SETHU INSTITUTE OF TECHNOLOGY

PULLOOR, KARIAPATTI – 626 115.

(AN AUTONOMOUS INSTITUTION)

REGULATION – 2019

M.E COMMUNICATION SYSTEMS

CURRICULUM & SYLLABI

Chairman

Board of Studies

Dr.R.VANI DEVI M.Tech., Ph.D.,
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DEPARTMENT OF ECE,
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Pulloor, Kariapatti, Virudhunagar-626 115.

Chair Person

Academic Council

CHAIRMAN
ACADEMIC COUNCIL
Sethu Institute of Technology
Pulloor, Kariapatti - 625 115

SETHU INSTITUTE OF TECHNOLOGY

Pulloor, Kariapatti – 626 115

M.E. Degree Programme

CURRICULUM

Regulation 2019

Master of Engineering in COMMUNICATION SYSTEMS

OVERALL COURSE STRUCTURE

Category	TOTAL No. of Courses	Credits	Percentage
PROGRAM CORE	4	12	17.2
PROGRAM ELECTIVE	5	15	21.4
OPEN ELECTIVE	1	3	4.3
MANDATORY COURSE	1	3	4.3
AUDIT COURSE	2	0	0
LABORATORIES	4	8	11.4
MINI PROJECT WITH SEMINAR	1	3	4.3
PROJECT WORK	2	26	37.1
TOTAL	20	70	100

COURSE CREDITS – SEMESTER WISE

Branch	I	II	III	IV	TOTAL
COMMUNICATION SYSTEMS	16	16	22	16	70

POs	Program Outcomes-Statements The Graduate will have an ability to	Level
1. **Scholarship of Knowledge**	Demonstrate a degree of mastery over the area as per the specialization of the program, higher than the requirements in the appropriate bachelor program	**Cognitive Domain (Apply)**
2. **Critical Thinking**	Analyze complex engineering problem critically and provide feasible/optimal solution after considering public health, safety, ethical, societal and environmental factors in the core area of expertise.	**Cognitive Domain (Analyze)**
3. **Problem Solving and Research Skill**	Independently carry out research /investigation and development work to solve practical problems	**Cognitive Domain (Create)**
4. Modern Tool Usage	Apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations	**Cognitive Domain (Apply)**
5. **Communication**	Write and present a substantial technical report/document	**Affective Domain (Organization)**
6. Life Long Learning	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with continuous enthusiasm and commitment to improve knowledge and competence.	**Affective Domain (Characterization)**

Program Educational Objectives
Our Graduates will :
Possess strong technical knowledge in the field of communication systems to meet the needs of Academia, research and Industry (Core Competence)
Demonstrate continual interest to learn new technologies through self learning for successful professional career.(Life Long Learning)
Exhibit effective communication skills, professional skills and practice ethical principles.(Professionalism)

SUMMER/ WINTER COURSES

Winter Courses									
Sl.No	**Subject Code**	**Subject Name**	**Sem**	**L**	**T**	**P**	**C**	**Summer/ Winter**	**Category**
1.	19PCM101	Adaptive Signal Processing	I	3	0	0	3	Winter	Program Core
2.	19PCM102	Antennas and Radiating Systems	I	3	0	0	3	Winter	Program Core
3.	-	Elective I	I	3	0	0	3	Winter	Program Elective
4.	19PCM103	Antennas and Radiating Systems lab	I	0	0	4	2	Winter	Program Core
5.	19PCM104	Adaptive Signal Processing Lab	I	0	0	4	2	Winter	Program Core
6.	19PGM701	Research Methodology and IPR	I	3	0	0	3	Winter	Program Core
7.	19PGM801	Pedagogy Studies	I	3	0	0	0	Winter	Program Core
8.	-	Elective III	III	3	0	0	3	Winter	Program Elective
9.	-	Elective IV	III	3	0	0	3	Winter	Program Elective
10.	-	Elective V	III	3	0	0	3	Winter	Program Elective
11.	-	Open Elective	III	3	0	0	3	Winter	Open Elective
12.	19PCM301	Dissertation Phase – I	III	0	0	20	10	Winter	Dissertation

Summer Courses									
13.	19PCM201	Advanced Communication Networks	II	3	0	0	3	Summer	Program Core
14.	19PCM202	Wireless and Mobile Communication	II	3	0	0	3	Summer	Program Core
15.	-	Elective II	II	3	0	0	3	Summer	Program Elective
16.	19PCM203	Advanced Communication Networks Lab	II	0	0	4	2	Summer	Program Core
17.	19PCM204	Wireless and Mobile Communication Lab	II	0	0	4	2	Summer	Program Core
18.	19PCM205	Mini Project with seminar	II	0	0	6	3	Summer	Program Core
19.	19PGM802	English for Research Paper Writing	II	3	0	0	0	Summer	Program Core
20.	19PCM401	Dissertation Phase – II	IV	0	0	32	16	Summer	Dissertation

COURSE CATEGORY: PROGRAM ELECTIVES

S.No	Course Code	Course Title	L	T	P	C
1.	**19PCM501**	Wireless Sensor Networks	**3**	**0**	**0**	**3**
2.	**19PCM502**	Optical Networks	**3**	**0**	**0**	**3**
3.	**19PCM503**	Cognitive Radio	**3**	**0**	**0**	**3**
4.	**19PCM504**	RF Circuits and Microwave Systems	**3**	**0**	**0**	**3**
5.	**19PCM505**	Communication Network Security	**3**	**0**	**0**	**3**
6.	**19PCM506**	Satellite Communication	**3**	**0**	**0**	**3**
7.	**19PCM507**	Communication Protocol Engineering	**3**	**0**	**0**	**3**
8.	**19PCM508**	Speech and Audio Signal Processing	**3**	**0**	**0**	**3**
9.	**19PCM509**	MIMO System	**3**	**0**	**0**	**3**
10.	**19PCM510**	High Performance Communication Networks	**3**	**0**	**0**	**3**
11.	**19PCM511**	Pattern Recognition	**3**	**0**	**0**	**3**
12.	**19PCM512**	Microelectronics and VLSI Technology	**3**	**0**	**0**	**3**
13.	**19PCM513**	Smart Devices and Emerging Mobile Technologies	**3**	**0**	**0**	**3**
14.	**19PCM514**	Network Management System	**3**	**0**	**0**	**3**
15.	**19PCM515**	Ubiquitous Computing and Pervasive Computing	**3**	**0**	**0**	**3**
16.	**19PCM516**	DSP Processor Architecture and Programming	**3**	**0**	**0**	**3**
17.	**19PCM517**	Mobile and Social Computing	**3**	**0**	**0**	**3**
18.	**19PCM518**	Data Compression	**3**	**0**	**0**	**3**
19.	**19PCM519**	Medical Imaging Techniques	**3**	**0**	**0**	**3**
20.	**19PCM520**	Global Positioning Systems	**3**	**0**	**0**	**3**

COURSE CATEGORY: OPEN ELECTIVE

S.No	Course Code	Course Title	L	T	P	C
1.	**19PCD601**	Industrial Safety	**3**	**0**	**0**	**3**
2.	**19PCS602**	Business analytics	**3**	**0**	**0**	**3**
3.	**19PCM603**	IoT for Smart Applications	**3**	**0**	**0**	**3**
4.	**19PPE604**	Bio Energy from Waste	**3**	**0**	**0**	**3**
5.	**19PSE605**	Smart City Technologies	**3**	**0**	**0**	**3**

COURSE CATEGORY: AUDIT COURSES

S.No	Course Code	Course Title	L	T	P	C
1.	**19PGM801**	Pedagogy Studies	**2**	**0**	**0**	**0**
2.	**19PGM802**	English for Research Paper Writing	**2**	**0**	**0**	**0**

REGULATION – 2019

(Applicable to the students admitted from the Academic Year 2019 – 2020 onwards)

CURRICULUM I TO IV SEMESTERS (FULL TIME)

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**19PCM101**	Adaptive Signal Processing	**3**	**0**	**0**	**3**
2.	**19PCM102**	Antennas and Radiating Systems	**3**	**0**	**0**	**3**
3.	**-**	Elective I	**3**	**0**	**0**	**3**
4.	**19PGM701**	Research Methodology and IPR (Mandatory course)	**3**	**0**	**0**	**3**
5.	**19PGM801**	Pedagogy Studies (Audit course-1)	**2**	**0**	**0**	**0**
PRACTICAL						
6.	**19PCM103**	Antennas and Radiating Systems lab	**0**	**0**	**4**	**2**
7.	**19PCM104**	Adaptive Signal Processing Lab	**0**	**0**	**4**	**2**
Total			**14**	**0**	**8**	**16**
Total Number of Credits: 16						

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**19PCM201**	Advanced Communication Networks	**3**	**0**	**0**	**3**
2.	**19PCM202**	Wireless and Mobile Communication	**3**	**0**	**0**	**3**
3.	**-**	Elective II	**3**	**0**	**0**	**3**
4.	**19PGM802**	English for Research Paper Writing (Audit Course-2)	**2**	**0**	**0**	**0**
PRACTICAL						
5.	**19PCM203**	Advanced Communication Networks Lab	**0**	**0**	**4**	**2**
6.	**19PCM204**	Wireless and Mobile Communication Lab	**0**	**0**	**4**	**2**
7.	**19PCM205**	Mini Project with seminar	**0**	**0**	**6**	**3**
Total			**11**	**0**	**14**	**16**
Total Number of Credits: 16						

SEMESTER III

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**-**	Elective III	**3**	**0**	**0**	**3**
2.	**-**	Elective IV	**3**	**0**	**0**	**3**
3.	**-**	Elective V	**3**	**0**	**0**	**3**
4.	**-**	Open Elective	**3**	**0**	**0**	**3**
PRACTICAL						
5.	**19PCM301**	Dissertation Phase – I	**0**	**0**	**20**	**10**
Total			**12**	**0**	**20**	**22**
Total Number of Credits: 22						

SEMESTER IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	**19PCM401**	Dissertation Phase – II	**0**	**0**	**32**	**16**
Total			**0**	**0**	**32**	**16**
Total Number of Credits: 16						

TOTAL NO. OF CREDITS: 70

SEMESTER I

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**19PCM101**	Adaptive Signal Processing	**3**	**0**	**0**	**3**
2.	**19PCM102**	Antennas and Radiating Systems	**3**	**0**	**0**	**3**
3.	**-**	Elective I	**3**	**0**	**0**	**3**
4.	**19PGM701**	Research Methodology and IPR (Mandatory Course with credit)	**3**	**0**	**0**	**3**
5.	**19PGM801**	Pedagogy Studies (Audit Course-1)	**2**	**0**	**0**	**0**
PRACTICAL						
6.	**19PCM103**	Antennas and Radiating Systems lab	**0**	**0**	**4**	**2**
7.	**19PCM104**	Adaptive Signal Processing Lab	**0**	**0**	**4**	**2**
Total			**14**	**0**	**8**	**16**
Total Number of Credits: 16						

SYLLABUS

19PCM101	ADAPTIVE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart the fundamental concepts of discrete random signal processing and spectrum estimation.
- To explain linear estimation, prediction and adaptive filters.
- To give an outline about multirate digital signal processing.

UNIT I DISCRETE RANDOM SIGNAL PROCESSES 9

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

UNIT II MULTIRATE DIGITAL SIGNAL PROCESSING 9

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

UNIT III LINEAR PREDICTION AND ADAPTIVE FILTERS 9

Linear prediction – forward & backward filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction, Adaptive Filters - Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm, Applications.

UNIT IV SPECTRUM ESTIMATION 9

Estimation of Spectra from Finite-Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

UNIT V APPLICATIONS OF DSP 9

Application of DSP & Multi rate DSP, Application to Radar, Application to image processing, Application of DSP in design of phase shifters, DSP in speech processing & other applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Explain random processes and their power spectral density
- Apply the theory of multirate DSP
- Design the linear and adaptive filters
- Apply the power spectrum estimation techniques
- Implement the DSP techniques for various applications.

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REFERENCES:

1. J.G.Proakis and D.G.Manolakis—Digital signal processing: Principles, Algorithm and Applications‖, 4th Edition, Prentice Hall, 2007.
2. M. H. Hayes, —Statistical Digital Signal Processing and Modeling‖, John Wiley & Sons Inc., 2002.
3. S.Haykin, —Adaptive Filter Theory‖, 4th Edition, Prentice Hall, 2001.
4. D.G.Manolakis, V.K. Ingle and S.M.Kogon, —Statistical and Adaptive Signal Processing‖, McGraw Hill, 2000

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	2	-	-	-	-	-
CO.2	3	-	-	-	-	-
CO.3	3	-	-	-	-	-
CO.4	3	-	2	3	-	-
CO.5	3	3	2	-	-	2
CO.6	3	-	3	-	-	3
CAM	3	3	2	3	-	2

19PCM102	ANTENNAS AND RADIATING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To give an idea about radiation from different current distributions and radiation field of different types of apertures.
- To summarize the performance characteristics of various antenna arrays,microstrip antennas and its radiation analysis.
- To review horn, microstrip, reflector antennas and various measuring parameters of EMC antenna.

UNIT I ANTENNA FUNDAMENTALS 9

Antenna fundamental parameters,Friis Transmission equation Radiation integrals ,Radiation from surface and line current distributions – dipole, monopole, loop antenna; Mobile phone antenna- base station, hand set antenna; Image; Induction ,reciprocity theorem, Broadband antennas and matching techniques, 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, and design consideration.

UNIT III ARRAY ANTENNA 9

Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Two dimensional uniform array; Phased array, beam scanning, grating lobe, feed network,; Linear array synthesis techniques – Binomial and Chebyshev distributions.

UNIT IV MICROSTRIP ANTENNA 9

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

UNIT V EMC ANTENNA AND ANTENNA MEASUREMENTS 9

Concept of EMC measuring antenna; Rx and Tx antenna factors; Log periodic dipole, Biconical, Ridge guide, Multi turn loop; Antenna measurement and instrumentation – Gain, Impedance and antenna factor measurement; Antenna test range Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Explain the working principles of antennas and design any type of antenna.
- Evaluate the performance of various aperture antennas.
- Describe various array antennas and synthesis techniques.
- Analyze and design microstrip patch antennas and EMC antennas and perform the various EMC antenna measurements.
- Gain knowledge about EMC antennas and perform various EMC antenna measurements.

REFERENCES:

1. Balanis.A, — Antenna Theory Analysis and Design ǁ, John Wiley and Sons, New York, 1982.
2. Krauss.J.D, — Antennas ǁ, John Wiley and sons, II edition, New York, 1997.
3. Bahl.I.J, Bhartia.P, — Microstrip Antennas ǁ, Artech House Inc, 1980..
4. Stutzman.W.L,Thiele.G.A, — Antenna Theory and Design ǁ, John Wiley& Sons Inc, 2nd edition, 1998.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	2	-	-	-	-	-
CO.2	3	-	-	-	-	-
CO.3	3	-	-	-	-	-
CO.4	3	-	2	3	-	-
CO.5	3	3	2	-	-	2
CO.6	3	-	3	-	-	3
CAM	3	3	2	3	-	2

19PCM103	ANTENNAS AND RADIATING SYSTEMS LAB	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To impart the knowledge on various antenna simulation tools used in communication engineering.

LIST OF EXPERIMENTS:

1. Simulation of half wave dipole antenna.
2. Simulation of radiation pattern of dipole antenna.
3. Simulation of radiation pattern of Monopole antenna.
4. Simulation of the numerical evaluation of the parameters for the design of a patch antenna.
5. Simulations of Micro strip patch antenna using given specifications.
6. Simulation of different types of patch antenna using same operating frequency and analyze the parameters.
7. Simulation of slot antenna using given specifications.
8. Simulation of Radiation pattern of loop antenna.
9. Simulation of half wave dipole antenna array.
10. Simulation of Radiation pattern of Broad side array and End fire array antenna.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Design and simulate an antenna which can be implemented in specific wireless applications.
- Write a code and simulate the radiation pattern of various antennas using given specifications.
- Analyze the parameters of the different patch antenna using given specifications

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	3	-	2	3	2	2
CO.2	3	2	2	3	2	2
CO.3	3	2	2	2	2	2
CAM	3	2	2	3	2	2

19PCM104 **ADAPTIVE SIGNAL PROCESSING LAB** **L T P C**

0 0 4 2

OBJECTIVE:

- To impart the knowledge on various simulation tools used in communication engineering.

1. Stability analysis using Hurwitz Routh Criteria
2. Sampling of Input Sequence using FFT
3. State Space Matrix from Differential Equation
4. Normal Equation using Levinson Durbin
5. Decimation and Interpolation using Rationale Factors
6. Maximally Decimated Analysis DFT Filter
7. Chebychev Type I, II Filter
8. Cascade Digital IIR Filter Realization
9. Parallel Realization of IIR filter
10. Estimation of PSD
11. Inverse Z Transform
12. Group Delay Calculation
13. Separation of T/F

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Analyze the stability of the system
- Design different digital filters in software
- Apply various transforms in time and frequency
- Perform decimation and interpolation

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	3	2	2	3	2	2
CO.2	3	2	2	3	2	2
CO.3	3	-	2	3	2	2
CAM	3	2	2	3	2	2

19PGM701	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT I INTRODUCTION TO PROJECT FORMULATION 9

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. Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis

UNIT II DATA COLLECTION, ANALYSIS AND ETHICS 9

Execution of the research - Observation and Collection of data - Methods of data collection Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation - Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

UNIT III REPORT,THESIS, PAPER AND RESEARCH PROPOSAL WRITING 9

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes, how to write report- Paper Developing a Research Proposal- Format of research proposal- a presentation and assessment by a review committee

UNIT IV INTELLECTUAL PROPERTY 9

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

UNIT V PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR 9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Identify and Formulate the Research Problem.
- Collect and Analyze data from various sources of Literature.
- Write thesis effectively including technical reports and other contents.
- Explain the ethical principles to be followed while patenting or obtaining copyright.
- Apply for patent rights and demonstrate New developments in IPR.

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

Additional Reading

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	-	-	-	-	-	-
CO.2	-	-	3	3	-	-
CO.3	-	-	3	-	-	-
CO.4	-	-	-	-	3	-
CO.5	-	3	-	-	-	-
CO.6	-	3	-	-	-	3
CAM	-	3	3	3	3	3

SEMESTER II

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**19PCM201**	Advanced Communication Networks	**3**	**0**	**0**	**3**
2.	**19PCM202**	Wireless and Mobile Communication	**3**	**0**	**0**	**3**
3.	**-**	Elective II	**3**	**0**	**0**	**3**
4.	**19PCM802**	English for Research Paper Writing (Audit Course-2)	**3**	**0**	**0**	**0**
PRACTICAL						
5.	**19PCM203**	Advanced Communication Networks Lab	**0**	**0**	**4**	**2**
6.	**19PCM204**	Wireless and Mobile Communication Lab	**0**	**0**	**4**	**2**
7.	**19PCM205**	Mini Project with seminar	**0**	**0**	**6**	**3**
Total			**12**	**0**	**14**	**16**
Total Number of Credits: 16						

19PCM201	ADVANCED COMMUNICATION NETWORK	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand advanced concepts, design and develop protocols for Communication Networks.
- To understand the mechanisms in QoS in networking and optimize the network design.
- To implement project based learning in recent communication networks

UNIT I INTRODUCTION 9

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

UNIT II REAL TIME COMMUNICATIONS 9

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

UNIT III INTERNET QOS 9

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

UNIT IV INTERNET PROTOCOLS 9

IP address lookup-challenges. Routing Algorithm classification. Link -State Routing Algorithm State Routing Algorithm Packet classification algorithms and Flow Identification- Grid of Tries, Cross Producting and controlled prefix expansion algorithms. IP tunneling, IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS, QoS Protocols and Algorithms, Security Protocols and Algorithms,

UNIT V APPLICATIONS 9

Securing network connected applications with proposed security models. Locality of Internet Traffic: An analysis based upon traffic in an IP access network. 4G, 5G and Internet Protocols Integration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimize the Network Design.
- Design and develop projects in the current trends of communication networks

REFERENCES:

1. Jean Wairand and PravinVaraiya, —High Performance Communications Networks‖, 2nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, —Network Calculus A Theory of Deterministic Queueing Systems for the Internet‖, Springer Veriag, 2001.
3. Zhang Wang, —Internet QoS‖, Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, —Communication Networking: An Analytical Approach‖ , Morgan Kaufman Publishers, 2004.

George Kesidis, —ATM Network Performance‖, Kluwer Academic, Research Papers, 2005

CO-PO Mapping:

	POs					
	Scholarship of Knowledge	**Critical Thinking**	**Problem solving and Research Skill**	**Modern Tool usage**	**Communication**	**Life Long Learning**
CO.1	2	-	-	-	-	-
CO.2	-	-	2	-	-	-
CO.3	3	3	-	2	-	-
CO.4	2	-	-	2	-	-
CO.5	2	3	2	-	-	-
CO.6	3	3	-	-	-	-
CAM	3	3	2	2	-	-

19PCM202	WIRELESS AND MOBILE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand advanced concepts in the wireless propagation model.
- To understand the mechanisms in the different multicarrier modulation.
- To implement project based learning in recent multiple access schemes.

UNIT I CELLULAR COMMUNICATION FUNDAMENTALS 9

Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE .

UNIT II SPECTRAL EFFICIENCY ANALYSIS FOR MULTIPLE ACCESS TECHNOLOGIES 9

TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations) Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

UNIT III MOBILE RADIO PROPAGATION 9

Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT IV CODE DIVISION MULTIPLE ACCESS 9

Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

UNIT V HIGHER GENERATION CELLULAR STANDARDS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Understanding cellular communication fundamentals.
- Apply the concept of diversity and combining in various multiple access Technologies.
- Discuss the different propagation techniques.
- Understanding Cellular concepts, GSM.
- Understanding the concept of Higher generation cellular standards.

REFERENCES:

1. Andrea Goldsmith, — Wireless Communications, Cambridge University Press ǁ, 2007.
2. Harry r. Anderson, — Fixed Broadband Wireless System Design ǁ, John Wiley, India, 2003.
3. Simon Haykin & Michael Moher, — Modern Wireless Communications ǁ, Pearson Education, 2007.
4. Yong Soo Cho, Jaekwon Kim et. al. MIMO-OFDM wireless Communication with Matlab, Wiley IEEE Press, 2010.
5. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
6. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
7. William C. Y. Lee "Mobile Communications Engineering" Mc Graw Hill Publications,2017
8. Mobile cellular Telecommunication system Lee.C. Y William , Mc Graw Hill education ,Newdelhi 2017 ,ISBN13:978 -0070635999

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	2	-	-	-	-	2
CO.2	3	-	-	-	-	2
CO.3	3	3	2	-	-	2
CO.4	3	-	-	-	-	2
CO.5	3	-	-	-	-	2
CO.6	3	3	2	2	-	2
CAM	3	3	2	2	-	2

19PCM203 **ADVANCED COMMUNICATION NETWORKS LAB** **L T P C**

0 0 4 2

OBJECTIVE:

- To impart the knowledge on various advanced networking concepts in communication engineering.

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
    a. Configuring NIC's IP Address.
    b. Determining IP Address and MAC Address using if-config command.
    c. Changing IP Address using if-config.
    d. Static IP Address and Configuration by Editing.
    e. Determining IP Address using DHCP.
    f. Configuring Hostname in /etc/hosts file.
3. Design TCP iterative Client and Server application to reverse the given input sentence.
4. Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call —select‖.
5. Design UDP Client Server to transfer a file.
6. Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.
    a. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterize traffic when the DNS server is up and when it is down.
7. Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.
8. Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterize file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.
9. Signaling and QoS of labeled paths using RSVP in MPLS.
10. Find shortest paths through provider network for RSVP and BGP.
11. Understand configuration, forwarding tables, and debugging of MPLS.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Identify the different types of network devices and their functions within a network.
- Understand and build the skills of sub-netting and routing mechanisms.
- Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	3	-	2	3	-	2
CO.2	3	3	2	3	-	2
CO.3	3	-	2	3	-	2
CAM	3	3	2	3	-	2

19PCM204 **WIRELESS AND MOBILE COMMUNICATION LAB** **L T P C**

0 0 4 2

OBJECTIVE:

- To impart the knowledge on various simulation tools used in communication engineering.

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi path environment, Coverage and Capacity issues using communication software.
2. Knowing GSM architecture, network concepts, call management, call setup, call release,Security and Power Control, Handoff Process and types, Rake Receiver etc.
3. Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
4. To study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.
5. To study various GSM AT Commands their use and developing new application using it.
6. Understating of 3G Communication System with features like; transmission of voice and videocalls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.
7. Knowing CDMA architecture, network concepts, call management, call setup, call release,Security and Power Control, Handoff Process and types, Rake Receiver etc.
8. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.
9. To learn and develop concepts of Software Radio in real time environment by studying the building blocks like Base band and RF section, convolution encoder, Interleaver and De- Interleaver.
10. To study and analyze different modulation techniques in time and frequency domain using SDR kit.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Understanding Cellular concepts, GSM and CDMA networks .
- To study GSM handset by experimentation and fault insertion techniques.
- Understating of 3G communication system by means of various AT commands usage in GSM.
- Understanding CDMA concept using DSSS kit.
- To learn, understand and develop concepts of Software Radio in real time environment.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communi cation	Life Long Learning
CO.1	3	3	2	3	-	2
CO.2	3	-	2	3	-	2

CO.3	**3**	**3**	**2**	**3**	**-**	**2**
CAM	**3**	**3**	**2**	**3**	**-**	**2**

19PCM205	MINI PROJECT WITH SEMINAR	L	T	P	C
		0	0	6	3

OBJECTIVE:

- To inculcate the importance of communication skills
- To familiarize with the concepts in emerging engineering field

DESCRIPTION:

This course is introduced to enrich the communication skills of the student and to create awareness on recent development in Electrical and Electronics Engineering through Technical presentation. In this course, a student has to present at least two Technical papers or recent advances in Engineering / Technology that will be evaluated by a Committee constituted by the Head of the Department. Students should work on a small research problem. Students have to carry out the project under the guidance of faculty member using the knowledge of subjects that he/she has learned. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

- Understand the basic concept of core subject
- Explain the concept in an effective manner
- Apply innovative ideas on emerging engineering field.
- Implement the novelty in Mini Project with seminars
- Demonstrate the Technical ideas with good communication skill.

SEMESTER III

SEMESTER III

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	**-**	Elective III	**3**	**0**	**0**	**3**
2.	**-**	Elective IV	**3**	**0**	**0**	**3**
3.	**-**	Elective V	**3**	**0**	**0**	**3**
4.	**-**	Open Elective	**3**	**0**	**0**	**3**
PRACTICAL						
5.	**19PCM301**	Dissertation Phase – I	**0**	**0**	**20**	**10**
Total			**12**	**0**	**20**	**22**
Total Number of Credits: 22						

19PCM301	PHASE-I DISSERTATION	L	T	P	C
		0	0	20	10

Every candidate shall be permitted to undertake a research based project work of his/her choice related to his/her discipline in consultation with the Head of the Department. The project shall be supervised by faculty members of the department in which the candidate registered a course.

In case of a project work at Industrial/research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

He/she shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and viva-voce examination conducted by a committee consisting of an external examiner, internal examiner and the supervisor of the candidate.

SEMESTER IV

SEMESTER IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	**19PCM401**	Phase II Dissertation	**0**	**0**	**32**	**16**
Total			**0**	**0**	**32**	**16**
Total Number of Credits: 16						

19PCM401	PHASE II DISSERTATION	L	T	P	C
		0	0	32	16

Every candidate shall be permitted to undertake a research based project work of his/her choice related to his/her discipline in consultation with the Head of the Department. The project shall be supervised by faculty members of the department in which the candidate registered a course.

In case of a project work at Industrial/research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

He/she shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and viva-voce examination conducted by a committee consisting of an external examiner, internal examiner and the supervisor of the candidate.

LIST OF PROGRAM ELECTIVES

S.No	Course Code	Course Title	L	T	P	C
1.	**19PCM501**	Wireless Sensor Networks	**3**	**0**	**0**	**3**
2.	**19PCM502**	Optical Networks	**3**	**0**	**0**	**3**
3.	**19PCM503**	Cognitive Radio	**3**	**0**	**0**	**3**
4.	**19PCM504**	RF Circuits and Microwave Systems	**3**	**0**	**0**	**3**
5.	**19PCM505**	Communication Network Security	**3**	**0**	**0**	**3**
6.	**19PCM506**	Satellite Communication	**3**	**0**	**0**	**3**
7.	**19PCM507**	Communication Protocol Engineering	**3**	**0**	**0**	**3**
8.	**19PCM508**	Speech and Audio Signal Processing	**3**	**0**	**0**	**3**
9.	**19PCM509**	MIMO System	**3**	**0**	**0**	**3**
10.	**19PCM510**	High Performance Communication Networks	**3**	**0**	**0**	**3**
11.	**19PCM511**	Pattern Recognition	**3**	**0**	**0**	**3**
12.	**19PCM512**	Microelectronics and VLSI Technology	**3**	**0**	**0**	**3**
13.	**19PCM513**	Smart Devices and emerging mobile technologies	**3**	**0**	**0**	**3**
14.	**19PCM514**	Network Management System	**3**	**0**	**0**	**3**
15.	**19PCM515**	Ubiquitous Computing and Pervasive Computing	**3**	**0**	**0**	**3**
16.	**19PCM516**	DSP Processor Architecture and Programming	**3**	**0**	**0**	**3**
17.	**19PCM517**	Mobile and Social Computing	**3**	**0**	**0**	**3**
18.	**19PCM518**	Data Compression	**3**	**0**	**0**	**3**
19.	**19PCM519**	Medical Imaging Techniques	**3**	**0**	**0**	**3**
20.	**19PCM520**	Global Positioning Systems	**3**	**0**	**0**	**3**

19PCM501	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To expertise on sensor networks and their Applications, localization and positioning.
- To explain the concepts of routing protocols and topology control.
- To summarize the Operating Systems and Programming Concepts for WSNs

UNIT I INTRODUCTION **9**

Wireless Sensor Networks - Characteristics requirements- -Unique Constraints and Challenges – Difference between Mobile adhoc and Sensor Networks- Advantages of sensor networks - Sensor Node Architecture - Sensor Network Architecture - Sensor Networks Applications :Environmental Monitoring, Industry Automation, Disaster Management , Mobile Crowd Sensing Applications -Smart Cities, Road Transportation ,Health Care and Well-Being ,Marketing/Advertising

UNIT II LOCALIZATION AND POSITIONING **9**

Properties of localization and positioning procedures, Possible approaches, Mathematical basics for the lateration problem, Single-hop localization, Positioning in multi hop environments, Impact of anchor placement.

UNIT III ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWOR **9**

Introduction, Background, Data Dissemination and Gathering, Routing Challenges and Design Issues in WSN. Network Scale and Time-Varying Characteristics, Resource Constraints, Data Models, Routing Strategies in WSN, WSN Routing Techniques, Flooding and its Variants, Sensor Protocols for Information via Negotiation, Low Energy Adaptive Clustering Hierarchy, Power Efficient Gathering in Sensor Information Systems Directed Diffusion, Geographical Routing.

UNIT IV TOPOLOGY CONTROL **9**

Motivation and basic ideas, Controlling topology in flat networks – Power control, Hierarchical networks by dominating sets, Hierarchical networks by dominating sets, Combining hierarchical topologies and power control, Adaptive node activity.

UNIT V OPERATING SYSTEMS AND PROGRAMMING WSN **9**

Operating Systems for WSNs: Introduction, Architecture, Execution Model Case Study: Popular Operating Systems-TinyOS, Contiki, MagnetOS, Mantis OS. Programming WSNs: Simulation Tools-TOSSIM, COOJA, Castalia, NS-3 Case study: Performance comparison of energy efficient cluster based routing protocols

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Summarize the advantages and applications of sensor networks.
- Discuss the different methods of localization and positioning methods.
- Analyze the various routing protocols in sensor networks.
- Distinguish the flat and hierarchical network topology control.
- Develop Energy efficient protocols for wireless sensor networks.

REFERENCES:

1. Feng Zhao Feng Zhao Leonidas Guibas Leonidas Guibas, Wireless Sensor Networks,‖An Information Processing Approach, 1st Edition, 2004, Elsevier.
2. Holger Karl And Andreas Willig, — Protocols and Architectures for Wireless Sensor Networks ", John Wiley & Sons, 2005.
3. KazemSohraby, Daniel Minoli, &TaiebZnati, —Wireless Sensor Networks-s Technology, Protocols, And Applications ", John Wiley, 2007.
4. Nandini Mukherjee SarmisthaNeogySarbani Roy, Building Wireless Sensor Networks Theoretical & Practical Perspectives, CRC Press, 2016.
5. John R. Vacca, Handbook of Sensor Networking Advanced Technologies and Applications, CRC Press, 2015.

19PCM502	OPTICAL NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart knowledge on optical system components and optical network architectures.
- To give an idea about the wavelength routing networks and packet switching and access networks**.**
- To familiarize the students on the network design and management.

UNIT I OPTICAL SYSTEM COMPONENTS 9

Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 8

Introduction to Optical Networks; Metropolitan-Area Networks, Layered Architecture Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Test beds for Broadcast & Select WDM; Introduction to PON, GPON, APON.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The optical layer, Node Designs, Optical layer cost tradeoff, Routing and wavelength assignment, Virtual topology design, Wavelength Routing Test beds, Architectural variations.

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

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

UNIT V NETWORK DESIGN AND MANAGEMENT 10

Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization ; Overall design considerations; Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Explain the concepts of optical system components.
- Infer knowledge on optical network architectures.
- Design routing networks and virtual topology.
- Explain the various packet switching techniques and compare different network management methods.
- Analyze the Fault Management and Optical safety.

REFERENCES:

1. Rajiv Ramaswami, Sivarajan, Sasaki, —Optical Networks: A Practical Perspectivel, MK, Elsevier, 3 rd edition, 2010.
2. Siva Ram Moorthy , Mohan Gurusamy, — WDM Optical Networks : Concept, Design and Algorithms l, Prentice Hall of India, 1st Edition, 2002.
3. Green P.E, Jr, — Fiber Optic Networks l, Prentice Hall, NJ, 1993.
4. Biswajit Mukherjee, — Optical Communication Networks l, TMG, 1998.

19PCM503	COGNITIVE RADIO	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To give an idea about the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
- To discuss the research challenges in Cognitive Radio Techniques
- To give an idea about the evolving next generation wireless networks and their associated challenges.

UNIT I INTRODUCTION TO SDR **9**

Definitions and potential benefits, software radio architecture evolution – foundations, technology tradeoffs and architecture implications, Antenna for Cognitive Radio.

UNIT II SDR ARCHITECTURE **9**

Essential functions of the software radio, architecture goals, quantifying degrees of programmability, top level component topology, computational properties of functional components, interface topologies among plug and play modules, architecture partitions.

UNIT III INTRODUCTION TO COGNITIVE RADIOS **9**

Marking radio self-aware, the cognition cycle, organization of cognition tasks, structuring knowledge for cognition tasks, Enabling location and environment awareness in cognitive radios – concepts, architecture, design considerations.

UNIT IV COGNITIVE RADIOS - TECHNICAL CHALLENGES **9**

Design Challenges associated with Cognitive Radios – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security

UNIT V NEXT GENERATION WIRELESS NETWORKS **9**

The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design, White Space Radio.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Describe the fundamentals of SDR .
- Explain the essential functions of SDR architecture.
- Analyze the various cognitive radio communication strategies.
- Discuss the research challenges in Cognitive Radio Techniques.
- Develop the solutions in future wireless network design.

REFERENCES:

1. Alexander M. Wyglinski, MaziarNekovee, And Y. Thomas Hou, — Cognitive Radio Communications And Networks - Principles And Practice ǀ, Elsevier Inc., 2010.
2. HuseyinArslan , —Cognitive Radio, Software Defined Radio and Adaptive wireless system, Springer, 1 edition ,September 24, 2007.
3. Mitola, J. and J. Maguire, G. Q., —Cognitive radio: making software radios more personal,ǀ IEEE Personal Commun. Mag., vol. 6, no. 4, pp. 13–18, Aug. 1999.
4. Kwang-Cheng Chen and Ramjee Prasad, — Cognitive Radio Networks ǀ, John Wiley & Sons, Ltd, 2009.
5. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, —Cognitive Radio Networks – From Theory to Practice ǀ, Springer Series: Analog Circuits and Signal Processing, 2009.
6. J. Mitola, — Cognitive Radio: An Integrated Agent Architecture for software defined radio ǀ, Doctor of Technology thesis, Royal Inst. Technology, Sweden, 2000.
7. Simon Haykin, — Cognitive Radio: Brain –empowered wireless communications ǀ, IEEE Journal on selected areas in communications, Feb 2005.
8. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, — Next generation / dynamic spectrum access / cognitive radio wireless networks ǀ, A Survey Elsevier Computer Networks, May 2006.

19PCM504	RF CIRCUITS AND MICROWAVE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the concept of filters and RF amplifier design
- To familiarize with the usage of active and passive components of microwave systems.
- To know the various microwave measurements and its effect on different applications

UNIT I RF TRANSISTOR AMPLIFIER DESIGN 9

RF Components : Diodes, BJT,FET, Characteristics of Amplifiers-Amplifiers Power relations-Stability Considerations-Constant Gain-Noise Figure Circles-Constant VSWR circles-Broadband High Power and Multistage Amplifiers.

UNIT II RF FILTER DESIGN 9

Generalization-Basic Resonator and Filter configurations: Low pass, High Pass, Band Pass and Band stop type Filters-Special filter Realizations-Filter Implementations using unit element and kuroda`s identities-Coupled Filters.

UNIT III INTRODUCTION ON MICROWAVE SYSTEMS 9

Wireless Communications system, Radar Systems, Radiometer Systems, Satellite Communication, Remote sensing, Microwave Propagation, Microwave Antennas

UNIT IV MICROWAVE MEASUREMENTS

Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure, Measurement of Microwave antenna parameters.

UNIT V MODERN TRENDS IN MICROWAVES ENGINEERING 9

Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), RF MEMS for microwave components, Microwave Imaging.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Design Amplifiers using RF active components.
2. Design various types of filters used for RF circuits.
3. Describe the principle of various microwave systems.
4. Implement measurement techniques using suitable RF analyzers.
5. Explain the impact of microwaves from day to day applications.

REFERENCE BOOKS:

1. Reinhold.Ludwig and PavelBretshko, —RF Circuit Design‖, Pearson Education,2006.
2. Joseph J. Carr, —RF Components and Circuits‖, Newnes,2002.
3. AnanjanBasu —An Introduction to Microwave Measurements‖, CRC Press July 2017.
4. Kai chang, —RF and Microwave Wireless Systems‖ wiley edition 2000.

19PCM505	COMMUNICATION NETWORK SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce the concept of security and explain symmetric and asymmetric key algorithms.
- To impart knowledge on integrity, authentication and key management.
- To outline the concept of network security and wireless network security .

UNIT I INTRODUCTION ON SECURITY 9

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

UNIT II SYMMETRIC & ASYMMETRIC KEY ALGORITHMS 9

Substitutional Ciphers, Transposition Ciphers, Stream and Block Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, principle of asymmetric key algorithms, RSA Cryptosystem , Shamir's secret sharing and BE, Identity-based Encryption (IBE), Attribute-based Encryption (ABE). Introduction to Quantum Cryptography, Block chain, Bit coin and Crypto currency.

UNIT III INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT 9

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

UNIT IV NETWORK SECURITY , FIREWALLS AND WEB SECURITY 9

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature. Side-channel attack, Pretty Good Privacy (PGP).

UNIT V WIRELESS NETWORK SECURITY 9

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. WEP for Wi-Fi network, Security for 4G networks: Secure Ad hoc Network, Secure Sensor Network Projects for Teaching cryptography and network security. Research projects, Programming projects reading report assignment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Explain the attacks, security services and mechanisms.
- Explain symmetric and asymmetric key algorithms and **Introduction to Quantum Cryptography**
- Summarize the concepts of Digital Signature, Authentication and key management techniques.
- Identify IP security, web security requirement and secure electronic transaction.
- Discuss about wireless networks security and **projects in cryptography.**

REFERENCES:

1. Behrouz Forouzan.A , — Cryptography and Network security ‖, Tata McGraw- Hill, 2008.
2. William Stallings, — Cryptography and Network security: principles and practice ‖, Prentice Hall of India, 2ndEdition, New Delhi, 2002.
3. Atul Kahate, — Cryptography and Network security ‖, Tata McGraw- Hill , 2nd Edition, 2008.
4. Yang.H, — Security in Mobile Ad Hoc Networks: Challenges and Solution ‖, IEEE Wireless Communications, 2004.

19PCM506	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce about the elements of satellite Communication.
- To explain the modulation and multiple access schemes.
- To summarize about satellites and its applications

UNIT I ELEMENTS OF SATELLITE COMMUNICATION 9

Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.

UNIT II TRANSMISSION, MODULATION, MULTIPLE ACCESS 9

Phased arrays for satellite communications, satellite laser communications, Features of RF and optical space communication systems, wireless standards in satellite networking, Tracking and Data Relay Satellite K (TDRS-K) , Multiple Access Techniques – DMA, TDMA, CDMA, and DAMA.

UNIT III SATELLITE LINK DESIGN 9

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM 9

Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS.

UNIT V SERVICES AND APPLICATIONS 9

Mixed and mobile services - Multimedia satellite services - Advanced applications based on satellite platforms - INTELSAT series ,Remote Sensing - Special services, E-mail, Video conferencing and Internet connectivity ,Mission Chandrayan and Mission Mangalyan.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Distinguish the elements of satellite.
- Compare the various multiplexing and modulation techniques involved in satellite communication.
- Analyze the design methods of satellite link.
- Describe about satellite navigation and global positioning system.
- Explain the applications of satellite communication.

REFERENCES:

1. Wilbur Pritchard.L,Suyderhoud.H.D,RobertNelson.A, — Satellite Communication Systems Engineering ‖, Prentice Hall, New Jersey, 2006.
2. Timothy Pratt, Charles Bostain.W, — Satellite Communications ‖, John Wiley and Sons, 2010.
3. Roddy.D, — Satellite Communication ‖, McGrawHill, 2008.
4. Tri T Ha, — Digital Satellite Communication ‖, McGraw Hill, 2009.

19PCM507	COMMUNICATION PROTOCOL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To explain the specifications of protocol and various protocol verification/validation approaches
- Give knowledge on protocol conformance, performance testing and their implementation and synthesis.
- To impart knowledge in Networking protocols and standards used in Internet of Things.

UNIT I PROTOCOL SPECIFICATIONS 9

Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol other protocol specification languages.

UNIT II PROTOCOL VERIFICATION / VALIDATION 9

Protocol verification, Verification of a protocol using finite state machines, Protocol validation, protocol design errors, Protocol validation approaches, SDL based protocol verification and validation.

UNIT III PROTOCOL CONFORMANCE/PERFORMANCE TESTING 9

Conformance testing methodology and frame work, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controllable interfaces - RIP,SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, Scalability testing.

UNIT IV PROTOCOL SYNTHESIS AND IMPLEMENTATION 9

Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis of SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol compilers, Tool for protocol engineering.

UNIT V INTERNET OF THINGS PROTOCOLS AND STANDARDS 9

IoT Data Link Protocol, Network Layer Routing Protocols, Network Layer Encapsulation Protocols, MQTT,SMQTT,CoAP Protocols, IoT Management Protocol, and Security in IoT Protocols, IoT Challenges.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Analyze the protocol specifications and SDL based protocol.
- Relate the different protocol validation and verification.
- Explain the types of testing in protocol performance and conformance.
- Explain various protocol synthesis and implementation.
- Describe the various standards and networking protocols used in Internet of things.

REFERENCES:

1. PallapaVenkataram and SunilkumarS.Manvi, — Communication protocol Engineering ‖, Eastern Economy edition, 2004.
2. Richard Lai and Jirachief pattana, — Communication Protocol Specification and Verification ‖, Kluwer Publishers, Boston, 1998.
3. Tarnay. K, — Protocol Specification and Testing ‖, Plenum, New York, 1991.
4. Mohamed G. Gouda, — Elements of Network Protocol Design ‖, John Wiley & Sons, Inc, New York, USA, 1998.
5. https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html,https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot.pdf

19PCM508	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVE

- To study the basics of speech signal, speech production mechanisms
- To explore time domain and frequency domain analysis of speech signal
- To focus on the applications of speech signal processing

UNIT I MECHANICS OF SPEECH **9**

Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system–Psychoacoustics.

UNIT II TIME DOMAIN METHODS FOR SPEECH PROCESSING **9**

Time domain parameters of Speech signal – Methods for extracting the parameters Energy- Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.

UNIT III FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING **9**

Short Time Fourier analysis – Filter bank analysis – Formant extraction – Pitch Extraction – Analysis by Synthesis-Analysis synthesis systems- Phase vocoder—Channel vocoder. Homomorphic speech analysis: Cepstral analysis of Speech – Formant and Pitch Estimation Speech enhancement techniques in time domain –Homomorphicvocoders.

UNIT IV LINEAR PREDICTIVE ANALYSIS OF SPEECH **9**

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

UNIT V APPLICATION OF SPEECH & AUDIO SIGNAL PROCESSING ALGORITHMS **9**

Spectral Estimation, dynamic time warping – Hidden Markov model – Music analysis – Pitch Detection– Feature analysis for recognition – Music synthesis – Automatic Speech Recognition – Feature Extraction for ASR – Deterministic sequence recognition – Statistical Sequence recognition – ASR systems – Speaker identification and verification – Voice response system 9 Hours Unit VI$ Speech Synthesis: Text to speech - voice over IP-Enhancement of speech using spectral subtraction, wiener filter- Voice activity detection for speech coding-simulation of audio coding techniques - Pitch detection using LPC.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Understanding of continuous-time wavelet transforms.
- Understanding of discrete-time wavelet transforms.
- The ability to design wavelet filter banks
- Knowledge of Compression techniques
- The ability to apply above knowledge and skills to image processing applications.

REFERENCES:

1. L.R.Rabiner and R.W. Schaffer., Digital Processing of Speech signals – Prentice Hall –1978.
2. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., 2004.
3. Quatieri ,Discrete-time Speech Signal Processing , Prentice Hall, 2001.
4. J.L.Flanagan ,Speech analysis: Synthesis and Perception ,Berlin,1972.
5. I.H. Witten, Principles of Computer Speech – Academic Press, 1982.

19PCM509	MIMO SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart knowledge about MIMO Channel modeling and system architecture.
- To introduce space time block codes and space time trellis codes.
- To explain the practical applications of MIMO systems.

UNIT I SPATIAL MULTIPLEXING AND CHANNEL MODELING 9

Review of SISO fading communication channels, Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO Channels, Modelling of MIMO fading channels , MIMO wireless communication, MIMO channel and signal model, A fundamental trade-off, MIMO transceiver design, MIMO in wireless networks, MIMO in wireless standards.

UNIT II CAPACITY AND MULTIPLEXING ARCHITECTURES 9

The V-BLAST architecture, Fast fading MIMO channel, Receiver architectures, Slow fading MIMO channel, D-BLAST: an outage-optimal architecture.

UNIT III DIVERSITY–MULTIPLEXING TRADEOFF AND SPACE TIME BLOCK CODES 9

Diversity–multiplexing tradeoff, Space time block codes on real and complex orthogonal designs, Code design criteria for quasi-static channels (Rank, determinant and Euclidean distance), Orthogonal designs, Generalized orthogonal designs, Quasi-orthogonal designs and Performance analysis.

UNIT IV SPACE TIME TRELLIS CODES 9

Representation of STTC, shift register, generator matrix, state-transition diagram, trellis diagram, Code construction, Delay diversity as a special case of STTC and Performance analysis.

UNIT V MULTIUSER COMMUNICATION 9

Access protocols: duty-cycle, scheduled, random access, polling-based, Uplink with multiple receive antennas, MIMO uplink, Downlink with multiple transmit antennas, MIMO downlink, MIMO in 4G (LTE, LTE-Advanced and WiMAX) and 5G. Antenna partitioning technique for MIMO-CDMA systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Develop mathematical models for MIMO Channels
- Design a space time MIMO wireless communication receiver architecture as per given specifications
- Design space time block codes
- Design space time trellis codes
- Explain the applications of MIMO systems

REFERENCES:

1. Nei David Tse and PramodViswanath, — Fundamentals of Wireless Communication ǁ, Cambridge University Press 2005, Press 2005.
2. Hamid Jafarkhani, , — Space-Time Coding: Theory and Practice ǁ, Cambridge University, Press 2005.
3. Paulraj, R. Nabar and D. Gore, — Introduction to Space-Time Wireless Communications ǁ, Cambridge University, Press 2005.
4. E.G. Larsson and P. Stoica,— Space-Time Block Coding for Wireless Communications ǁ, Cambridge University, Press 2008.
5. M. Janakiraman,—Space-time codes and MIMO systems ǁ, Artech House, 2004.
6. EzioBiglieri , Robert Calderbank et al, — MIMO Wireless Communications ǁ, Cambridge University, Press 2007.
7. B. Clerckx and C. Oestges, —MIMO Wireless Networks: Channels, Techniques and Standards for Multi-Antenna, Multi-User and Multi-Cell Systemsǁ, Academic Press (Elsevier), Oxford, UK, Jan 2013.

19PCM510	HIGH PERFORMANCE COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart knowledge on Fundamentals of computer networks and wireless networks.
- learn the architecture and uniqueness of high performance networks.
- To familiarize the students on the network design and management.

UNIT I INTRODUCTION COMMUNICATION NETWORKS 9

Telephone and computer networks - cable television networks - wireless networks - networking principles - digitalization - network externalities - service integration; Layered Architecture: - network bottlenecks - network elements - network mechanisms - traffic characterization and QoS.

UNIT II MANET 8

Multihop wireless broadband networks - mesh networks; MANET architecture - classification of routing protocols in MANET -routing metrics; packet scheduling algorithms - power control mechanism.

UNIT III INTERNET AND TCP 9

Internet and TCP / IP Networks Internet Protocol (IP): Technology trends in IP networks - IP packet communications in mobile communication networks; TCP and UDP - performance of TCP/ IP networks; Circuit Switched Networks: SONET- DWDM - fiber to the home - DSL; Intelligent Network (IN) scheme - comparison with conventional systems - merits of the IN scheme; CATV and layered network - services over CATV.

UNIT IV ENABLING NETWORKS 9

Overview - architecture - PHY an d MAC layer; WiMAX overview - system architecture - frame structure - PMP mode - mesh mode - multihop relay mode; UWB overview - time hopping UWB - direct sequence UWB - multiband UWB; LTE and LTE- A overview - system model - frame structure - comparison with broadband technologies.

UNIT V INSTRUCTIONAL ACTIVITIES 10

Simulation of WiFi network - Simulation of WiMAX network in mesh mode and multi hop relay mode - Simulation of integration of LTE - A and WiMAX network with single IP network.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Explain the concepts of the various topologies.
- Infer knowledge on services offered by broadband.
- Design routing networks and virtual topology.
- Explain the various WiMAX, UWB.
- Analyze the various LTE networks.

REFERENCES:

1. Jean Warland and PravinVaraiya, —High Performance Communication Networks‖, 2nd Edition, Harcourt and Morgan Kanffman Publishers, London, 2008.
2. Leon Gracia and Widjaja, —Communication Networks‖, Tata McGraw Hill, 2008.
3. LumitKasera and PankajSethi, —ATM Networks: Concepts and Protocols‖, Tata McGraw Hill, 2007.
4. Jeffrey G. Andrews, ArunabhaGhosh and RiasMuhamed, —Fundamentals of WiMAX Understanding Broadband Wireless Networking‖, Prentice Hall of India, 2008.
5. AmitabhaGhosh and RapeepatRatasuk, —Essentials of LTE and LTE-A‖, Cambridge University, 2011.
6. David Tung Chong Wong, Peng-Yong Kong, Ying-Chang Liang, KeeChaing Chua and Jon W. Mark, —Wireless Broadband Networks‖, John Wiley and Sons, 2009.
7. Ada Gavrilovska, —Attaining High Performance Communications: A Vertical Approach‖, CRC Press, 2016.
8. Dimitris N. Chorafas, —High-Performance Networks, Personal Communications and Mobile Computing‖, Springer, 2016.

19PCM511	PATTERN RECOGNITION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To Introduce the statistical theory in pattern recognition .
- To give knowledge on parametric and nonparametric models.
- To explain the various clustering algorithms in Pattern Recognition.

UNIT I INTRODUCTION **9**

Introduction: Basics of pattern recognition – Design principles of pattern recognition system – Learning and adaptation – Pattern recognition approaches. Mathematical foundations: Linear algebra – Probability theory – Expectation – Mean and Covariance – Normal distribution – Multivariate normal densities – Chi square test of hypothesis

UNIT II STATISTICAL PATTERN RECOGNITION **9**

Statistical Patten Recognition: Bayesian Decision Theory – Classifiers – Normal density and discriminant functions.

UNIT III MODELS **9**

Parameter estimation methods: Maximum-Likelihood estimation – Bayesian Parameter estimation – Dimension reduction methods – Principal Component Analysis (PCA) – Fisher Linear Discriminant analysis – Expectation – maximization (EM) – Hidden Markov Models (HMM) – Gaussian mixture models.

UNIT IV NON PARAMETRIC TECHNIQUES **9**

Nonparametric Techniques: Density Estimation – Parzen Windows – K-Nearest Neighbor Estimation – Nearest Neighbor Rule – Fuzzy classification.

UNIT V CLUSTERING TECHNIQUES **9**

Unsupervised Learning and Clustering: Criterion functions for clustering – Clustering Techniques: Iterative square – Error partitional clustering – K-Means – agglomerative hierarchical clustering – Cluster validation, SVM, CNN, RNN algorithms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Outline the basic principles and application of Linear algebra in pattern recognition
- Introduce various pattern recognition methods using Statistical theory.
- List the Parameter estimation and Dimension reduction methods
- Categorize the various non-parametric techniques in Pattern Recognition.
- Summarize the various clustering Techniques used in Pattern Recognition.

REFERENCES:

1. Richard O. Duda, Peter E. Hart, David G. Stork, — Pattern Classification ‖, John Wiley, 2nd Edition, 2006.
2. Bishop Christopher M, — Pattern Recognition and Machine Learning ‖, Springer, 1st Edition, 2009.
3. Theodoridis S, Koutroumbas K, — Pattern Recognition ‖, Academic Press, 4th Edition, 2009.
4. KeinosukeFukunaga, — Introduction to Statistical Pattern Recognition ‖, Academic Press, 2nd Edition, 2003.
5. SergiosThedoridis, KonstantinosKoutroumbas, — Pattern Recognition ‖, Academic Press, 4th Edition, 2009.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	2	-	-	-	-	-
CO.2	3	-	2	2	-	2
CO.3	3	-	2	2	-	2
CO.4	3	3	2	2	-	2
CO.5	3	-	2	2	-	2
CO.6	3	-	3	3	-	2
CAM	3		2	2	-	2

19PCM512	MICROELECTRONICS AND VLSI TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To Impart Knowledge on physics of semiconductors and quantitative models.
- To understand the basics of semiconductor crystal properties, IC fabrication and automation.
- To identify the issues at various stages of VLSI physical design involved in fabrications.

UNIT I PHYSICS OF SEMICONDUCTORS 9

Review of semiconductor physics –quantum foundations -Semiconductor band structure, Simplified band structure models, Carrier concentration –non equilibrium –quasi Fermi levels -drift and diffusion –mobility –generation and recombination –continuity equation.

UNIT II BASICS OF SEMICONDUCTOR CRYSTAL PROPERTIES 9

Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, phase diagram and solid solubility, Crystal growth techniques, Epitaxy, Clean room and safety requirements. Oxidation: wet and dry oxidation, Deal-Grove model, Diffusion process, Ion implantation, modeling of Ion implantation, statistics of ion implantation, rapid thermal annealing, SIMS.

UNIT III ADVANCED METHODS IN FABRICATIONS 9

Deposition & Growth: Various deposition techniques CVD, PVD, evaporation, sputtering, spin coating, LPCVD, MBE, ALCVD, Growth of High k and low k dielectrics, Etching -wet and dry etch, plasma and RIE etch, Photolithography: Positive photo resist, negative photo resist, comparison of photo resists, components of a resist, light sources, exposure, resolution, depth of focus, numerical aperture sensitivity, contrast, proximity and projection lithography, step and scan, optical proximity correction.

UNIT IV PHYSICAL DESIGN AUTOMATION 9

Introduction to digital IC design -custom and semicustom flow, combinational logic synthesis -Technology independent and technology dependent optimization -Binary decision diagrams -High level synthesis-Scheduling and allocation –Physical design –terminology –graph algorithms –heuristic algorithms–Basic Unix/Linux commands –introduction to C shell/Perl scripting.

UNIT V NANO –ELECTRONICS 9

Nano-scale electronics; Foundation of nano-electronics – low dimension transport, quantum confinement, Coulomb blockade and quantum dot; Ballistic transport and Quantum interferences; Landauer formula, quantization of conductance, example of Quantum point contact.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Apply the qualitative understanding of physics of semiconductors to develop quantitative models for semiconductor phenomena relevant to the field of electronics.
- Outline the basics of semiconductor crystal properties and identify the fundamentals of IC fabrication.
- Identify the issues at various applications of nanometer technology..
- Illustrate the advanced methods involved in deposition and photolithography.
- Build an idea on nano-electronics and its technology.

REFERENCES:

1. S.M. Sze& Kwok K. Ng, Physics of Semiconductor Devices, 3rdEdition, Wiley, 2007.
2. B.L. Anderson & R. L. Anderson, Fundamentalsof Semiconductor Devices, McGraw-Hill, 2005.
3. Naveed A. Sherwani, Algorithms for VLSI Physical Design Automation, Springer, 3rdEdition,1999.
4. James Plummer, M. Deal and P.Griffin, Silicon VLSI Technology,Prentice Hall Electronics, 2010
5. S.M. Sze, Stephen Campbell, The Science and Engineering of Microelectronics, Oxford University Press, 2012.
6. S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc, New York, 2005.

19PCM513	SMART DEVICES AND EMERGING MOBILE TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To give an idea about the components of smart devices.
- To summarize the various mobile communication generations and functionality of 5G architecture and internet.
- To explain the functions of small cells for 5G network and its security challenges.

UNIT I ELEMENTS OF SMART DEVICES 9

Introduction to core technology and components used in smart devices ,Characteristics of smart phone - Smart device sensors- gyro (gyroscope sensor), heart rate sensor, optical IR light sensor, and pressure altimeters along with the GPS and A-GPS.

UNIT II SMART DEVICES DISPLAY AND EVOLUTION OF 5G 9

Smart device display technology- AMOLED, Super AMOLED, Characteristics of wireless charging technologies. Evolution of LTE technology to beyond 4G - 5G roadmap-10 pillars of 5G- IoT: relation to 5G

UNIT III 5G ARCHITECTURE AND INTERNET 9

Introduction- High-level requirements for the 5G architecture-Functional architecture and 5G flexibility-Physical architecture and 5G deployment- IoT and context awareness –networking reconfiguration and virtualization and support-Mobility – Quality of service control-emerging approach for resource over provisioning

UNIT IV SMALL CELLS FOR 5G MOBILE NETWORK 9

Small cells- the future of cellular networks-frequency assignments approaches and access methods-closed access, open access. Mobile data demand-small cell challenges.

UNIT V SECURITY CHALLENGES IN 5G 9

Introduction-Radio system design-nonlinear crosstalk in MIMO systems. Security issues and challenges in 5G communication systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Summarize the components of smart devices.
- Illustrate the various smart devices displays and evolution of 5G.
- Explain the functionality of 5G architecture and internet.
- Categorize the functions of small cells for 5G network.
- Explain the security challenges in 5G communication system.

REFERENCES:

1. https://www.coursera.org/learn/smart-device-mobile-emerging-technologies.
2. https://www.hindawi.com/journals/js/2019/6514520/.
3. Jonathan Rodriguez, — Fundamentals of 5G Mobile Networks ‖, John Wiley and Sons, New York, 2015.
4. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, ‖ 5G Mobile and Wireless Communications Technology‖, Cambridge University Press 2016
5. Holger Claussen, David Lo´pez-Pe´rez, Lester Ho, Rouzbeh Razavi and Stepan Kucera, — Small Cell Networks‖, John Wiley and Sons, New York, 2017.

19PCM514	NETWORK MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Gain in-depth theoretical and practical knowledge of network management, and in particular of SNMP (Simple Network Management Protocol).
- Familiarization with network management to be prepared for a career in the industry or to pursue further research on the subject.

UNIT 1 DATA COMMUNICATION AND NETWORK MANAGEMENT 9

Analogy of Telephone Network Management. Communications Protocols and Standards. Case Histories on Networking and Management. Network Management Functions. Network and System Management.

UNIT 2 STANDARDS, MODELS, AND LANGUAGES 9

Network Management Standards. Network Management Models. Organization Model. Information Model. Communication Model. Functional Model. Network Management Applications. Abstract Syntax Notation One (ASN.1) Encoding Structure**.**

UNIT 3 NETWORK MANAGEMENT PROTOVOLS 9

Simple Network Management protocol (SNMPv1, SNMPv2, SNMPv3) - Data Structures and its comparisons,Remote Monitoring system (RMON1,RMON2) - SMI MIB and its comparison.

UNIT 4 NETWORK MANAGEMENT TOOLS 9

Tools for IP Management, VoiP Monitoring, Network Mapping, Bandwidth Analysis, Performance Monitoring, Trouble Shooting, Switch port Management and configuration management.

UNIT 5 SNMP – APPLICATIONs 9

Web-Based Management, XML-Based Network Management, Distributed Network Management, Reliable & Fault Tolerant Network Management, Secured Management Techniques in real time applications**.**

TOTAL:45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Describe the network topologies and its components used in computer networks.
- Relate SNMP model with OSI model.
- Show how to apply network management standards to manage practical networks.
- Explain various management methods of a network.

REFERENCES:

1. Salah Aiidarous, Thomas Plevayk, —Telecommunications Network Management Technologies and Implementations ‖, IEEE press, Eastern Economy Edition, New Delhi, 1998.
2. —Network Management – Principles and Practice‖ by Mani Subramanian, AddisonWesley Pub Co, First Edition, 2000.
3. Behrouz A.Forouzan, —Data Communications and Networking ‖, Tata McGraw Hill, 2nd Edition, 2003.
4. —SNMP, SNMPv2, SNMPv3, AND RMON 1 and 2‖ by William Stallings, AddisonWesley, Third Edition, 1999.
5. http:// solarwinds.com/network-management-software

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	**Critical Thinking**	**Problem solving and Research Skill**	**Modern Tool usage**	**Communication**	**Life Long Learning**
CO.1	**2**	**-**	**-**	**-**	**-**	**-**
CO.2	**3**	**-**	**-**	**-**	**-**	**-**
CO.3	**3**	**2**	**2**	**-**	**-**	**-**
CO.4	**3**	**2**	**2**	**-**	**-**	**-**
CO.5	**3**	**-**	**2**	**2**	**-**	**-**
CO.6	**3**	**-**	**2**	**2**	**-**	**-**
CAM	**3**	**2**	**2**	**2**	**-**	**-**

19PCM515	UBIQUITOUS COMPUTING AND PERVASIVE COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart knowledge on optical system components and optical network architectures.
- To give an idea about the wavelength routing networks and packet switching and access networks**.**
- To familiarize the students on the network design and management.

UNIT I INTRODUCTION 9

Overview- Founding Contributions to Ubiquitous Computing, Ubicomp Systems and Challenges, Creating Ubicomp Systems, Evaluating and Documenting Ubicomp Systems Networking Basics: NFC, Wireless LAN.

UNIT II LOCATION IN UBIQUITOUS COMPUTING 8

Introduction, Characterizing Location Technologies, Location Systems, Location based social networks (LBSN), LBSN Recommendation.

UNIT III CONTEXT-AWARE COMPUTING 9

Introduction, Context-Aware Applications, Designing and Implementing Context-Aware Applications, Issues to Consider when Building Context-Aware Applications.

UNIT IV SMART DEVICES AND SERVICES 9

Pervasive Computing Device Technologies and Service Architectures: Device types, Device Characteristics, Pervasive Computing Service Architectural Paradigms, Service / Resource Discovery basics, Elements of service composition, invocation and deployment, select concepts in Operating Systems, Virtualization and their relevance to Pervasive Computing, select example Operating Systems of relevance.

UNIT V SMART MOBILES, CARDS AND DEVICE NETWORKS 10

Smart Phones, Smart Cards and related hardware / software concepts (OS included), select case studies, connectivity through Gateway services: the OSGi Human–Computer Interaction approach: Hidden UI Via Basic Smart Devices, Human Centred Design (HCD), User Models: Acquisition and Representation.

TOTAL: 45 PERIODS

Course Outcomes:

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

- To explore the high-level facilities, system architecture and protocols of the ubiquitous system
- To apply data analytics to facilitate next generation computing
- To provide a sound conceptual foundation in the area of Pervasive Computing aspects
- To conceptualize, analyse and design select classes of pervasive computing systems

REFERENCES:

1. Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010
2. StefenPoslad: Ubiquitous Computing: Smart Devices, Environments and Interactions, Wiley, London, 2009, Indian reprint, 2014.

19PCM516	DSP PROCESSOR ARCHITECTUREAND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVE:

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

- Basics of programmable Digital Signal Processor
- Various DSP processor and programming skills
- Advanced DSP architectures and some applications

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

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

UNIT II TMS320C5X PROCESSOR 9

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

UNIT III TMS320C6X PROCESSOR 9

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

UNIT IV ADSP PROCESSORS 9

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

UNIT V PROGRAMMABLE DIGITAL SIGNAL PROCESSORS 9

Architecture of TMS320C54X: Pipe line operation, Addressing modes, Instruction Set, Code Composer studio - Implementation of Basic DSP Algorithms: The Q-notation, FIR Filters, IIR Filters, interpolation Filters, Decimation filters, Adaptive Filters, 2-D Signal Processing. Implementation of FFT Algorithms

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Explain the architectural features of programmable DSPs.
- Demonstrate the power of TMS320C5X processor by simple programming.
- Explain the architectural features of TMS320C6X processors.
- Implement Filters and FFT using ADSP processors.
- Realize the basic DSP functions through programming on TMS320C54X processor.

REFERENCES:

1. Avatar Singh and S. Srinivasan, —Digital Signal Processing‖, Thomson Learning, 2004.
2. Venkataramani.B, Bhaskar.M, — Digital Signal Processors – Architecture, Programming and Applications ‖, Hill Publishing Company Limited, 2003.
3. Peter Pirsch ,—Architectures for Digital Signal Processing‖, John Weily, 2007
4. —http://www.analog.com/en/processors-dsp/ADSP-1x/products/mals/resources/index.html‖, Using the ADSP-2100 Family volume 1(Rev 1.0,1990).
5. User guides: Texas Instrumentation, Analog Devices, Motorola.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	Critical Thinking	Problem solving and Research Skill	Modern Tool usage	Communication	Life Long Learning
CO.1	2	-	-	-	-	-
CO.2	3	-	-	2	-	-
CO.3	3	-	-	2	-	-
CO.4	3	3	2	2	-	-
CO.5	3	-	2	2	-	-
CO.6	3	-	3	3	-	-
CAM	3	3	2	2	-	-

19PCM517	MOBILE AND SOCIAL COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Understand the basic concepts of mobile computing and mobile platforms with its applications
- To give an idea about the online social networks and its techniques
- To familiarize the students on Social data analytics

UNIT I INTRODUCTION TO MOBILE COMPUTING 9

Mobile Computing – Mobile Computing Vs wireless Networking – Mobile Computing Applications – Characteristics of Mobile computing – Structure of Mobile Computing Application. MAC Protocols – Wireless MAC Issues – Fixed Assignment Schemes – Random Assignment Schemes – Reservation Based Schemes.

UNIT II MOBILE PLATFORMS AND APPLICATIONS 9

Mobile Device Operating Systems – Special Constrains & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues.

UNIT III ONLINE SOCIAL NETWORKS 9

Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data ,Techniques to study different aspects of OSNs -- Follower-followee dynamics, link farming, spam detection, hashtag popularity and prediction, linguistic styles of tweets-Human Centered Computing - Classes of human-centered computation, Methods of human-centered computation, Incentives for participation, computer supported co-opeartive work, computer supported collaborative learning,Crowdsourcing as a Model for Problem Solving, ESP Game.

UNIT IV FUNDAMENTALS OF SOCIAL DATA ANALYTICS 9

Introduction - Working with Social Media Data-Topic Models-Modeling social interactions on the Web-Random Walks-Variants of random walk

UNIT V APPLIED SOCIAL DATA ANALYTICS 9

Application of Topic models-Opinions and Sentiments - Mining, Analysis and Summarization-Recommendation Systems-Language dynamics and influence in online communities-Community identification, link prediction and topical search in social networks-Psychometric analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Explain the basics of mobile telecommunication system
- Understand the different mobile platforms and its applications
- Explain the types of social networks
- Analyze the various topic models
- Discuss the application of Topic Models

REFERENCES:

1. Prasant Kumar Pattnaik, Rajib Mall, —Fundamentals of Mobile Computing, PHI Learning Pvt. Ltd, New Delhi – 2012.Cioffi-Revilla, Claudio. *Introduction to Computational Social Science*, Springer, 2014.
2. Jochen H. Schller, —Mobile Communications, Second Edition, Pearson Education, New Delhi, 2007.
3. Matthew A. Russell. *Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More*, 2nd Edition, O'Reilly Media, 2013.
4. Robert Hanneman and Mark Riddle. *Introduction to social network methods.* Online Text Book, 2005.

19PCM518	DATA COMPRESSION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To explain the concepts of multimedia and compression techniques.
- Give knowledge on text compression and audio compression.
- To impart the concepts of image and video compression techniques.

UNIT I INTRODUCTION **9**

Special features of Multimedia - Graphics and Image Data Representations -Fundamental Concepts in Video and Digital Audio-Storage requirements for multimedia applications -Need for Compression - Taxonomy of compression techniques – Overview of source coding, source models, scalar and vector quantization theory – Evaluation techniques – Error analysis and methodologies.

UNIT II TEXT COMPRESSION **9**

Compaction techniques – Huffman coding – Adaptive Huffman Coding – Arithmetic coding – Shannon-Fanon coding – Dictionary techniques – LZW family algorithms.

UNIT III AUDIO COMPRESSION **9**

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

UNIT IV IMAGE COMPRESSION **9**

Contour based compression – Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - JBIG, JBIG2 standards,JPEG XL

UNIT V VIDEO COMPRESSION **9**

Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video.

TOTAL: 45 PERIODS

COUURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Describe the various data representations of multimedia, quantization and compression techniques.
- Analyze the different types of coding in text compression.
- Explain the concepts of various coding and compression techniques in audio compression.
- Describe the concepts of image compression.
- Compare the different types of MPEG video coding and compression techniques.

REFERENCES:

1. Khalid Sayood, — Introduction to Data Compression ‖, Morgan Kauffman Harcourt India, 3rd Edition, 2011.
2. David Salomon, — Data Compression – The Complete Reference ‖, Springer Verlag, 4th Edition, New York, 2011.
3. Yun Q.Shi, Huifang Sun, — Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards ‖, CRC press, 2003.
4. Mark S.Drew, Ze-Nian Li, — Fundamentals of Multimedia ‖, PHI, 1st Edition, 2004.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	**Critical Thinking**	**Problem solving and Research Skill**	**Modern Tool usage**	**Communication**	**Life Long Learning**
CO.1	**2**	**-**	**-**	**-**	**-**	**-**
CO.2	**3**	**-**	**-**	**-**	**-**	**-**
CO.3	**3**	**2**	**2**	**2**	**-**	**2**
CO.4	**3**	**2**	**-**	**2**	**-**	**2**
CO.5	**3**	**-**	**2**	**3**	**-**	**2**
CO.6	**3**	**-**	**2**	**3**	**-**	**2**
CAM	**3**	**2**	**2**	**3**	**-**	**2**

19PCM519	MEDICAL IMAGING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Explain the principles of the gamma camera, SPET and PET
- Understand how Doppler and echo information can be combined in an ultrasound image
- Describe what a pulse sequence consists of in magnetic resonance imaging
- Understand the distinction between anatomical functional imaging

UNIT I ULTRASONIC IMAGING 9

Ultra Sound In Medicine - Introduction, production of ultra sound - properties principles of image formation,Capture and display - principles of A -mode, B-mode and M-mode display - Doppler Ultra sound and Colour flow mapping - Applications of diagnostic ultra sound.

UNIT II CT IMAGING 9

X-Ray computed tomography - Principles of sectional imaging - scanner configuration - data acquisition system -image formation principles - conversion of x-ray data in to scan image - 2D image reconstruction techniques -Iteration and Fourier methods. Types of CT scanners.

UNIT III MAGNETIC RESONANCE IMAGING 9

Magnetic Resonance Imaging - Principles of MRI pulse sequence- image acquisition and reconstruction techniques MRI instrumentation magnets gradient system RF coils - receiver system Functional MRI - Application of MRI.

UNIT IV NUCLEAR MEDICINE IMAGING 9

Radio isotope imaging - Rectilinear scanners, linear scanners - SPECT - PET Gamma Camera Radio nuclides for imaging, Emission Computed Tomography.

UNIT V IMAGE RECONSTRUCTION AND 3D VISUALIZATION 9

Image reconstruction from projection in two dimension, Mathematical preliminaries for two and three dimensional image reconstructions, Radon Transform, 3D visualization, Preprocessing, Scene based visualization, Object based visualization, Manipulation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to :

- Discuss physics of how signals, from which images are formed, are obtained
- Discriminate characteristics of different
- modalities
- Compare the effect of different imaging modalities on the human body
- Discuss the basic concepts of image reconstruction and 3D visualizations**.**

REFERENCES:

1. S Webb, Adam Highler, Bristol, — The Physics of Medical Imaging l, IEEE Press New York, 1998.
2. A C Kak, — Principle of Computed Tomography l, IEEE Press New York.
3. G A Hay, — Medical Image Formation Perception and Measurementl .
4. William R. Hendee and Russell Ritenour. E. Woods, — Medical Imaging Physicsl, A John Wiley & Sons, Inc. publications, 2002.
5. Atam.P. Dhawan, —Medical Image Analysisl, Second Edition, John Wiley and Sons, 2011.
6. Jacob Beutel and M. Sonka, —Handbook of Medical Imagingl, SPIE press 2000.

CO-PO Mapping:

COs	POs					
	Scholarship of Knowledge	**Critical Thinking**	**Problem solving and Research Skill**	**Modern Tool usage**	**Communication**	**Life Long Learning**
CO.1	**3**	**3**	**2**	**3**	**-**	**2**
CO.2	**3**	**-**	**2**	**3**	**-**	**2**
CO.3	**3**	**3**	**2**	**3**	**-**	**2**
CAM	**3**	**3**	**2**	**3**	**-**	**2**

19PCM520	GLOBAL POSITIONING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce the concepts GPS and GPS co-ordination system .
- To give an idea about the GPS communication and its propagation models.
- To outline the applications of GPS.

UNIT I INTRODUCTION **9**

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

UNIT II GPS CO-ORDINATION SYSTEM **9**

Coordinate Systems – Geo Centric Coordinate System – Conventional Terrestrial Reference System – Orbit Description – Keplerian Orbit – Kepler Elements – Satellite Visibility – Topocentric Motion – Disturbed Satellite Motion – Perturbed Motion –Disturbing Accelerations - Perturbed Orbit – Time Systems – Astronomical Time System– Atomic Time – GPS Time – Need for Coordination – Link to Earth Rotation – Time and Earth Motion Services.

UNIT III GPS COMMUNICATION **9**

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

UNIT IV PROPAGATION MODELS **9**

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

UNIT V APPLICATION **9**

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

TOTAL: 45 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Explain the basic concepts of GPS constellation and different segments.
- Identify the need for coordination in GPS.
- Relate the various codes and range models in GPS communication. .
- Analyze various propagation models and multipath effects.
- Explain the various applications of GPS.

REFERENCES:

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

LIST OF OPEN ELECTIVES

OPEN ELECTIVES

S.No	Course Code	Course Title	L	T	P	C
1.	**19PCD601**	Industrial Safety	**3**	**0**	**0**	**3**
2.	**19PCS602**	Business analytics	**3**	**0**	**0**	**3**
3.	**19PCM603**	IoT for Smart Applications	**3**	**0**	**0**	**3**
4.	**19PPE604**	Bio Energy from Waste	**3**	**0**	**0**	**3**
5.	**19PSE605**	Smart City Technologies	**3**	**0**	**0**	**3**

19PCD601	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the operational safety
- To understand the safety management

UNIT I ACCIDENT INVESTIGATION AND ANALYSIS ` 9

Concept of an Accident, reportable and non-reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition- Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

UNIT III HAZARDS AND THEIR CONTROL 9

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipment.

UNIT IV FIRE PREVENTION AND PROTECTION 9

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- CO2 system, foam system and DCP system.

UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice- motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Evaluate the concept of accident prevention& accident investigation
- Identify the human behavior
- Demonstrate hazards and their control
- Prepare the fire prevention and protection
- Summarize the safety management techniques

TEXT BOOKS:

1. Heinrich.H.W. —Industrial Accident Prevention‖, McGraw Hill Company, New York, 1980.
2. John V. Grimaldi and Rollin H. Simonds, —Safety Management‖ , All India Travellers Book Seller, New Delhi, 1989.
3. E.J.McCormick and M.S. Sanders —Human Factors in Engineering and Design‖, TMH, New Delhi, 1982.
4. Hand Book of —Occupational Safety and Health‖, National Safety Council, Chicago, 1982.
5. Derek, James, —Fire Prevention Hand Book‖, Butter Worth's and Company, London, 1986.

REFERENCES:

1. Krishnan.N.V. —Safety Management in Industry‖, Jaico Publishing House, Bombay, 1997.
2. Lees, F. P. —Loss Prevention in Process Industries‖, Butter Worth publications, London, 2nd Edition, 1990.
3. Dan Peterson, —Techniques of Safety Management‖, McGraw Hill Company, Tokyo, 1981.
4. —Accident Prevention Manual for Industrial Operations‖, N.S.C. Chicago, 1982.
5. Hunter, Gomos, —Engineering Design for Safety‖, McGraw Hill Inc., 1992.
6. Encyclopedia of —Occupational Health and Safety‖ Vol I and II, Published by International Labour Office, Geneva, 1985.
7. Gupta. R.S., —Hand Book of Fire Technology‖, Orient Longman, Bombay, 1977.

19PCS602	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- Use decision-making tools/Operations research techniques.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

UNIT I BUSINESS ANALYTICS 9

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

UNIT II TRENDINESS AND REGRESSION ANALYSIS 9

Trendiness and Regression Analysis: 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 ANALYTICS MODELLING AND MINING 9

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

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 10

Forecasting Techniques: 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 Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V DECISION ANALYSIS 8

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

TOTAL: 45 Periods

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

Demonstrate the knowledge of data analytics.

Demonstrate the ability of think critically in making decisions based on data and deep analytics.

Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.

Demonstrate the ability to translate data into clear, actionable insight.

REFERENCES:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

19PCM603	IOT FOR SMART APPLICATIONS	L	T	P	C
		3	0	0	3

Objectives:

- Brief about the interconnection and integration of smart devices with controller/SoC
- Learn the architecture of IoT and its standards
- Give an basic idea about M2M-IoT

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UNIT I M2M and IoT- Introduction 9

The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

UNIT II M2M AND ioT TECHNOLOGY FUNDAMENTALS 9

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT III IOT REFERENCE ARCHITECTURE 9

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views..

Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges, Inductive Sensors- Sensitivity and Linearity of the Sensor, Types- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors, Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

UNIT V INTERNET OF THINGS –PRIVACY, SECURITY AND GOVERNANCE 9

Introduction, Overview of Governance, Privacy and Security Issues, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Understand the concept of web technology for IoT
- Understand the concept of IOT and M2M
- Differentiate between IOT architecture and Embedded Architecture
- Apply IoT technology for smart applications
- Study the security and privacy issues in IOT..

REFERENCES:

1. Vijay Madisetti and Arshdeep Bahga, —Internet of Things (A Hands-on-Approach)‖, 1st Edition, VPT, 2014.
2. Francis da Costa, —Rethinking the Internet of Things: A Scalable Approach to Connecting Everything‖, 1stEdition, A press Publications, 2013.
3. Cuno Pfister, —Getting Started with the Internet of Things‖, O Reilly Media, 2011.
4. McEwen, H. Cassimally, —Designing the Internet of Things‖, Wiley, 2013.
5. Samuel Green guard, —Internet of things‖, MIT Press, 2015.
6. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things1.html
7. https://developer.mbed.org/handbook/AnalogIn
8. http://www.libelium.com/50_sensor_applications

19PPE604	BIOENERGY FROM WASTE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the details of types of wastes.
- To illustrate the concept of waste treatment and disposal.
- To outline concepts behind eco-technological alternatives for waste to energy.

UNIT-I INTRODUCTION TO WASTE & WASTE PROCESSING 9

Definitions, sources, types and composition of various types of wastes; Characterization of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste.

UNIT-II WASTE TREATMENT AND DISPOSAL 9

Aerobic composting, incineration, different type of incineration; medical and pharmaceutical waste incinerations- land fill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases.

UNIT-III ENERGY FROM WASTE-THERMO CHEMICAL CONVERSION 9

Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifies, briquetting, utilization and advantages of briquetting,-environmental and health impacts of incineration; strategies for reducing environmental impacts.

UNIT-IV ENERGY FROM WASTE- BIO-CHEMICAL CONVERSION 9

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

UNIT-V ENVIRONMENTAL AND HEALTH IMPACTS-CASE STUDIES 9

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potential sand constraints in India, eco-technological alternatives for waste to energy conversions – Rules related to the handling, treatment and disposal of MSW and BMW in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

- Classify different types of waste.
- Implement the waste disposal & energy conversion techniques.
- Apply the strategies for reducing environmental impacts.
- Design the waste to energy plants

REFERENCES:

1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1-57808-200-1; 2002
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155-1132-9.
6. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier AppliedScience, London, 1985.
7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
9. Robert Green, From Waste to Energy, Cherry Lake Pub. ISBN: 1602795096, 2009.
10. G. Evans, Biowaste and Biological Waste Treatment, 2005
11. Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-Vch Publication 2010

19PSE 605	SMART CITY TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students understand the core challenges relating to the foundation of sustainable smart cities
- To impart knowledge on understanding, and critical thinking related to smart, sustainable urban development.
- To explore issues relating to the development and deployment of new and emerging technologies, that will create a thorough understanding of smart processes and systems of the present and future

UNIT I INTRODUCTION TO SMART CITIES 9

Introduction, Definition, Drivers, barriers and benefits of smart cities, characteristics and factors of Smart cities, understanding Livability, Affordability and Inequality, Development standards, Fundamentals of smart city rankings, emerging trends and technologies.

UNIT II SMART CITIES FRAMEWORK 9

Smart city responsibilities: Built environment, Energy, Telecommunications, Transportation, Health and human services, Water and wastewater, Smart city enablers: instrumentation and control, connectivity, security, privacy and data management.

UNIT III SMART AND SUSTAINABLE URBAN DEVELOPMENT 9

Principles of sustainable development and smart growth, low carbon and renewable energy technologies, pollution prevention, climate adaptation, environmental systems management, smart buildings infrastructure

UNIT IV SMART TECHNOLOGIES 9

Concepts of Big Data Analytics: big data platforms and cloud computing, urban informatics, GIS and spatial analysis, measuring impact and data visualization Smart Technologies: Internet of things, remote sensing and communication technologies.

UNIT V INDIAN INITIATIVES TOWARDS SMART CITIES 9

ICT initiatives in Indian Cities, Institutional frame work, selection of cities for suitability to become a smart city, e- governance, identification parameters for smart city fnd allocation, Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the concepts of smart cities.
- Describe the framework of smart cities.
- Analyze the principles of sustainable development.
- Apply Big data analytics and smart technologies in creating smart cities
- Evaluate the smart city projects implemented in India

REFERENCE BOOKS:

1. Jesse Berst, Liz Enbysk and Christopher Williams Smart Cities Readiness Guide – The planning manual for building tomorrow's cities today, Smart Cities Council, 2014.
2. Joy Sen, Sustainable Urban Planning, The Energy and Resources Institute, New Delhi, 2013. (ISBN 978-81-7993-324-4).
3. Anthony M. Townsend, SMART CITIES Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, Inc., 2013.(ISBN-13: 978-0393082876)
4. Aniket Bhagwat, Suparna Bhalla, Sanjay Prakash Ashish Bhalla Destination 100 (The making of Smart Cities in India, Future Institute publishers, 2014.(ISBN 13: 9781 4392 57883).
5. Vinod kumar T. M., Geographic Information Systems for Smart Cities, Copal Publishing, New Delhi, 2014.(ISBN: 9788 1924 73352).

AUDIT COURSES

19PGM801	PEDAGOGY STUDIES	L	T	P	C
		3	0	0	3

Objectives:

- To make the students understand a range of cognitive capacities in human learners
- To explain the outcome-based education system
- To describe the curriculum design process

UNIT I EDUCATIONAL PSYCHOLOGY AND ENGINEERING EDUCATION **4**

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners, Engineering education and recent trends, Research in Engineering education, General maxims of teaching, Teacher-centered, learner-centered and learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education

UNIT II OUTCOME BASED EDUCATION **4**

Outcome Based Education: A broad context for quality teaching and learning, planning for quality teaching and learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes, learning outcomes in the cognitive domain, learning outcomes in the affective domain, learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

UNIT III CURRICULUM DESIGN **4**

Curriculum design cycle, curriculum structure, credit and academic load, need assessment – feedback from stakeholders, concept of —Constructive alignment‖, the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculum design and implementation, concept mapping, Instructional design and delivery.

UNIT IV TEACHING AND ASSESSMENT STRATEGIES **4**

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching, role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students' achievement, assessment of learning outcomes - assessment tools: direct and indirect assessment tools, rubrics for assessment, attainment analysis, corrective action- curriculum updation, improvement in pedagogy, innovative assessment methods.

COURSE OUTCOMES:

After successful completion of the course students will be able to:

1. Develop pedagogical expertise through an introduction to theoretically-based teaching methods and strategies
2. Write learning outcomes and link learning outcomes to appropriate assessments
3. Design syllabus and lesson plans that align with learning outcomes
4. Use technology to enhance teaching and learning
5. Choose teaching-learning strategies appropriate to the needs of the learners

References:

1. Dr.Sue Duchesne, Anne McMaugh, Sandra Bochner, Kerri-Lee Krause, —Educational Psychology for Learning and Teaching‖, Cengage Learning, 4th Edition, 2019.
2. Lisa R. Lattuca, Patrick T. Terenzini, J. Fredericks Volkwein, and George D. Peterson, —The Changing Face of Engineering Education‖ The Bridge, National Academy of Engineering, Summer 2006.
3. Anderson, L. & Krathwohl , D. A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives . New York: Longman, 2001.
4. Blumberg, P. Developing learner-centred teaching: A practical guide for faculty. San Francisco: Jossey-Bass, 2017.
5. Teaching Support Services. Learning objectives. University of Guelph, Guelph, ntario. Retrieved from http://www.uoguelph.ca/tss/resources/idres/learningobjectives1.pdf.
6. O.V. Boev, N.Gruenwald and G.Heitmann, —Engineering Curriculum Design aligned with Accrediation Standards‖, Hochschule Wismar Publishers, 2013.
7. Fink, D. L. Integrated course design. Manhattan, KS: The IDEA Center, 2005. Retrieved from http://www.theideacenter.org/sites/default/files/Idea_Paper_42.pdf.

19PGM802	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		3	0	0	3

Objectives:

Students will be able

- To give and exposure on writing skills and readability
- Toimpart the knowledgeof each section of the paper
- To enhance the student to write the good quality Research paper

UNIT 1 INTRODUCTION TO RESEARCH 9

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticising, Paraphrasing and Plagiarism - Useful idioms & phrases.

UNIT 2 STRUCTURE OF RESEARCH PAPER 6

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper – Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract - Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment - the First Draft.

UNIT 3 METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION 9

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow – Research gap - Writing the Methodology – Sequence - Specification – Explaining results – Interpretation and plotting – Discussion of the salient findings – Critical analysis – Writing the Conclusion

UNIT 4 SUBMISSION OF RESEARCH PAPER 6

References – Citations and Checking the Citations – Various forms of Citation - Guildlines for authors –Manuscript submission – Conflict of Interest - Authors reply for Reviewer comments – Point by Point Explanation – Resubmission – Acceptance – Copyright - Proofreadingand final submission.

TOTAL : 30 PERIODS

COURSE OUTCOMES :

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

- Write research paper effectively with improved standard of language
- Explain the different sections of the Research paper
- Formulate the AcceptableResearch Manuscript

References :

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

Additional Reading :

1. MLA Handbook for Writers of Research Papers, The Modern Language Association of America, New York 2009