Radar cross section, Transmit/Receive and Anti-Transmit/Receive Switches.

UNIT III SIGNAL PROCESSING – I 9

Radar Signal Processing Fundamentals – Detection and likelihood ratio, binary detection, matched filtering, radar ambiguity functions, pulse compression and radar waveforms, radar resolution, Detection of radar signals in Noise and clutter, detection of non fluctuating target in noise, Matched filter response to delayed Doppler shifted signals.

UNIT IV SIGNAL PROCESSING – II 9

Doppler Processing, Linear FM Pulse Compression, Waveform diversity, Passive System: Digital compression, SAW pulse compression. Signal processing in Antenna arrays.

UNIT V APPLICATIONS OF RADAR SIGNAL PROCESSING 9

Pulse-Doppler radar, CFAR detection, synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), moving target indication (MTI), displaced-phase-center-antenna technique (DPCA), adaptive radar, super resolution (MUSIC), space-time adaptive processing (STAP).

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Demonstrate an understanding of the basic principles of radar operation and the types.

CO2 : Appreciate the impact of the different performance measures in a radar system.

CO3 : Identify and apply different signal processing tools in the design of radar systems.

CO4 : Design radar systems to meet user specified operational goals.

CO5 : Model radar returns in various operational environments and analyze performance.

CO6 : Understand the design of various RADAR applications.

REFERENCES:

1. M.I. Skolnik, “Introduction to Radar Systems”, Tata McGraw Hill 2006.
2. Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, 2005.
3. Peyton Z. Peebles, Jr., “Radar Principles”, Wiley India Pvt. Ltd., 2007.
4. Nadav Levanon, “Radar Principles”, Wiley – Technology and Engineering Publication, 1988.
5. Nathansan, “Radar design principles-Signal processing and environment”, PHI, 2nd Edition, 2007.
6. Roger J.Sullivan, “Radar foundations for Imaging and advanced concepts”, PHI, 2004.

20CU1E3 ANALOG AND MIXED MODE VLSI DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

The course aims at understanding the engineering and design principles of analog CMOS technology for application in analog integrated circuits and subsystems. Students will have an in-depth knowledge of basic concepts in CMOS RF design, scattering parameters, modern integrated circuit technologies, fundamental limitations of speed of operation of transistors, physics of noise, impedance matching, low-noise amplifiers, mixers, oscillators, phase noise and phase locked loops.

UNIT I INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues - MOS FET structures and characteristics - large signal and small signal model of single stage Amplifier - Source follower - Common gate stage – Cascode Stage – large and small signal analysis of differential amplifier with active load, pole-zero estimation, zero value time constant method, frequency response of CS, cascade and cascade amplifiers

UNIT II SUBMICRON CIRCUIT DESIGN 9

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements – Adders - OP Amp parameters and Design

UNIT III DATA CONVERTERS 9

Static and dynamic errors in DAC and ADC – Architectures & Characteristics of Sample and Hold - Digital to Analog Converters - DAC - R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC

UNIT IV SNR IN DATA CONVERTERS 9

Overview of SNR of Data Converters - Clock Jitters - Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters - Interpolating Filters for DAC

UNIT V SWITCHED CAPACITOR CIRCUITS 9

Resistors, First order low pass Circuit, Switched capacitor Amplifier, Switched Capacitor Integrator – Design of flip around sample and hold circuit – pipelined ADC

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the concepts of MOS large signal model and small signal model.

CO2 : Design of analog CMOS subcircuits including MOS switch, current sinks and sources and current mirrors.

CO3 : Understand the concepts of D/A conversion methods and their architectures.

CO4 : Discuss the submicron circuit design.

CO5 : Design of CMOS single stage amplifiers, including differential amplifiers, cascade amplifiers and inverters.

CO6 : Design and analyze the switched capacitor circuits.

REFERENCES:

1. J. Jacob Wikner, Mikael Gustavsson and Nianxiong Tan, “CMOS Data Converters for Communications”, Springer, 2000.
2. Van de Plassche and Rudy J., “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters”, Springer, 2003.

20CU1E4 REAL TIME EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the concepts of embedded systems and its real-time applications using the ARM processor, real-time operating system and embedded software design techniques. The student can learn the architecture and programming of ARM processor, embedded computing platform design and analysis. Also they learn the system design techniques and networks for embedded systems.

UNIT I INTRODUCTION TO ARM PROCEESORS 9

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT II COMPUTING PLATFORM AND DESIGN ANALYSIS 9

CPU buses – Memory devices – I/O devices – Memory Protection Units – Memory Management Units – Component interfacing – Design with microprocessors – Development and Debugging – Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT III PROCESS AND OPERATING SYSTEMS 9

Multiple tasks and multi processes – Processes – Context Switching – Scheduling policies - Multiprocessor – Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes – Firmware and Operating Systems for ARM processor.

UNIT IV HARDWARE ACCELERATES & NETWORKS 9

Accelerators – Accelerated system design – Distributed Embedded Architecture – Networks for Embedded Systems – Network based design – Internet enabled systems.

UNIT V CASE STUDY 9

Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants Set–Top–Box – System-on-Silicon – FOSS Tools for embedded system development.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Describe the architecture and programming of ARM processor.

CO2 : Outline the concepts of program level in embedded processor computing.

CO3 : Explain the basic concepts of real time Operating system.

CO4 : Use the system design techniques and networks for embedded systems.

CO5 : Model the real-time applications using embedded-system concepts.

CO6 : Understand case studies related to embedded systems.

REFERENCES:

1. Andrew N Sloss, Dominic Symes and Chris Wright, “ARM system developer’s guide – Designing and Optimizing System Software”, Morgan Kaufmann publishers, 2004.
2. David E-Simon, “An Embedded Software Primer”, Pearson Education, 2007.
3. K.V.K.K. Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dreamtech Press, 2005.
4. Tim Wilmshurst, “An Introduction to the Design of Small Scale Embedded Systems”, Pal grave Publisher, 2004.
5. Wayne Wolf, “Computers as Components - Principles of Embedded Computer System Design”, Morgan Kaufmann Publisher, 2006.

20CU1E5 **MARKOV CHAIN AND QUEUING SYSTEM**

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the concepts of key mathematical tools necessary to anticipate the performance levels of queuing systems and understand the behavior of other systems that evolve randomly over time. This course gives a good learning about how to describe a queuing system statistically, how to model the random evolution of queue lengths over time and calculate key performance indicators, such as an average delay or a loss probability.

UNIT I INTRODUCTION TO QUEUING THEORY 9

Introduction to Probability, Stochastic Processes and System Modeling, Markov Chains and regenerative processes, Modeling - variety of systems and phenomena. Systems model - queuing systems in aspect of the queue governed by a random process. Examples of modeling systems in telecommunication systems, manufacturing systems and computer systems.

UNIT II NO-LOSS QUEUE 9

System modeling using Markov chains with special emphasis on developing queueing models. Properties of nonnegative random variables, laws of large numbers and the Central Limit Theorem, Renewal Processes: Recurrence times, Rewards and Renewal reward theorem, Point processes, Poisson process, Walds equation, Blackwell's theorem.

UNIT III DISCRETE TIME MARKOV CHAINS 9

Stochastic processes in discrete time, Markov chains as recursions with examples, Chapman-Kolmogorov equations and n-step transition probabilities, Examples of Discrete State Space Markov Chains, Computing the Transient Distribution, Uniqueness/Existence for First Step Analysis, Matrix and Vector Norms.

UNIT IV CONTINUOUS TIME MARKOV CHAINS 9

Embedded Markov processes, semi Markov processes, reversible Markov chains. Random walks. Fundamental queueing results: Little's theorem, invariance of the mean delay, Conservation law.

UNIT V MULTISERVER AND FINITE CAPACITY QUEUES 9

Markovian queues: Jackson and BCMP networks, numerical algorithms. M/G/1 & G/M/1 queues and G/G/1 queues; Advanced queueing models: priority, vacation and retrials in queues.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Characterize a queue, based on probabilistic assumptions about arrivals and service times, number of servers, buffer size and service discipline.

CO2 : Describe the basics of discrete time and continuous time Markov chains.

CO3 : Model simple queuing systems, like M/M/1 or M/M/C/C queues, as continuous time Markov chains.

CO4 : Compute key performance indicators, such as an average delay, a resource utilization rate, or a loss probability, in simple single-server or multi-server system.

CO5 : Design queuing simulations with the Python language to analyze how systems with limited resources distribute them between customers.

CO6 : Understand case studies related to telecommunication systems.

REFERENCES:

1. Ronald W. Wolff, “Stochastic Modeling and the Theory of Queues”, Prentice-hall International Series, 1989.
2. P.Bremaud, “Markov Chains”, Springer-Verlag, 1999.
3. E.Seneta, “Non Negative Matrices and Markov Chains”, Springer Series in Statistics, Springer, 1981.
4. R.Gallager, “Discrete Stochastic Processes”, Kluwer Academic Press, 1996.
5. L.Kleinrock, “Queueing Systems” Vol. I and II, John Wiley and Sons, 1976.
6. D.Gross and C.Harris, “Fundamentals of Queueing Theory”, Third Edition, Wiley, 1998.
7. J.Medhi, “Stochastic Models in Queueing Theory”, Second Edition, Academic Press, 2003.
8. R.B.Cooper, “Introduction to Queueing Theory”, Second Edition, North-Holland, 1981.
9. R.Nelson, “Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modelling”, Springer, 1995.
10. E.Gelenbe and G.Pujolle, “Introduction to Queueing Networks”, Second Edition, Wiley, 1998.

20CU2E1 COMMUNICATION NETWORK MODELLING AND SIMULATION

L	T	P	C
3	0	0	3

OBJECTIVES:

The course introduces the fundamental principles of the communication system which can be evaluated using formula based calculations, waveform level simulation or through hardware prototyping and measurements. Hardware prototypes are in general, costly, time-consuming and non-flexible. In the simulation based approaches, systems can be modeled with almost any level of detail desired. Further, the mathematical, measured characteristics of devices and actual signals can be combined into the analysis and design of communication systems.

UNIT I INTRODUCTION TO MODELING AND SIMULATION 9

Introduction, Discrete-event simulation, Modeling for computer simulation, Tools and Methods for Network Simulation, The simulation platform, Simulation Framework, Tools and Modeling approaches for Simulating Hardware.

UNIT II MONTE CARLO SIMULATION 9

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semianalytic techniques, Case study: Performance estimation of a wireless system.

UNIT III LOWER LAYER & LINK LAYER WIRELESS MODELING 9

Physical Layer Modeling, Description of the Main Components of the PHY Layer, Accurate Simulation of Physical Layers, Physical Layer Modeling for Network Simulations, Link Layer Modeling, Medium Access Control (MAC) Protocols, Logical Link Control, Forward Error Detection and Correction, Backward Error Detection and Correction, Queueing and Processing Delay.

UNIT IV CHANNEL MODELING & MOBILITY MODELING 9

Channel Modeling: The Physics of Radiation, The Nature of Electromagnetic Radiation, Classification of Propagation Models, Deterministic Approaches by Classical Field Theory, Deterministic Geometric Optical Approaches, Empirical Path Loss Approaches, Stochastic Shadowing Models, Stochastic Fading Models, MIMO Channel Models.

Mobility modeling: Categorization of Mobility Models, Mobility Models, Random Walk Model, Random Waypoint Model, Random Direction Model, Gauss-Markov Model, Manhattan Model, Column Model, Pursue Model, Nomadic Community Model, Selection of Appropriate Mobility Models.

UNIT V HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY 9

Higher Layer Modeling: Modeling the Network Layer and Routing Protocols, Components of a Routing Protocol, Metrics, Virtual Routing on Overlays, Modeling Transport Layer Protocols, Modeling Application Traffic.

Modeling the Network Topology: Abstraction of Network Topologies by Graphs, Characterizing Graphs, Common Topology Models, Geometric Random Graphs – The Waxman Model, Hierarchical Topologies, Preferential Linking – The Barabási-Albert Model, Modeling the Internet.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the basics of computer based modeling and simulation tools.

CO2 : Apply the Monte Carlo simulation technique.

CO3 : Discuss Lower Layer and Link Layer Wireless Modeling.

CO4 : Compare the channel modeling and mobility modeling.

CO5 : Design and develop protocols for Communication Networks.

CO6 : Design protocols for various functions in the network.

REFERENCES:

1. Irene Karzela, “Modeling and Simulating Communications Networks”, Prentice Hall India, 1998.
2. K.Wehrie. Gunes and J.Gross, “Modeling and Tools for Network simulation”, Springer, 2010.
3. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, “Simulation of Communication Systems: Modeling, Methodology and Techniques”, Plenum Press, New York, 2001.
4. Nejat, Bragg and Arnold, “Recent Advances in Modeling and Simulation Tools for Communication Networks and Services”, Springer, 2007.
5. William H. Tranter, K. Sam Shanmugam, Theodore. S. Rappaport and Kurt L. Kosbar, “Principles of Communication Systems Simulation”, Pearson Education (Singapore) Pvt. Ltd., 2004.

20CU2E2 DIGITAL COMMUNICATION RECEIVERS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the fundamental principles of receiver design from analog front ends to mixed signal design and frequency synthesis with equal emphasis on theory and practical design. Also the students can acquire the design knowledge of futuristic wireless radios and modems which supports the multiple standards and modes.

UNIT I REVIEW OF DIGITAL COMMUNICATION TECHNIQUES 9

Base band communication, signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

UNIT II OPTIMUM RECEIVERS FOR AWGN CHANNEL 9

Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, optimum receivers for signals with random phase in AWGN channel, envelope detection of M-ary orthogonal signals and correlated binary signals.

UNIT III RECEIVERS FOR FADING CHANNELS 9

Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, parameter synchronization for flat fading channels, digital signaling over a frequency selective and slowly fading channel, coded waveform for fading channel.

UNIT IV SYNCHRONIZATION TECHNIQUES 9

Carrier and signal synchronization, carrier phase estimation - PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

UNIT V ADAPTIVE EQUALIZATION 9

Zero forcing algorithm, LMS algorithm, adaptive decision - feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Apply basic principles of digital communication techniques.

CO2 : Discuss on receivers for AWGN & Fading channel.

CO3 : Describe and determine the performance of different error control coding schemes for the reliable transmission of digital information over the channel.

CO4 : Describe various synchronization techniques.

CO5 : Design optimum coherent and non-coherent receiver for digital modulation schemes.

CO6 : Design adaptive equalization algorithms to satisfy the evolving demands in digital communication.

REFERENCES:

1. Heinrich Meyer, Mare Moeneclacy and Stefan A. Fechtel, “Digital communication receivers”, Vol. I and Vol. II, John Wiley, New York, 1997.
2. H. Meyr and G. Ascheid, “Synchronization in Digital Communications”, John Wiley, 1990.
3. John G. Proakis, “Digital communication” Fourth Edition, McGraw-Hill, New York, 2001.
4. R.G. Gallager, "Principles of Digital Communication", New York, Cambridge University Press, 2008.
5. Simon Marvin, “Digital communication over fading channel: An unified approach to performance Analysis”, John Wiley, New York, 2000.
6. U. Mengali and A.N.D Andrea, “Synchronization Techniques for Digital Receivers”, Kluwer, 1997.

20CU2E3 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the basics of EMI, EMI sources, EMI problems, PCB design methodologies and measurement techniques for emission and immunity. Also, it discusses about the comparison of various 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, Basic Standards, 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.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Explain the basic principles of EMI/EMC.

CO2 : Discuss various EMI coupling methods.

CO3 : Compare various EMI/EMC standards.

CO4 : Explain the various isolation, grounding and shielding techniques to minimize EMI effects.

CO5 : Design the printed circuit board traces and layouts with minimum crosstalk.

CO6 : Discuss the various EMI mitigation techniques.

REFERENCES:

1. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Edition, 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 and Technology Books, 2002.
4. Dr. Kenneth L. Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press, 2005.
5. Norman Violette, “Electromagnetic Compatibility”, Published by Springer, 2013.
6. Donald R. J. White, “Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications” Volume 1 of “A Handbook Series on Electromagnetic Interference and Compatibility”, Don white consultants Original from the University of Michigan Digitized on Dec. 2007.
7. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons Inc., New York, 2009.
8. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, New York, 2001.
9. W Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

20CU2E4 **VLSI FOR WIRELESS COMMUNICATION**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the principles of the design concepts of low noise amplifiers and various types of mixers which can be designed for wireless communication. It also explains the design of PLL, VCO and the concepts of CDMA in wireless communication. The students can able to understand the fundamentals of VLSI architectures for a Multitier Wireless System.

UNIT I COMMUNICATION CONCEPTS 9

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS 9

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.

UNIT III MIXERS 9

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.

UNIT IV FREQUENCY SYNTHESIZERS 9

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9

Transmitter back end design – Quadrature LO generator – Power amplifier design.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Describe the various wireless communication concepts for VLSI implementation.

CO2 **:** Explain the various wireless receiver architectures and low noise amplifiers for hardware implementation.

CO3 **:** Discuss the various types of mixers and its characteristics with and without noise properties.

CO4 **:** Demonstrate the design of various frequency synthesizers with PLL, VCO and PD.

CO5 **:** Discuss the wireless transmitter architectures and power amplifiers for hardware implementation for wireless communication systems and its design issues.

CO6 **:** Discuss the concepts related to wireless communication in VLSI, which can be efficiently implemented in real time**.**

REFERENCES:

1. Bosco H. Leung, “VLSI for Wireless Communication”, Pearson Education, 2002.
2. B. Razavi, “RF Microelectronics”, Prentice-Hall, 1998.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill, 1999.
4. Emad N. Farag and Mohamed I. Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, “CMOS Wireless Transceiver Design”, Boston, Kluwer Academic Pub., 1997.
6. Thomas H. Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press, 2003.

20CU2E5 **COGNITIVE RADIO NETWORKS**

L	T	P	C
3	0	0	3

OBJECTIVES:

The main purpose of this course is to introduce the emerging areas of cooperative communication and cognitive radio communication. This will enable the students to acquire a solid understanding of different cooperative protocols in wireless communication and compressive sensing in communication engineering problems. Also the students can learn about spectrum sensing, spectrum decision and spectrum sharing in cognitive radio networks.

UNIT I INTRODUCTION TO SOFTWARE DEFINED RADIO AND COGNITIVE RADIO 9

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

UNIT II COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

UNIT III SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS 9

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection, Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing - Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

UNIT IV MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO 9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

UNIT V ADVANCED TOPICS IN COGNITIVE RADIO 9

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques - Requirement and challenges of IoT – Energy efficiency – MIMO Cognitive Radio – Power allocation algorithms.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Describe the basics of the software defined radios.

CO2 : Compare MAC and network layer design for cognitive radio.

CO3 : Design the wireless networks based on the cognitive radios.

CO4 : Describe in detail about the architecture of cognitive radios.

CO5 : Explain the concepts behind the wireless networks and next generation networks.

CO6 : Discuss cognitive radio for the Internet of Things and M2M technologies.

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee and Thomas Hou, “Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.
3. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
4. Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, 2007.
5. S.Shanmugavel, M.A.Bhagyaveni and R.Kalidoss, “Cognitive Radio - An Enabler for Internet of things”, River Publishers, 2017.

20CU3E1 **ADVANCED ANTENNA DESIGN**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the fundamental principles of the antenna radiation characteristics and arrays. It can provide various antenna design techniques with practical applications and assess the performance of various antennas.

UNIT I ANTENNA FUNDAMENTALS AND ARRAYS 9

Review of Electromagnetic Wave equations, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Antenna parameters, linear array theory, frequency scanned arrays, phased arrays - Retro directive and self-phased arrays. Introduction to numerical techniques.

UNIT II MICRO STRIP ANTENNA 9

Radiation Mechanism from patch; transmission line model based analysis, cavity model, Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, Microstrip Yagi antenna, Microstrip array, Gain improvement techniques in microstrip antenna.

UNIT III APERTURES AND REFLECTOR ANTENNAS 9

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

UNIT IV MODERN ANTENNA STRUCTURES 9

Frequency independent antenna, spiral antenna, active antenna, dielectric antenna, Leaky wave antenna, Plasma antenna, wearable antenna, reconfigurable antenna, meta material, EBG antenna, Frequency selective structures, Broadband and multi-band antenna, Antenna for cellular base stations, MIMO antennas.

UNIT V ANTENNA FOR SPECIAL APPLICATIONS 9

Antenna for EMI/EMC testing, Antenna for EM issues in medical diagnosis and treatment, Antenna for MRI systems, Antenna for 60 GHz applications, RFID antenna, Antenna for wireless charging systems, Antenna for automobile radar, Terahertz antennas, antenna for sensor applications.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the different design and performance parameters of antenna.

CO2 : Understand the overall idea about various existing antennas and different advance antennas presently in practice.

CO3 : Understand the principles of operation, analysis and application of different antennas such as micro-strip antenna, smart antenna, etc.

CO4 : Understand the recent design techniques in antenna.

CO5 : Design and assess the performance of various antennas.

CO6 : Design the antenna for various industrial, medical and sensor applications.

REFERENCES:

1. Balanis. A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 1982.
2. Hubregt J. Visser, “Antenna Theory and Applications”, First Edition, John Wiley & Sons Ltd., New York, 2012.
3. John D. Krauss, Ronald J. Marhefka and Ahmad S. Khan, “Antennas and Wave Propagation”, Fourth Edition, Tata McGraw-Hill, 2006.
4. Zhijun Zhang, “Antenna Design for Mobile Devices”, First Edition, John Wiley & Sons (Asia) Ltd., New York, 2011.

20CU3E2 **ADVANCED DIGITAL IMAGE PROCESSING**

L	T	P	C
3	0	0	3

OBJECTIVES:

The purpose of this course is to provide the basic concepts and methodologies for Digital Image Processing in three different levels. At the lowest level, the course introduces the terminology of image processing, different imaging technologies and the algorithms deal directly with the raw pixel values. In the middle level, it addresses the Quality improvement techniques like enhancement and restoration approaches, segmentation and image representation techniques for analysis purpose. At the highest level, it addresses the classification using statistical decision making and it includes the image processing applications with a few case studies.

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, Run length 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

Course Outcomes (COs):

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

CO1 : Demonstrate the knowledge of image acquisition, digitization and spatial filters for enhancement.

CO2 : Employ color image processing techniques.

CO3 : Apply morphological image processing algorithms.

CO4 : Apply segmentation algorithms and descriptors for image processing.

CO5 : Use neural networks, fuzzy logic and genetic algorithms in object recognition.

CO6 : Apply compression, watermarking and steganography algorithms to images.

REFERENCES:

1. Ardeshir Goshtasby, “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 and Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press, 2008.
5. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson Education Inc., Second Edition, 2004.
6. Rick S. Blum and Zheng Liu, “Multisensor image fusion and its Applications”, Taylor & Francis, 2006.

20CU3E3 SPEECH PROCESSING AND SYNTHESIS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the speech production and its related parameters of speech. It illustrates the concepts of speech signal representations and coding and different speech modeling procedures such Markov and their implementation issues. Also the students can gain knowledge about text analysis and speech synthesis.

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis, Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vocoders.

UNIT III SPEECH RECOGNITION 9

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV TEXT ANALYSIS 9

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation.

UNIT V SPEECH SYNTHESIS 9

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Illustrate the mechanism and model of speech production.

CO2 : Apply auditory perception techniques.

CO3 : Analyze speech signals and extract its features.

CO4 : Analyze speech processing methods in time and frequency domain.

CO5 : Estimate LPC parameters and apply for speech processing.

CO6 : Apply various algorithms for speech and audio signal processing.

REFERENCES:

1. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Wiley India Edition, 2006.
2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999.
3. Daniel Jurafsky and James H. Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002.
4. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997.

5. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
6. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing, 1997.
7. Thomas F. Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004.

20CU3E4 ADVANCED WIRELESS NETWORKS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the current and next generation wireless networks, cellular networks, WLANs, sensor networks, mobile ad-hoc networks and intermittently connected mobile networks. Also, it proposes the alternative approaches to meet specific communication requirements. It can useful in design and analyze various medium access and resource allocation techniques such as power control for fixed-rate and rate-adaptive systems. Also useful in design and analyze the network layer routing protocols by ensuring security.

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 LTE-A - 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 Bearers and QoS in LTE networks.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Analyze the advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.

CO2 : Understand the wireless IP architecture, Packet Data Protocol and LTE network architecture.

CO3 : Understand the adaptive link layer, hybrid ARQ and graphs routing protocol.

CO4 : Understand about the mobility management, cellular network and micro cellular networks.

CO5 : Understand about the wireless sensor network architecture and its concept.

CO6 : Understand the wireless medium access, wireless security, power saving mechanisms, routing algorithms and QoS in wireless communication networks.

REFERENCES:

1. Ayman ElNashar, Mohamed El-saidny and Mahmoud Sherif, “Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach”, John Wiley & Sons, 2014.
2. Cross point Boulevard, “Wireless and Mobile All-IP Networks”, Wiley Publication, 2005.
3. Jyh-Cheng Chen and Tao Zhang, “IP-Based Next Generation Wireless Networks Systems, Architectures, and Protocols”, John Wiley & Sons Inc. Publication, 2006.
4. Minoru Etoh, “Next Generation Mobile Systems: 3G and Beyond”, Wiley Publications, 2005.
5. Savo Glisic, “Advanced wireless networks technology and business models”, Third Edition, John Wiley & Sons Ltd., 2016.
6. Savo Glisic, “Advanced Wireless Networks: 4G Technologies”, John Wiley & Sons Ltd., 2006.
7. 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.

20CU3E5 FUNDAMENTALS OF 5G MOBILE NETWORKS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces a comprehensive overview of the latest research and standardization progress towards the 5th generation (5G) of mobile communications technology and beyond. It covers a wide range of topics from 5G use cases and their requirements, to spectrum, 5G end-to-end (E2E) system architecture, including core network (CN), transport network (TN) and radio access network (RAN) architecture, network slicing, security and network management.

UNIT I INTRODUCTION 9

Rationale of 5G: high data volume, twenty-five billion connected devices and wide requirements - 10 pillars of 5G - Requirements and key performance indicators. 5G system concept overview, Extreme mobile broadband Massive machine-type communication Ultra-reliable machine-type communication – Dynamic radio access network 3 - Lean system control plane - Localized contents and traffic flows – Spectrum toolbox - The 5G architecture - High-level requirements for the 5G architecture.

UNIT II MACHINE-TYPE COMMUNICATIONS 9

Introduction - Use cases and categorization of MTC - MTC requirements - Fundamental techniques for MTC - Data and control for short packets - Non-orthogonal access protocols - Massive MTC – Design principles - Technology components - Summary of MTC features - Ultra-reliable low-latency MTC - Design principles - Technology components.

UNIT III SMALL CELLS FOR 5G MOBILE NETWORKS 9

Introduction - Small Cells - WiFi and Femto cells as Candidate Small Cell Technologies – WiFi and Femto Performance – Indoors vs Outdoors - Capacity Limits and Achievable Gains with Densification - Gains with Multi-Antenna Techniques - Gains with Small Cells - Mobile Data Demand - Approach and Methodology - Demand vs Capacity - Small-Cell Challenges.

UNIT IV THE 5G RADIO-ACCESS TECHNOLOGIES 9

Access design principles for multi-user communications - Orthogonal multiple-access systems – Spread spectrum multiple-access systems - Capacity limits of multiple-access methods - Multi-carrier with filtering: a new waveform - Filter-bank based multi-carrier - Universal filtered OFDM - Non-orthogonal schemes for efficient multiple access - Non-orthogonal multiple access (NOMA) - Sparse code multiple access (SCMA) - Interleave division multiple access (IDMA) - Radio access for dense deployments - OFDM numerology for small-cell deployments - Small-cell sub-frame structure - Radio access for V2X communication – Medium access control for nodes on the move - Radio access for massive machine-type communication – The massive access problem - Extending access reservation - Direct random access.

UNIT V SECURITY FOR 5G COMMUNICATIONS 9

Overview of a Potential 5G Communications System Architecture - Security Issues and Challenges in 5G Communications Systems - User Equipment - Access Networks - Mobile Operator's Core Network – External IP Networks, SON Evolution for 5G Mobile Networks - SON in UMTS and LTE - The Need for SON in 5G - Evolution towards Small-Cell Dominant HetNets - Towards a New SON Architecture for 5G.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the key features of the 5th Generation (5G) mobile networks and discussing the motivation for 5G.

CO2 : Analyze the new 5G system technology, paving the path towards future research and development with main challenges in developing this new technology.

CO3 : Understand the 5G landscape, including the future Internet, cloud computing, small cells and self-organizing networks (SONs).

CO4 : Understand about the cooperative communications, dynamic spectrum management and cognitive radio, Broadcast-Broadband convergence.

CO5 : Understand the 5G security challenges and green RF techniques.

CO6 : Understand the 5G technology used in a wide range of new applications, including strengthening e-Health like telemedicine, remote surveillance and tele-surgery.

REFERENCES:

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons, 2015.
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, Mischa Dohler and Takehiro Nakamura, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
3. Madhusanka Liyanage, Ijaz Ahmad, Ahmed Bux Abro, Andrei Gurtov and Mika Ylianttila, "A Comprehensive Guide to 5G Security", Wiley, 2018.

20CU4E1 WAVELET TRANSFORMS AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course provides the detailed knowledge about the Wavelet transforms and its applications. Also, it gives expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing for data compression and noise suppression.

UNIT I INTRODUCTION TO WAVELETS 9

Introduction to Multirate signal processing - Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space.

UNIT II MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM 9

Multiresolution formulation of wavelet systems - signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks - Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III WAVELET SYSTEM DESIGN 9

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV WAVELET FAMILIES 9

Continuous Wavelets - Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets - Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V WAVELET APPLICATIONS 9

Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Illustrate the fundamentals of vectors, signals and their relationships.

CO2 : Examine the convergence of signals in Hilbert and Fourier signal spaces.

CO3 : Analyze signals using Multi Resolution Analysis.

CO4 : Assess the different family of wavelets for real-time applications.

CO5 : Apply wavelet transform for image processing.

CO6 : Explain the principle of non-linear wavelets.

REFERENCES:

1. C. Sidney Burrus, Ramesh Gopinath and Haito Guo, “Introduction to wavelets and wavelet transform”, Prentice Hall, 1998.
2. G. Strang and T. Nguyen, “Wavelet and filter banks”, Wellesley-Cambridge Press, Second Edition, 1996.
3. Metin Akay, “Time frequency and wavelets in biomedical signal processing”, Wiley-IEEE Press, 1997.
4. M. Vetterli and J. Kovacevic, “Wavelets and sub band coding”, Prentice Hall, 1995.
5. P.P. Vaidyanathan, “Multi rate systems and filter banks”, Prentice Hall, 1993.
6. Raguveer M. Rao and Ajith S. Bopardikar, “Wavelet transforms – Introduction to theory and applications”, Addison Wesley, 1998.
7. S. Mallet, “A Wavelet tour of Signal Processing”, Academic Press, 1998.

20CU4E2 SOFTWARE DEFINED RADIO

L	T	P	C
3	0	0	3

OBJECTIVES:

This course presents the state-of-the-art in the field of Software Defined Radio Systems. The course will enable the students to learn about the architecture, design methodologies and spectrum sensing techniques used in Software Defined Radio Systems. It provides the capability to build an experiment with real wireless waveform and applications, accessing both PHY and MAC.

UNIT I INTRODUCTION AND 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 MULTIRATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS 9

Sample rate conversion principles, Digital filter Banks, Timing recovery in Digital Receivers using Multirate Digital filters, Approaches to Direct Digital Synthesis, Analysis of spurious signal bandpass 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, ASICs, Tradeoffs, Object oriented programming, Object Brokers, GNU Radio, USRP.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the implementation of radio frequency in hardware systems.

CO2 : Explain the multirate signal processing and digital generation of signals.

CO3 : Design of data converters.

CO4 : Evaluate the smart antennas.

CO5 : Discuss the digital hardware and software choices for SDR.

CO6 : Implement of modern wireless system based on OFDM, MIMO and Smart Antennas.

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, First Edition, 2000.
3. “The GNU software radio”, Available from World Wide Web: https://gnuradio.org, 2007.
4. S. Shanmugavel, M.A. Bhagyaveni and R. Kalidoss, “Cognitive Radio: An Enabler for Internet of things”, River Publishers, 2017.

20CU4E3 SPACE TIME WIRELESS COMMUNICATION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course describes and categorizes the various wireless MIMO channel models. With the performance analysis. It can provide different spatial diversity techniques and explain various ST coding techniques for MIMO systems. It can analyze and evaluate advanced signal processing techniques for wireless communications.

UNIT I MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION 9

Wireless channel, Scattering model in macro cells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

UNIT II CAPACITY OF MULTIPLE ANTENNA CHANNELS 8

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

UNIT III SPATIAL DIVERSITY 8

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

UNIT IV MULTIPLE ANTENNA CODING AND RECEIVERS 10

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

UNIT V ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION 10

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Explain the various modulation and coding schemes for space-time Wireless Communications.

CO2 : Design and evaluate the receiver and transmitter diversity techniques.

CO3 : Understand the transmission and decoding techniques associated with wireless communications.

CO4 : Understand multiple-antenna systems such as multiple-input multiple-output (MIMO) and Space-Time Codes.

CO5 : Design and develop the OFDM based MIMO systems.

CO6 : Calculate the capacity of MIMO systems.

REFERENCES:

1. Andre Viterbi, “Principles of Spread Spectrum Techniques”, Addison Wesley, 1995.
2. Jafarkhani and Hamid, “Space-time coding: Theory and Practice”, Cambridge University Press, 2005.
3. Paulraj, Rohit Nabar and Dhananjay Gore, “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2003.
4. Sergio Verdu, “Multi User Detection”, Cambridge University Press, 1998.

20CU4E4 PATTERN RECOGNITION AND MACHINE LEARNING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the fundamentals of pattern classifier, various clustering concepts, and various structural pattern recognition and feature extraction methodologies. It also focuses on the basics of concept learning, decision trees and explores recent advances in pattern recognition techniques including neural networks, SVM and nonlinear classifiers. The students can able to solve clustering problems through functional optimization and graph theory.

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 RECENT ADVANCES 9

Neural network structures for pattern recognition - Neural network based pattern associations – Unsupervised learning in neural pattern recognition - Self organizing networks - Fuzzy logic - Fuzzy pattern classifiers - Pattern classification using Genetic Algorithms.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the supervised and unsupervised classifiers to problems in computer vision, speech recognition, data mining, statistics and information retrieval.

CO2 : Explain the neural networks and SVM to appreciate the signal detection and classification encountered communication.

CO3 : Classify the data and identify the patterns.

CO4 : Utilize the given data set to extract and select features for pattern recognition.

CO5 : Describe the decision tree and concept learning.

CO6 : Discuss on recent advances in pattern recognition.

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 and Sons, New York, 1993.
3. Narasimha Murty 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 and 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, 1974.

20CU4E5 **VIRTUAL REALITY SYSTEMS**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the basics of Virtual Reality (VR) and its different applications, the psychology of Virtual Reality and the challenges of the medium. This course explains the Mobile VR as well as devices such as the Oculus Rift and HTC Vive. A learner with no previous experience in Virtual Reality and/or game programming will be able to evaluate existing VR applications, and design, test, and implement their own VR experience/games using Unity by the end of the specialization.

UNIT I VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS 7

The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality.

UNIT II HARDWARE TECHNOLOGIES FOR 3D USER INTERFACES 10

Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces. Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.

UNIT III SOFTWARE TECHNOLOGIES 10

Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits, Available software in the market.

UNIT IV 3D INTERACTION TECHNIQUES 9

3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Deign Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Mutimodal System Control Techniques, Design Guidelines, Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry.

UNIT V ADVANCES IN 3D USER INTERFACES 9

Strategies for Designing and Developing of 3D User Interfaces, Guidelines and Evaluation of 3D User Interfaces, 3D User Interfaces for the Real World, AR Interfaces as 3D Data Browsers, 3D Augmented Reality Interfaces, Augmented Surfaces and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces - The future of 3D User Interfaces, Questions of 3D UI Technology, 3D Interaction Techniques, 3D UI Design and Development, 3D UI Evaluation and Other Issues. Applications in Engineering, Architecture, Education, Medicine, Entertainment, Science and Training.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Differentiate between Virtual, Mixed and Augmented Reality platforms.

CO2 : Understanding of fundamental techniques, processes, technologies and equipment used in immersive virtual reality.

CO3 : Explain the basics of historical and theoretical contexts relevant to immersive virtual reality.

CO4 : Discuss about the materials and processes used in immersive virtual reality.

CO5 : Categorize the benefits/shortcomings of available immersive technology platforms.

CO6 : Understanding of the importance of critical and self-reflective practice.

REFERENCES:

1. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
2. Gerard Kim, “Designing Virtual Reality Systems: The Structured Approach”, Springer, 2005.
3. Joseph LaViola Jr, Ernest Kuijff, Ryan McMahan, Doug Bowman and Ivan Poupyrev, “3D User Interfaces: Theory and Practice”, Addison-Wesley, 2007.
4. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Merging Real and Virtual Worlds”, A K Peters/CRC Press, 2005.
5. Philippe Coiffet and Grigore C Burdea, “Virtual Reality Technology”, Wiley-IEEE Press, 2003.
6. John Vince, “Virtual Reality Systems”, Pearson Education India, 2002.
7. Howard Rheingold, “Virtual Reality: The Revolutionary Technology of Computer-Generated Artificial Worlds-And How It Promises to Transform Society”, Simon and Schuster, 1992.
8. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, 2002.

20CU5E1 NETWORK ROUTING ALGORITHMS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course provides the exposure to the layered architecture for communication networks and the specific functionality of the network layer. It focuses the basic principles of routing and implementation of conventional networks. It can evolve routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network. The student can understand the different routing algorithms existing and their performance characteristics.

UNIT I INTRODUCTION 7

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 10

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 10

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting - Benefits and Issues, Light path 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, Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing, Hybrid Routing: Zone Based Routing (ZRP).

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Compare and analyze the various network routing algorithms.

CO2 **:** Discuss about interior and exterior routing protocols.

CO3 **:** Explain the routing algorithms for optical WDM Networks.

CO4 **:** Elaborate Mobile-IP network and its protocol.

CO5 **:** Analyze routing algorithm for mobile Adhoc-network.

CO6 **:** Design a new algorithm or modify an existing algorithm for the user applications.

REFERENCES:

1. A.T. Campbell et al., “Comparison of IP Micro-mobility Protocols”, IEEE Wireless Communications, 2002.
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 Shantidev Mohanty, “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, New York, 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”, Second Edition, Pearson Education Asia, Reprint India, 2002.

20CU5E2 MACHINE LEARNING IN COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

OBJECTIVES:

The students could understand the concept of machine learning and its application in wireless communication and bio-medical engineering. They can able to familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

UNIT I MATHEMATICAL BACKROUND 9

Linear Algebra – Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition, Pseudo inverse, Principal Component analysis. Probability theory – probability distribution, conditional probability, Chain rule, Bayes rule, Information theory, Structured Probabilistic models.

UNIT II MACHINE LEARNING BASICS 9

Supervised and Unsupervised learning, Capacity, Overfitting and Underfitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbor.

UNIT III NEURAL NETWORKS 9

Feedforward Networks, Backpropagation, Convolutional Neural Networks-LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks. Recurrent Neural Network (RNN) – Backpropagation through time (BPTT), Vanishing and Exploding Gradients.

UNIT IV ML IN WIRELESS AND SECURITY 9

Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems. Optimization in beamformer design – Robust receive beamforming, Transmit downlink beamforming. Application: Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis.

UNIT V ML IN BIO-MEDICAL 9

Machine Learning in Medical Imaging. Deep Learning for Health Informatics. Deep Learning Automated ECG Noise Detection and Classification System for Unsupervised Healthcare Monitoring. Techniques for Electronic Health Record (EHR) Analysis.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Demonstrate the mathematical principles underlying machine learning.

CO2 : Understand the different machine learning techniques and their use cases.

CO3 : Formulate machine learning problems corresponding to different applications.

CO4 : Recognize the characteristics of machine learning techniques that are useful to solve real-world problems.

CO5 : Synthesize the current research papers, and understand the issues and the machine learning based solution approaches.

CO6 : Formulate the solutions for bio-medical issues through the deep learning techniques.

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, “Deep learning”, Cambridge, MA, MIT Press, 2017.
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill, 1997.
3. Ethem Alpaydın, “Introduction to machine learning”, MIT Press, 3rd Edition, 2014.
4. M.N. Wernick, Y. Yang, J.G. Brankov, G. Yourganov and S.C. Strother, “Machine Learning in Medical Imaging”, IEEE Signal Processing Magazine, vol. 27, no. 4, pp. 25-38, July 2010.
5. Ravì et al., “Deep Learning for Health Informatics,” IEEE Journal of Biomedical and Health Informatics, vol. 21, no. 1, pp. 4-21, Jan. 2017.
6. U. Satija, B. Ramkumar and M. S. Manikandan, “Automated ECG Noise Detection and Classification”, IEEE Journal of Biomedical and Health Informatics PP(99), March 2017.
7. “System for Unsupervised Healthcare Monitoring,” IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 3, pp. 722-732, May 2018.
8. B. Shickel, P. J. Tighe, A. Bihorac and P. Rashidi, “Deep EHR: A Survey of Recent Advances in Deep Learning Techniques for Electronic Health Record (EHR) Analysis,” IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 5, pp. 1589-1604, Sept. 2018.
9. 9. A. Heuser, S. Picek, S. Guilley and N. Mentens, “Lightweight Ciphers and their Side-channel Resilience,” IEEE Transactions on Computers, DOI 10.1109/TC.2017.2757921.

20CU5E3 **MULTIMEDIA COMPRESSION TECHNIQUES**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course introduces the basic ideas of compression algorithms related to multimedia components such as text, speech, audio, image and video. It gives exposure to the multimedia principles, standards and applications with an emphasis on the underlying technologies, algorithms, and performance. It also analyzes the different approaches of compression algorithms in multimedia related mini projects.

UNIT I FUNDAMENTALS OF COMPRESSION 9

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

UNIT II TEXT COMPRESSION 9

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

UNIT III IMAGE COMPRESSION 9

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

UNIT IV AUDIO COMPRESSION 9

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

UNIT V VIDEO COMPRESSION 9

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Explain the various compression and quantization techniques.

CO2 **:** Discuss various data compression algorithms and compare their efficiency in terms of speed and compression ratio.

CO3 : Analyze different compression techniques and standards for image and video.

CO4 : Compare various video compression standards.

CO5 : Apply knowledge for identifying a suitable strategy for compression of text, image, audio and video.

CO6 : Implement basic compression algorithms with MATLAB and its equivalent open source environments.

REFERENCES:

1. David Solomon, “Data Compression: The Complete Reference”, Fourth Edition, Springer Verlog, New York, 2006.
2. Darrel Hankerson, Greg A. Harris and Peter D. Johnson, “Introduction to Information Theory and Data Compression”, Second Edition, Chapman and Hall, CRC Press, 2003.
3. Khalid Sayood, “Introduction to Data Compression”, Third Edition, Morgan Kauffman Harcourt India, 2010.
4. Mark S. Drew and Ze-Nian Li, “Fundamentals of Multimedia”, PHI, 2009.
5. Peter Symes, “Digital Video Compression”, McGraw Hill Publication, 2004.
6. Yun Q. Shi and Huifang Sun, “Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals”, CRC Press, 2003.

20CU5E4 **ULTRA WIDEBAND COMMUNICATION**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course focuses on the basic signal processing techniques that concerns present and future dynamic UWB communication systems. This course encompasses all areas of design and implementation of UWB systems.

UNIT I INTRODUCTION TO UWB **9**

History, Definition, FCC Mask, UWB features, UWB Interference: IEEE 802.11a 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 Broadband antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broadband 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 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand the basics of UWB technologies.

CO2 **:** Understand the channel model and signal processing for UWB.

CO3 **:** Assess the performance of UWB channels.

CO4 **:** Design UWB antenna for various applications.

CO5 **:** Design and analyze antennas for UWB transmission.

CO6 **:** Compare the UWB based standards.

REFERENCES:

1. Homayoun Nikookar and Ramjee Prasad, “Introduction to Ultra Wideband for Wireless Communications” First Edition, Springer Science & Business Media B.V., 2010.
2. Thomas Kaiser and Feng Zheng, “Ultra Wideband Systems with MIMO”, First Edition, John Wiley and 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.

20CU5E5 SMART ANTENNAS FOR 5G COMMUNICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course focuses on the smart antennas for wireless communications with MATLAB. It is an exhaustive course on smart antenna design and deployment. Smart antennas are one of the key technologies, helping to transform the wireless market. It offers comprehensive guidance to understanding their fundamental behavior and real-world application. Also, it offers a complete overview of basic electromagnetic, propagation and signal processing behind the smart antenna design.

UNIT I 5G CONCEPTS 9

5G Objectives and Usage Scenarios, 5G Activities, Channel Access Method/Air Interface, 5G Policy, 5G Timelines, 4G/5G Radio Access Network, 5G system concept, LTE-Advanced, LTE-Advanced Pro, 5G NR, The 5G architecture, Spectrum Analysis and Regulations for 5G.

UNIT II INTRODUCTION TO SMART ANTENNA 9

Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.

UNIT III SMART ANTENNA CONFIGURATIONS 9

Fixed Sidelobe Canceling, Retrodirective Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beamformers, Switched Beam Systems, Multiple Fixed Beam System. Uplink Processing, Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming, Downlink Processing.

UNIT IV ANGLE-OF-ARRIVAL ESTIMATION 9

Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.

UNIT V MIMO ANTENNAS 9

Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO, MIMO, Hybrid antenna array for mmWave massive MIMO: Massive Hybrid Array Architectures, Hardware Design for Analog Subarray.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the basics of smart and adaptive antennas.

CO2 : Apply different adaptive algorithms for 5G antenna.

CO3 : Understanding the concept of direction of arrival and angle of arrival.

CO4 : Design of antenna array architectures to meet 5G requirement.

CO5 : Design the device to device communication and millimeter wave communication.

CO6 : Implementation options for smart antennas for 5G communications.

REFERENCES:

1. Ahmed El Zooghby, “Smart Antenna Engineering”, Artech House Publishers, 2005.
2. Frank Gross, “Smart Antennas with MATLAB”, Second Edition, McGraw-Hill Education, 2015.
3. T.K.Sarkar, Michael C Wicks, M.Salazar-Palma and Robert J Bonneau, “Smart Antennas”, First Edition, Wiley-IEEE Press, 2003.
4. Constantine A Balanis and Panayiotis I Ioannides, “Introduction to Smart Antennas”, Morgan & Claypool Publishers, 2007.
5. Shahid Mumtaz, Jonathan Rodriguez and Linglong Dai, “mmWave Massive MIMO: A Paradigm for 5G”, Academic Press, 2016.

20CU6E1 SOFT COMPUTING TECHNIQUES AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to serve as an introduction to the field of soft computing and illustrate the potential of presenting methods in a range of case study applications. In this sense the course is not aimed at providing particularly deep theoretical insights, but rather making students familiar with fundamental concepts as well as giving them a broad perspective of emerging synergistic effects and their practical implications. The scope of the course mainly embraces neural networks, fuzzy systems, genetic algorithm, Neuro fuzzy modelling and evolutionary computing paradigms with applications in pattern recognition, optimization, forecasting and control among others.

UNIT I ARTIFICIAL NEURAL NETWORK 9

Introduction - Basic concepts of Neural Network - Model of an Artificial Neuron - Characteristics of Neural Network - Learning Methods - Backpropagation Network Architecture - Backpropagation 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 and Defuzzification - Fuzzy Controller.

UNIT III NEURO-FUZZY MODELLING 9

ANFIS Architecture - Classification and Regression, Trees-Data Clustering algorithms – Rule base Structure Identification.

UNIT IV GENETIC ALGORITHMS 9

Basic concepts - Working Principle - Inheritance Operators - Cross Over - Inversion and 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

Course Outcomes (COs):

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

CO1 : Classify optimization algorithms.

CO2 : Explain the concepts of neural network theory.

CO3 : Discuss the principles of genetic algorithms.

CO4 : Apply neural networks, fuzzy logic and genetic algorithms for optimization problems.

CO5 : Develop Neuro fuzzy models for real-time applications.

CO6 : Apply the soft computational techniques to solve various research oriented problems.

REFERENCES:

1. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic Theory and Applications”, Prentice Hall of India, 2002.
2. J.S.R. Jang, C.T. Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education, 2004.
3. Laurene Fausett, “Fundamentals of Neural Networks: Architectures and Algorithms”, 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 Edition, 2011.

20CU6E2 **NETWORK PROCESSORS**

L	T	P	C
3	0	0	3

OBJECTIVES:

The course gives an introduction to network processors, including architecture and how such devices can be used in a system. Additionally, the course looks at how to program Intel IXP network processors and how to use these in a distributed multimedia system.

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, Pipeline of homogeneous processors. Configurable Instruction set processors – Pipeline of heterogeneous processors – Extensive and Diverse processors – Flexible RISC plus Coprocessors – Scalability issues – Design Tradeoffs and consequences.

UNIT IV NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING **9**

Intel Network Processor Architecture: 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 – Manageability – QoS – Security – Switching – Layer VPN2.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Discuss the network processor architecture and its components.

CO2 : Compare the different processor programming techniques.

CO3 : Understand about the basics of synchronous, asynchronous and wave and pipelining and parallel processing techniques.

CO4 : Understand the performance parameters like area, speed, power, flexibility, multithreading and interfacing factors.

CO5 : Understand the commercial network processors.

CO6 : Explain the IOS technologies.

REFERENCES:

1. Douglas E. Comer, “Networks Systems Design using Network Processors”, Prentice Hall, 2003.
2. Erik J. Johnson and Aaron R. Kunze, “IXP2400/2800 Programming: The Microengine Coding Grade”, Intel Press, 2003.
3. Bill Carlson, “Intel Internet Exchange Architecture and Applications: A Practical Guide to Intel’s IXP2XXX network Processors”, Intel press, 2003.
4. Panas C. Lekkas, “Network Processors: Architectures, Protocols and Platforms (Telecom Engineering)”, McGraw-Hill Education, First Edition, 2003.
5. Mark A. Franklin, Patrick Crowley, Haldun Hadimioglu, Peter Z. Onufryk, “Network Processor Design: Issues and Practices”, Vol. 2, Morgan Kaufmann, 2003.
6. Mark A. Franklin, Patrick Crowley, Haldun Hadimioglu and Peter Z. Onufryk, “Network Processor Design: Issues and Prentices”, Vol. 1, Morgan Kaufman, 2002.
7. Ran Giladi, “Network Processors: Architecture, Programming and Implementation”, Morgan Kauffmann, 2008.

20CU6E3 NETWORK MANAGEMENT SYSTEMS AND TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

The course describes about the theoretical, practical and managerial aspects of managing communication networks. It will enable the students to familiarize the various aspects of network management, need for management of complex networks, monitoring using tools, manager/agent model of remote management; the Internet management protocols - SMI, MIBs, SNMP, MIB design case studies; TMN architecture, design and Implementation of NMS tools and platforms.

UNIT I OSI NETWORK MANAGEMENT 8

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 10

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, 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

Course Outcomes (COs):

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

CO1 : Classify and analyze the different types of network management.

CO2 : Analyze the operation of the different versions of the SNMP protocol.

CO3 : Implement the SNMP protocol through Remote Monitoring (RMON).

CO4 : Manage the broadband network such as ATM and ADSL technologies.

CO5 : Configure the different network management applications.

CO6 : Discuss about the multi-vendor components for general purpose NMS.

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”, Second Edition, Pearson Education, 2010.
3. Mark Burges, “Principles of Network System Administration”, Wiley, 2000.
4. Salah Aiidarons and Thomas Plevayk, “Telecommunications Network Technologies and Implementations”, Eastern Economy Edition, IEEE Press, New Delhi, 1998.
5. Stephen Morris, “Network Management, MIBs and MPLS: Principles, Design and Implementation”, Pearson Education, 2003.
6. http://www.apps.ietf.org/rfc/rfc1095.html

20CU6E4 COMMUNICATION NETWORK SECURITY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course provides deeper understanding of cryptography, its application to network security, threats/vulnerabilities to networks and countermeasures, then to study various approaches to encryption techniques, strengths of traffic confidentiality, message authentication codes and provide solutions for their issues and be familiar with cryptographic techniques for secure communication of two parties over an insecure channel.

UNIT I INTRODUCTION AND NUMBER THEORY 9

Introduction to Information Security, Computer Security and Network Security. Need For Security: Security Goals, Attacks, Security Services and Mechanisms, and Techniques. Number Theory and Mathematics for Symmetric Cryptography: Finite Arithmetic, Congruence Arithmetic, Linear Congruence and Quadratic Congruence. Mathematics for Asymmetric-Key Cryptography: Fermat’s Theorem and Euler’s Theorem, Primes, Primality Testing, Factorization, CRT, Exponentiation. Classical Symmetric: Key Ciphers, Substitution Ciphers, Transposition Ciphers.

UNIT II SYMMETRIC AND ASYMMETRIC CRYPTOSYSTEMS 9

Modern Symmetric - Key Cipher - Block Ciphers (DES, 3DES, AES and its mode of operations), Stream Ciphers, Asymmetric-Key Cryptosystem - RSA, ElGamal, ECC, Key Management - Diffie-Hellman (DH) Mechanism, Kerberos – Needham Schroeder Protocol.

UNIT III AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES 9

Message Integrity and Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution – RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management.

UNIT IV TRUSTED IDENTITY **9**

Entity Authentication: Password System - Fixed and One time Passwords (S/Key) RFC 2289 – Callback Systems, Zero Knowledge, Challenge and Response Systems – RADIUS — ITU-T X.509.

UNIT V SECURITY AT LAYERS **9**

Network Layer Security - IPSec, Transport Layer Security - SSL/TLS, SSH, Application Layer Security – PGP, S/MIME, Firewall - Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Diagnose problems and make minor repairs to computer networks using appropriate diagnostics software.

CO2 **:** Analyze the need for interoperable network management as a typical distributed application.

CO3 **:** Demonstrate how to correctly maintain LAN computer systems.

CO4 **:** Understand the concepts and terminologies associated with SNMP.

CO5 **:** Understand the maintenance of networks by performing routine maintenance tasks.

CO6 **:** Apply the network management tools.

REFERENCES:

1. Behrouz A. Forouzan, “Cryptography and Network Security”, Special Edition, Tata McGraw Hill, 2007.
2. Bruce Scheneier, “Applied Cryptography”, John Wiley and Sons, 1994.
3. Charlie Kaufmann, Radia Perlman and Mike Speciner, “Network Security”, Second Edition, Prentice Hall, 2002.
4. Douglas R. Stinson, “Cryptography: Theory and Practice”, Third Edition (Discrete Mathematics and its Applications), Chapman and Hall/CRC, 2005.
5. David M. Durton, “Elementary Number Theory”, Sixth Edition, Tata Mcgraw Hill, 2009.
6. William Stallings, “Cryptography and Network Security: Principles and Practice”, Third Edition, Pearson Education, 2002.
7. William Stallings, “Network Security Essentials: Applications and Standards”, Second Edition, Pearson Education, 2000.

20CU6E5 HIGH PERFORMANCE SWITCHING ARCHITECTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

This course describes the fundamental principles to develop a comprehensive understanding of network architectures, control, performance, and wireless networks that explain current and emerging networking technologies. It also explains the evolution of data communication and networking paradigms to describe OSI and IP protocol suite. It introduces different LAN technologies to explain the overview of ATM networks. It gives exposes to the advances in packet switching architectures, IP addresses, switching solutions and approaches to integrate the best features of different architectures for high speed switching.

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, re-arrangable 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 Queueing - Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches.

UNIT IV PACKET SWITCHING ARCHITECTURES 9

Architectures of Internet Switches and Routers - Bufferless and buffered Crossbar switches, Multi-stage 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

Course Outcomes (COs):

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

CO1 : Analyze the categories and topologies of networks (LAN and WAN), layered architecture (OSI and TCP/IP), and protocol suites.

CO2 : Understand the channel error detection and correction mechanism, MAC protocols, Ethernet and WLAN technologies.

CO3 : Understand the backbone and trunking technologies (ATM).

CO4 : Identify the suitable switch architectures for a specified networking scenario and demonstrate its blocking performance.

CO5 : Apply the knowledge of switching technologies, architectures and buffering strategies for designing high speed communication networks and analyze their performance.

CO6 : Understand the different switching architectures and queuing strategies and their impact on the blocking performances.

REFERENCES:

1. Achille Pattavina, “Switching Theory: Architectures and performance in Broadband ATM networks”, John Wiley and Sons Ltd., New York, 1998.
2. Christopher Y. Metz, “Switching Protocols and Architectures”, McGraw-Hill Professional Publishing, NewYork.1998.
3. Elhanany M. Hamdi, “High Performance Packet Switching architectures”, Springer Publications, 2007.
4. Rainer Handel, Manfred N. Huber and Stefan Schroder, “ATM Networks: Concepts, Protocols, Applications”, Third Edition, Addison Wesley, New York, 1999.
5. Rich Siefert and Jim Edwards, “The All New Switch Book: The Complete Guide to LAN Switching Technology”, Second Edition, Wiley Publishing Inc., 2008.

20OEP31 **BUSINESS ANALYTICS**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course provides the detail analysis and problem solutions for different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace and so on. It can provide an ability of thinking critically in making decisions based on data and deep analytics. Also, it provides technical skills in predicative and prescriptive modelling to support business decision-making.

UNIT I BUSINESS ANALYTICS AND STATISTICAL TOOLS 9

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, Competitive advantages of Business Analytics, Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II TRENDINESS AND REGRESSION ANALYSIS 9

Modelling Relationships and Trends in Data, Simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, Problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III BUSINESS ANALYTICS AND DESCRIPTIVE ANALYTICS 9

Organizational Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring the contribution of Business analytics, Managing Change. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, Nonlinear Optimization.

UNIT IV FORECASTING TECHNIQUES 9

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carle Simulation Using Analytic Solver Platform, New - Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS 9

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand the role of business analytics within an organization.

CO2 **:** Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.

CO3 **:** Understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.

CO4 : Understanding the processes needed to develop report and analyze business data.

CO5 : Use decision-making tools/Operations research techniques.

CO6 : Mange business process using analytical and management tools.

REFERENCES:

1. Marc J Schniederjans, Dara G Schniederjans and Christopher M Starkey, “Business Analytics Principles, Concepts and Applications: What, Why and How”, Pearson FT Press, 2014.
2. James R Evans, “Business Analytics”, Person, 2012.

20OEP32 INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

OBJECTIVES:

The object of this course is to familiarize students with basic safety practices in the Electronics industry and other common industrial settings. Specifically, the course will illustrate and discuss the signage commonly used for Hazards and warning signs in the industrial workplace. The labeling used on hazardous products – including the Material Safety Data Sheet (MSDS) - will be illustrated and discussed. Standard safety precautions used when working on electrical equipment will be presented along with a discussion of electrocution hazard.

UNIT I INDUSTRIAL SAFETY 9

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

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

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

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

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

UNIT IV FAULT TRACING 9

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

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understanding of the documentation used with hazardous materials, such as the MSDS.

CO2 : Describe the different levels of danger that exist with electrical shock.

CO3 : Describe several appropriate actions to take in the event of an electrical accident.

CO4 : Describe the situations under which static electricity may cause damage to electrical components (ESD - electrostatic discharge).

CO5 : Apply the methods of prevention of fire and explosions.

CO6 : Understand the industrial laws, regulations and source models.

REFERENCES:

1. Keith Mobley, "Maintenance Engineering Handbook", Eight Edition, McGraw-Hill Education, 2014.
2. H.P.Garg, "Industrial Maintenance", S.Chand (G/L) & Company Ltd., 1987.
3. Frank Graham, "Audels Pumps Hydraulics Air Compressors: A Practical Guide", Theo Audel & Co., 1949.
4. Manjriker Gunaratne, "The Foundation Engineering Handbook", Second Edition, CRC Press, 2013.

20OEP33 **OPERATIONS RESEARCH**

L	T	P	C
3	0	0	3

OBJECTIVES:

The objective of operations research is optimization to do things best under the given circumstances. This general concept has great many applications, for instance, in agricultural planning, biotechnology, data analysis, distribution of goods and resources, emergency and rescue operations, engineering systems design, environmental management, financial planning, health care management, inventory control, manpower and resource allocation, manufacturing of goods, military operations, production process control, risk management, sequencing and scheduling of tasks, telecommunications, and traffic control.

UNIT I INTRODUCTION TO OPERATIONS RESEARCH 9

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT II LINEAR PROGRAMMING PROBLEM 9

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

UNIT III NON-LINEAR PROGRAMMING PROBLEM 9

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

UNIT IV SCHEDULING AND SEQUENCING 9

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

UNIT V APPLICATIONS OF OPERATIONS RESEARCH 9

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Understand the concepts and tools of Operations Research.

CO2 : Understand the mathematical models used in Operations Research.

CO3 : Apply these techniques constructively to make effective business decisions.

CO4 : Solve the Linear Programming Problems.

CO5 : Solve the Non-Linear Programming Problems.

CO6 : Understand the usage of game theory and Simulation for Solving Business Problems.

REFERENCES:

1. Hamdy A Taha, “Operations Research: An Introduction”, Tenth Edition, Pearson, 2017.
2. Wagner H.M., “Principles of Operations Research, with Applications to Managerial Decisions”, Prentice Hall India Learning Private Limited, 1980.
3. J.C.Pant, “Introduction to Optimization Operations Research”, Seventh Edition, Jain Brothers, 2008.
4. Hitler Libermann, “Operations Research”, Mc-Graw Hill Pub., 2009.
5. R.Pannerselvam, “Operations Research”, Prentice Hall of India, 2010.

20OEP34 COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

OBJECTIVES:

The objective of Project Cost Management is to ensure that the cost aspects of the project are delivered. This must be achieved within the overall project objectives, in particular the (usually) need to maximize value for the client’s business. Most of the key decisions which will influence the cost outcome of a project will be made in the project development and definition phase. Hence, effective decision making and cost management in this phase is vital.

UNIT I INTRODUCTION TO STRATEGIC COST MANAGEMENT PROCESS 9

Cost concepts in decision-making, Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System, Inventory valuation, Creation of a Database for operational control, Provision of data for Decision-Making.

UNIT II PROJECT MANAGEMENT 9

Project: Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT III COST BASED DECISION-MAKING 9

Cost Behavior and Profit Planning Marginal Costing, Distinction between Marginal Costing and Absorption Costing, Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT IV PRICING STRATEGIES 9

Pricing: Pareto Analysis, Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking, Balanced Score Card and Value-Chain Analysis. Budgetary Control, Flexible Budgets, Performance budgets, Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V PRACTICAL COST MANAGEMENT 9

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 : Creating the project requirements document and project scope statement.

CO2 : Identify ways to control the scope of the project.

CO3 : Create a work breakdown structure and develop work packages.

CO4 : Develop a critical path Schedule.

CO5 : Perform a cost and schedule analysis.

CO6 : Calculate planned and earned value to compare with actual cost.

REFERENCES:

1. Srikant M Datar and Madhav V Rajan, “Horngren's Cost Accounting: A Managerial Emphasis”, Pearson, 2017.
2. Robert Kaplan and Anthony A Atkinson, “Advanced Management Accounting”, Pearson Education India, 2015.
3. Alnoor Bhimani, Charles T Horngren, Srikant M Datar and Madhav V Rajan, “Management & Cost Accounting”, Pearson, 2015.
4. Ashish K Bhattacharya, “Principles and Practices of Cost Accounting”, Prentice Hall India Learning Private Limited, 2004.
5. N.D.Vohra, “Quantitative Techniques in Management”, McGraw Hill Education, 2009.

20OEP35 **COMPOSITE MATERIALS**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to introduce students a new composite course that focuses on student learning outcomes for community college students, future designers, and technicians. These students are trained with computer-aided design, engineering graphics, and lab testing in their co-op jobs. Therefore, they are in need of learning the principles of designing components made of composite materials. The basics of composite properties, mechanics, and manufacturing processes are introduced. Design guidelines and drafting notations will be emphasized for composite components with various fiber-reinforcements, such as unidirectional fibers, random short fibers, and laminate stacking sequences.

UNIT I INTRODUCTION 9

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

UNIT II REINFORCEMENTS 9

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

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

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

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

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

UNIT V STRENGTH 9

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand the fundamental properties of composite materials.

CO2 **:** Apply the fundamental principles and mechanics of composite materials.

CO3 **:** Apply modern analytical techniques to mechanical systems with composite materials.

CO4 : Apply computational techniques to mechanical systems with composite materials.

CO5 : Understand the manufacturing processes and cost analysis in composite materials.

CO6 : Demonstrate effective communication and teamwork skills through technical presentations and reports in term projects.

REFERENCES:

1. R. W. Cahn, P. Haasen and E. J. Kramer, “Material Science and Technology: A Comprehensive Treatment” – Vol. 13 – “Structure and Properties of Composites” (T. W. Chou), Wiley-VCH Verlag GmbH & Co., KGoA.
2. William D Callister and David G Rethwisch, “Materials Science and Engineering: An Introduction”, John Wiley & Sons, 2010.
3. George Lubin, “Handbook of Composites”, Springer, 2013.
4. Krishan K Chawla, “Composite Materials: Science and Engineering”, Springer, 2010.
5. Deborah D.L. Chung, “Composite Materials: Science and Applications (Engineering Materials and Processes)”, Springer, 2012.
6. Danial Gay and Suong V Hoa, “Composite Materials: Design and Applications”, CRC Press, 2007.

20OEP36 **WASTE TO ENERGY**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the teaching, research, and application of science and engineering to the sustained production, transformation, utilization and impact of biomass energy. Coverage focuses on four main areas: biomass and bioenergy; bioenergy production and accounting; biomass conversion and end-use technologies; and an appraisal of the costs and benefits of biomass energy.

UNIT I INTRODUCTION TO ENERGY FROM WASTE 9

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

UNIT II BIOMASS PYROLYSIS 9

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

UNIT III BIOMASS GASIFICATION 9

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

UNIT IV BIOMASS COMBUSTION 9

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

UNIT V BIOGAS 9

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

TOTAL: 45 PERIODS

Course Outcomes (COs):

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

CO1 **:** Understand the technologies for generation of energy from solid waste.

CO2 **:** Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.

CO3 **:** Identify sources of energy from bio-chemical conversion.

CO4 **:** Understand and assess the biomass resource, appropriate conversion technology for the given biomass resource and end use.

CO5 **:** Evaluate the cost-benefit of various biomass energy conversion processes.

CO6 **:** Describe the challenges/risks involved in the waste disposal and identify appropriate waste management technique to handle and turn waste to energy.

REFERENCES:

1. Ashok V Desai, “Nonconventional Energy”, New Age Publishers, 1996.
2. K.C.Khandelwal and S.S.Mahdi, “Biogas Technology: A Practical Handbook”, Tata McGraw-Hill, 1986.
3. Devinder Singh Chahal, “Food, Feed and Fuel from Biomass”, Asia Publishing House, 1991.
4. Charles Y Wereko–Brobby and Essel B Hagan, “Biomass Conversion and Technology”, Wiley–Blackwell, 1996.

20AC101 **ENGLISH FOR RESEARCH PAPER WRITING**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

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

UNIT I	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	**4**
UNIT II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts and Introduction.	**4**
UNIT III	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**4**
UNIT IV	Key skills are needed when writing a Title, Key skills are needed when writing an Abstract, Key skills are needed when writing an Introduction, Skills needed when writing a Review of the Literature.	**4**
UNIT V	Skills are needed when writing the Methods, Skills needed when writing the Results, Skills are needed when writing the Discussion, Skills are needed when writing the Conclusions.	**4**
UNIT VI	Useful phrases, How to ensure paper is as good as it could possibly be the first-time submission.	**4**

TOTAL: 24 PERIODS

REFERENCES:

1. Robert Goldbort, “Writing for Science”, Yale University Press, 2006.
2. Robert A Day and Barbara Gastel, “How to Write and Publish a Scientific Paper”, Seventh Edition, Greenwood Press, 2011.
3. Nicholas J Higham, “Handbook of Writing for the Mathematical Sciences”, Society for Industrial and Applied Mathematics, 1998.
4. Adrian Wallwork, “English for Writing Research Papers”, Springer, 2011.

20AC102 **DISASTER MANAGEMENT**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

UNIT I	**Disaster:** Definition, Factors and Significance, Difference between Hazard and Disaster. **Natural and Manmade Disasters:** Difference, Nature, Types and Magnitude.	**4**
UNIT II	**Repercussions of Disasters and Hazards:** Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. **Natural Disasters:** Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches. **Man-made Disaster:** Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	**4**
UNIT III	**Disaster Prone areas in India:** Study of Seismic Zones, Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.	**4**
UNIT IV	**Disaster Preparedness and Management Preparedness:** Monitoring of Phenomena Triggering a Disaster or Hazard. **Evaluation of Risk:** Application of Remote Sensing, Data from Meteorological and other Agencies. **Media Reports:** Governmental and Community Preparedness.	**4**
UNIT V	**Risk Assessment Disaster Risk:** Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	**4**
UNIT VI	Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	**4**

TOTAL: 24 PERIODS

REFERENCES:

1. Nishith Rai and A.K.Singh, “Disaster Management in India: Perspectives, Issues and Strategies”, New Royal Book Company, 2007.
2. Pardeep Sahni, Alka Dhameja and Uma Medury, “Disaster Mitigation: Experiences and Reflections”, Prentice Hall India Learning Private Limited, 2001.
3. S.L.Goel, “Disaster Administration and Management: Text and Case Studies”, Deep & Deep Publication Pvt. Ltd., 2007.

20AC103 **SANSKRIT FOR TECHNICAL KNOWLEDGE**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Get a working knowledge in illustrious Sanskrit, the scientific language in the world.
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science and other subjects enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

UNIT I
- Alphabets in Sanskrit
- Past/Present/Future Tense
- Simple Sentences

8

UNIT II
- Order
- Introduction of roots
- Technical information about Sanskrit Literature

8

UNIT III Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics **8**

TOTAL: 24 PERIODS

REFERENCES:

1. H.R.Vishwas and Samskrita Bharati, “Abhyậsapustakam”, Samskrita-Bharti Publication, New Delhi.
2. Vempati Kutumba Shastri, “Teach Yourself Sanskrit: Prathama Diksha (Sanskrit)”, Rashtriya Sanskrit Samsthana, Delhi, 2012.
3. Suresh Soni, “Indias Glorious Scientific Tradition”, Prabhat Prakashan, 2006.

20AC104 **VALUE EDUCATION**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Understand the value of education and self-development.
- Imbibe good values in students.
- Know about the importance of character.
- Learn the importance of Human values.
- Developing the overall personality.

UNIT I **6**

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

UNIT II **6**

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

UNIT III **6**

- Personality and Behaviour Development - Soul and Scientific attitude.
- Positive Thinking.
- Integrity and Discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of Labour.
- Universal brotherhood and religious tolerance.
- True Friendship.
- Happiness vs. Suffering, Love for Truth.
- Aware of Self-Destructive habits.
- Association and Cooperation.
- Doing best for saving nature.

UNIT IV **6**

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

TOTAL: 24 PERIODS

REFERENCES:

1. S.K.Chakraborty, “Values of Ethics for Organization: Theory and Practice”, Oxford University Press, 1999.

20AC105 **CONSTITUTION OF INDIA**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I **History of Making of the Indian Constitution:** History, Drafting Committee (Composition and Working) **4**

UNIT II **Philosophy of the Indian Constitution:** Preamble, Salient Features **4**

UNIT III **Contours of Constitutional Rights and Duties:** **4**

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

UNIT IV Organs of Governance: **4**

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

UNIT V Local Administration: **4**

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

UNIT VI Election Commission: **4**

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

TOTAL: 24 PERIODS

REFERENCES:

1. The Constitution of India, January 1950 (Bare Act), Gazette of **India**.
2. S.N.Busi, "Dr. B.R. Ambedkar Framing of Indian Constitution", Vol. 1 to 6, First Edition, 2016.
3. M.P.Jain, Justice Jasti Chelameswar and Justice Dama Seshadri Naidu, "Indian Constitution Law", Lexis Nexis, 2018.
4. D.D.Basu, "Introduction to the Constitution of India", Lexis Nexis, 2011.

20AC106 **PEDAGOGY STUDIES**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the Department for International Development (DFID), other agencies and researchers.
- Identify critical evidence gaps to guide the development.
- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT I **Introduction and Methodology:** **5**

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

UNIT II **Thematic Overview:** **4**

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

UNIT III **Evidence on the effectiveness of pedagogical practices:** **5**

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

UNIT IV **Professional Development:** **5**

- Alignment with classroom practices and follow-up support.
- Peer support.
- Support from the head teacher and the community.
- Curriculum and Assessment.
- Barriers to learning: Limited resources and large class sizes.

UNIT V **Research gaps and future directions:** **5**

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

TOTAL: 24 PERIODS

REFERENCES:

1. Jim Ackers and Frank Hardman, “Classroom Interaction in Kenyan Primary Schools”, Compare, Vol. 31, No. 2, 2001. pp. 245-261.
2. Mamta Agrawal, “Curricular reform in schools: The importance of evaluation”, Journal of Curriculum Studies, Vol. 36, No. 3, 2004. pp. 361-379.
3. Kwame Akyeampong, “Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER), Country Report One, London, DFID, March 2003.
4. Kwame Akyeampong, Kattie Lussier, John Pryor and Jo Westbrook, “Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?”, International Journal of Educational Development, Vol. 33, No. 3, 2013. pp. 272‑282.
5. Robin J Alexander, “Culture and Pedagogy: International Comparisons in Primary Education”, Wiley-Blackwell, 2001.
6. www.pratham.org/images/resource%20working%20paper%202.pdf.

20AC107 **STRESS MANAGEMENT BY YOGA**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Achieve overall health of body and mind
- Overcome stress
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT I **Ashtanga:** **8**

Definitions of Eight parts of yoga.

UNIT II **Yam and Niyam:** Do and Not Do in life **8**

- Ahinsa, Satya, Astheya, Bramhacharya and Aparigraha
- Shaucha, Santosh, Tapa, Swadhyay, Ishwarpranidhan

UNIT III **Asan and Pranayam:** **8**

- Various yoga poses and their benefits for mind and body
- Regularization of breathing techniques and its effects - Types of Pranayam

TOTAL: 24 PERIODS

REFERENCES:

1. “Yogic Asanas for Group Training - Part-I”, Janardan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, “Raja-Yoga or Conquering the Internal Nature”, Vedanta Press, 1998.

20AC108 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

L	T	P	C
3	0	0	3

OBJECTIVES:

This course is intended to provide an integrated framework for the students can able to:

- Learn to achieve the highest goal happily
- Become a person with stable mind, pleasing personality and determination
- Awaken wisdom in students
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

UNIT I **Neetisatakam - Holistic development of personality:** **8**

- Verses - 19, 20, 21, 22 (Wisdom)
- Verses - 29, 31, 32 (Pride and Heroism)
- Verses - 26, 28, 63, 65 (Virtue)
- Verses - 52, 53, 59 (Dont's)
- Verses - 71, 73, 75, 78 (Do's)

UNIT II **Approach to day-to-day work and duties: Shrimad Bhagwad Geeta** **8**

- Chapter 2 - Verses - 41, 47, 48
- Chapter 3 - Verses - 13, 21, 27, 35
- Chapter 6 - Verses - 5, 13, 17, 23, 35
- Chapter 18 – Verses - 45, 46, 48

UNIT III **Statements of basic knowledge: Shrimad Bhagwad Geeta** **8**

- Chapter 2 - Verses - 56, 62, 68
- Chapter 12 - Verses - 13, 14, 15, 16, 17, 18

Personality of role model: Shrimad Bhagwad Geeta

- Chapter 2 - Verses – 17
- Chapter 3 - Verses - 36, 37, 42
- Chapter 4 - Verses - 18, 38, 39
- Chapter 18 - Verses - 37, 38, 63

TOTAL: 24 PERIODS

REFERENCES:

1. Swami Swarupananda, "Srimad Bhagavad Gita", by Advaita Ashram, Kolkata.
2. Pt. Gopinath, "Three Satakam of Bharatrhari (Niti, Srngara, Vairagya)", Rashtriya Sanskrit Sansthan, 2010.