With effect from academic year 2021-22

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (E.C.E.)

MICROWAVE AND RADAR ENGINEERING

Full Time & PTPG

AICTE Model Curriculum

2021-22

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous)
Osmania University
Hyderabad – 500 007, TS, INDIA

M.E. (ECE-Microwave and Radar Engineering)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	EC301	Advanced Electromagnetic Engineering	3	0	0	30	70	3
Core-II	EC302	Microwave Antennas	3	0	0	30	70	3
Programme Elective-I	EC311	Microwave Measurements	3	0	0	30	70	3
	EC312	Microwave Semiconductor Devices						
	EC114	Wireless and Mobile Communications						
ProgrammeElective-II	EC313	Satellite Radio Navigation	3	0	0	30	70	3
	EC314	RF MEMS						
	EC315	Computational Electro magnetics						
Audit Course -I	AC 031	English for Academic and Research Writing	2	0	0	30	70	0
	AC 032	Disaster Management						
	AC 033	Sanskrit for Technical Knowledge						
	AC 034	Value Education						
Lab-I	EC351	Microwave Systems Laboratory-I	0	0	3	50	-	1.5
	EC361	Seminar-I	0	0	3	50	-	1.5
MC	EC100	Research Methodology in ECE	3	0	0	30	70	3
TOTAL			**17**	**0**	**6**	**280**	**420**	**18**
SEMESTER-II								
Core-III	EC303	Microwave Circuits and Systems	3	0	0	30	70	3
Core-IV	EC304	Principles of Radar Engineering	3	0	0	30	70	3
Programme Elective-III	EC 316	Satellite and Microwave Communication	3	0	0	30	70	3
	EC 317	Phased Array Radar						
	EC 318	AD-HOC Wireless Networks						
Programme Elective-IV	EC 319	Electromagnetic Interference and Compatibility	3	0	0	30	70	3
	EC 320	Optical Communications and Networks						
	EC 221	Optimization Techniques						
Audit Course -II	AC 035	Stress Management by Yoga	2	0	0	30	70	0
	AC 036	Personality Development through life enlightenment skills						
	AC 037	Constitution of India						
	AC 038	Pedagogy Studies						
Lab-II	EC352	Microwave Systems Laboratory-II	0	0	3	50	-	1.5
	EC362	Seminar-II	0	0	3	50		1.5
	EC 070	Mini Project	0	0	6	50	-	3
TOTAL			**14**	**0**	**12**	**300**	**350**	**18**
SEMESTER-III								
Programme Elective-V	EC 322	Radar Signal Processing	3	0	0	30	70	3
	EC 323	Microwave Solid state Devices and Applications						
	EC 324	Software Defined Radio						
Open Elective	OE 941	Business Analytics	3	0	0	30	70	3
	OE 942	Industrial Safety						
	OE 943	Operations Research						
	OE 944	Cost Management of Engineering						

		Projects						
	OE 945	Composite Materials						
	OE 946	Waste to Energy						
	OE 947	Internet of Things						
	OE 948	Cyber Security						
Dissertation	EC381	Major project phase- I	0	0	20	100	-	10
TOTAL			**6**	**0**	**20**	**160**	**140**	**16**
SEMESTER-IV								
Dissertation	EC382	Major project phase- II	0	0	32	-	200	16
GRAND TOTAL								**68**

CIE: Continuous Internal Evaluation SEE: Semester End Examination

SEMESTER – I

EE 301

ADVANCED ELECTROMAGNETIC ENGINEERING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To become familiar with the basic Electromagnetic Theory and Electromagnetic Theorems and concepts*
- *To acquaint with theoretical analysis of the characteristics of electromagnetic waves in a wide variety of Practical Mediums*
- *To aware commercially available EM Simulation Software*

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

1. *Able to apply fundamental electromagnetic concepts in various applications*
2. *Able elaborate Maxwell's Equations for complex electromagnetic media.*
3. *Able to understand the resonators and radiation of antennas*
4. *Able to derive the propagation parameters for electromagnetic waves in various practical mediums.*
5. *Able to acquire the knowledge on EM Simulation Software*

UNIT – I

Fundamentals- Review of Basic Electromagnetic Theory, Maxwell's equations, Wave Equation, Time-Harmonic Fields, Plane waves in lossless and lossy media, Poynting's Theorem, Reflection and Transmission of waves.

UNIT – II

Theorems and Concepts- The Generalized Current Concept, Circuit-Field Relations, Auxiliary Vector potentials, The source concept, Duality, Uniqueness, Image Theory, The Equivalence Principle, Induction and Reciprocity theorems, Green's Functions.

UNIT – III

Guidance of Waves in Rectangular Cross section -The Parallel Plate Waveguide, The Rectangular Waveguide, Partially Filled Waveguide, The Dielectric Slab Guide, Surface Guided Waves.

UNIT – IV

Guidance of Waves in Circular Cross section - Circular wave guide, Radial wave guide. Resonance of Waves- Resonators, Radiation of waves-Antennas.

UNIT – V

Introduction to Metamaterials, EBG Structures and Frequency Selective Surfaces, Survey of Commercially available EM Simulation Software.

References:

1 R.F.Harrington, "*Time-Harmonic Electromagnetic Fields",* McGraw-Hill, 1961, reissued by IEEE Press, 2001.

2 C.A.Balanis, "*Advanced Engineering Electromagnetics"*, John Wieley & Sons, 1989.

3 R.E.Collin, "*Field Theory of Guided Waves*", IEEE Press, 1991, 2nd Ed.

4 J.A.Kong, "*Electromagnetic wave Theory*", EMW Publishing, 2005, 2008.

EC 302

MICROWAVE ANTENNAS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To familiarize the basic concepts of antenna parameters and radiation mechanism.*
- *To analyze aperture antennas with the knowledge of various theorems and study the principles of frequency independent antenna design.*
- *To understand, analyze and synthesize array antennas and also know the concepts of smart antennas*

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

1. *Able to understand different types of aperture antennas with the help of basic antenna fundamentals.*
2. *Able to understand the operating principles of microwave antennas.*
3. *Able to apply the knowledge in the design of various microwave aperture antennas.*
4. *Able to acquire basic knowledge of printed antennas*
5. *Able to acquire basic knowledge of smart antenna design*

UNIT – I

Fundamental parameters and definitions for antennas, Theories of radiation, Image theory, Schelkunoff's equivalence theorem, Huygens' principle, Babinet's principle.

UNIT – II

Radiation from rectangular and circular apertures, design considerations, Fourier transform method in aperture antenna theory. Broadband antenna concept, Log periodic antennas, Frequency independent antennas.

UNIT – III

Linear arrays: Uniform and Non uniform amplitude distribution, Planar arrays, Synthesis of antenna arrays using Schelkunoff polynomial method, Fourier transform method and Woodward-Lawson method.

UNIT – IV

Printed antennas: Rectangular and circular patch antenna design, Feeding techniques for micro strip antennas, Methods of analysis, Printed antenna arrays, Bandwidth enhancement techniques, and Compact and Tunable Microstrip antenna.

UNIT – V

Concept and benefits of smart antennas, Types of smart antennas, Beam forming techniques, Smart antenna methods, Algorithms.

References:

1. Constantine Balanis, *"Modern Antenna Handbook*", John wiley, 2008.
2. Stutzman, W.L. and Thiele, H.A., *"Antenna Theory and Design"*, 2nd Ed., John Wiley & Sons.
3. Bahl IJ, and Bhartia, *"Microstrip Antennas",* Artech House, 1982.
4. D.G.Fang , "*Antenna Theory and Microstrip Antennas",* CRC press 2010
5. James.JR.Hall PS.wood.C., "*Micro strip Antenna-Theory and Design*", Peter Peregrinu.1981

EC 311

MICROWAVE MEASUREMENTS
(PROGRAM SPECIFIC ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand and gain knowledge about measurement of wave length and Frequency of microwave signals.*
- *To understand and gain knowledge about the use of microwave test bench in analyzing various types of microwave measurements and knowledge about measurement of microwave power.*
- *To understand and gain knowledge about measurements on passive microwave components and Network analyzer*

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

1. *Understand functional blocks involved in Microwave Measurements such as test sets, couplers and other components.*
2. *Understand Network Analyzer principle, Reflection and Transmission measurements using vector network Analyzer.*
3. *Understand measurements of Antenna radiation pattern and gain.*
4. *Understand measurements of Antenna Far-field and Near-field techniques.*
5. *Understand the methods and limitation of different microwave parameters measurement.*

UNIT – I

Measurement of wave length and Frequency, equivalent circuit of cavity wave meters. Typical wave meters, Resonant cavities. Methods of frequency measurements-Direct measurement – Interpolation method.

UNIT – II

Measurement of reflection coefficient Low, high, medium VSWR measurements. Standing wave pattern, Slotted line section and its limitation. Impedance measurement techniques. Nodal shift method. Tangent method. Reflectometer.

UNIT – III

Measurement of microwave power: Typical barater elements, thermistor. Bolometer bridge circuits, extending range of bolometer devices, low and high-power measurement techniques.

UNIT – IV

Measurement of attenuation: insertion loss method. Substitution method. Measurement of S-parameters. Network Analyser principle. Reflection and Transmission measurements using vector network Analyser.

UNIT – V

Measurements on passive microwave components. Characteristics of directional coupler. Isolator, Circulator. Antenna Measurements. Measurements of radiation pattern, Antenna gain measurements. Far field and Near field techniques.

References:

1 Ginzton, EL.,*"Microwave Measurements"*, McGraw Hill.
2 Sucher & Fox., *"Microwave Measurements"*. Vol.I, II, III.
3 Montgemery. Cc., *"Techniques of Microwave Measurements*", Radiation Lab Series.

EC 312

MICROWAVE SEMICONDUCTOR DEVICES
(PROGRAM SPECIFIC ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand Schottky Barrier Diode, IMPATT & TRAPATT diodes: Principles and applications as amplifiers and oscillators.*
- *To understand PIN diodes working principle and its applications as Switches, limiters, phase shifters and modulators.*
- *To analyze Avalanche Transit-Time Devices and its applications in microwave amplifiers and oscillators and understand operating characteristics of MISFETs, MESFETs GaAs FETs and BJTs and their applications*

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

1. *Understand the working principles of the Microwave solid state devices (Tunnel Diode, PIN Diode, Schottky Barrier Diode ...etc.)*
2. *Choose a suitable microwave solid state device for a particular application.*
3. *Understand the use of Tunnel Diode and Gun Diode in microwave amplifiers.*
4. *Understand the use ofPIN diodes in microwave applications- Switches, limiters, phase shifters and modulators*.
5. *Understand operating characteristics of MISFETs, MESFETs, GaAs FETs and BJTs and their applications.*

UNIT – I

Transient and ac behavior of p-n junctions, effect of doping profile on the capacitance of p-n junctions, noise in p-n junctions, high-frequency equivalent circuit. Varactor diode: Equivalent circuit, static and dynamic figures of merit Manley Rowe power relation. Parametric amplifiers. Up converter, Degeneration amplifiers, Varactor multipliers. Charge storage capacitance.

UNIT – II

Tunnel diode: equivalent circuit. Tunnel diode stability, Tunnel diode amplifiers. Gunn devices: Volt amp. Characteristics, Small signal, Nonlinear, large signal theory, Modes of operation of Gunn diode, Gunn amplifiers-Gunn oscillators, Avalanche transit time MW diodes. Small signal theory, Large signal operation, Noise.

UNIT – III

PIN diodes: Description, the I-layer. Equivalent circuit behavior under reverse bias and forward bias. Diode impedance. Materials. Applications- Switches, limiters, phase shifters and modulators.

UNIT – IV

Schottky Barrier Diode: Physics of Schottky barriers. Design of and performance of Schottky barrier diode applications. IMPATT & TRAPATT diodes: Principles and applications as amplifiers and oscillators.

UNIT – V

High frequency limitations of BJT, microwave bipolar transistors, heterojunction bipolar transistors; GaAs FETs, low noise and power GaAs FETs and their applications. DC biasing

and impedance matching. Microwave transistor ‘S’ parameters. Operating characteristics of MISFETs and MESFETs, short-channel effects, highelectron mobility transistor.

References:

1 S.Y.Liao, *“Microwave Devices and Circuits”*, Third addition, Prentice Hall.

2 Watson, “*Microwave Semiconductor Devices and their applications”,* McGraw Hill, 1969.

3 Sze, S.M., and Ng, K.K., *“Physics of Semiconductor Dev ices”*, 3rd Ed., wiley-Interscience,2006

4 Golio, M., *“RF and Microwave Semiconductor devices Handbook”,* CRC Press (2002)

EC 114

WIRELESS AND MOBILE COMMUNICATIONS
(PROGRAM SPECIFIC ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *An overview of key wireless technologies: Various generations of mobile communications for voice and data, cordless, paging, fixed and mobile broadband wireless systems, and beyond*
2. *Wireless system design fundamentals: channel assignment, handoffs, interference, frequency reuse, capacity planning, large-scale fading, and Outdoor, Indoor propagation models and Path loss, small-scale fading, multipath, reflection, diffraction, scattering and Various statistical models for small-scale fading study*
3. *Various Diversity techniques, Equalizers used in communication receivers, Multiple Access techniques and their applications in wireless networks*

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

1. *Develop design models for cellular systems.*
2. *Analyze the various Large-scale fading effects in designing propagation models for Mobile communications in Outdoor environments.*
3. *Analyze the various types of Small-scale fading, measurement techniques, Parameters of multi-path radio and Statistical models.*
4. *Understand Various Diversity techniques and Equalizers used in communication receivers.*
5. *Develop the design models for various multiple access techniques and understand their spectral efficiencies.*

UNIT – I

Introduction to Wireless Communication Systems and the Cellular Concept
Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Overview of 1G,2G, 2.5 G,3 G, 4G and 5G Cellular networks.
The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving Coverage and Capacity in cellular systems.

UNIT – II

Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio wave propagation, Free space propagation model, Relating Power to Electric Field, the three basic propagation mechanisms- Reflection, Ground Reflection (Two Ray) model, Diffraction, Scattering.
Outdoor propagation models: Longley-Rice model, Okumura model, Hata model, PCS Extension to Hata model, Walfisch and Bertoni Model, Wideband PCS Microcell model.
Indoor propagation models: Partition losses (same floor), Partition losses between floors, Log-distance path loss model, Ericsson multiple breakpoint model, Attenuation factor

model, and Signal penetration into buildings.

UNIT – III

Mobile Radio Propagation: Small Fading and Multipath: Small scale multipath propagation, Factors influencing small scale fading, Doppler shift, Small scale multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile multipath channels, Types of Small Scale Fading, Statistical models for multipath Fading Channels-Clarke's model for flat fading, spectral shape due to Doppler, Level Crossings and Fading Statistics, Two-ray Rayleigh Fading model.

UNIT – IV

Equalization and Diversity: Introduction, Fundamentals of Equalization, Training a Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization

Diversity Techniques: Practical Space Diversity Considerations, Selection Diversity, Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.

UNIT – V

Multiple Access Techniques for Wireless Communications: FDMA, TDMA, Spread Spectrum Multiple Access- FHMA and CDMA, SDMA, Spectral efficiency analysis for Multiple Access Technologies: FDMA, TDMA and CDMA Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

References:

1. Theodore, S. Rappaport, *"Wireless Communications, Principles and Practice"*, 2nd Ed., 2002, PHI publication.
2. 2. Andrea Goldsmith, *"Wireless Communications*", 2005, Cambridge University Press.
3. Kaveh pah Laven and P.Krishna Murthy, *"Principles of Wireless networks",* 2002, PE.
4. P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, *"Wireless Networks",* 200, John Wiley & Sons Pte Ltd.
5. Ashok Raj, *"Wireless Communication*", First Edition, 2014, Khanna Publishers.

EC 313

SATELLITE RADIO NAVIGATION
(PROGRAM SPECIFIC ELECTIVE – II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To explore the basics of Satellite Communications.*
- *To sensitize about the GNSS signal structure, errors and the RINEX data.*
- *To analyse other GNSS constellations and SBAS.*

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

1. *Understand the properties of Satellite systems.*
2. *Study about the GPS and various coordinate systems.*
3. *Estimate the various GPS errors and DoPs*
4. *Explore the RINEX data formats and DGPS principles*
5. *Analyse the operation ofGNSS, SBAS and LAAS*

UNIT – I

Review of Satellite Communications: Brief History of Satellite Communications and itsproperties**,** Orbits, Keplers Laws and Orbital parameters, Earth stations and their types, Mechanics of Lunching a synchronous satellite, Satellite launch, launch vehicles and their comparison.

UNIT – II

GPS fundamentals: INS, Trilateration, Transit: advantages and its limitations, GPS principle of operation, and its operating frequencies, Solar and Sidereal days, GPS and UTC Time. GPS Signals: Signal structure, C/A and P-Code, ECEF and ECI coordinate systems and WGS 84 and types of GPS Receivers, link budget.

UNIT – III

*GPS Error:*Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, multipath; estimation of Total Electron Content (TEC) using dual frequency measurements, Various DOPs, Spoofing and Anti-spoofing: Future GPS satellites, new signals and their benefits.

UNIT – IV

*GPS data processing and DGPS***:** RINEX Navigation and Observation data formats, Ambiguity resolution, cycle slips, Position estimation, Principle of operation of DGPS, architecture and errors.

UNIT – V

Other Constellations and Augmentation systems Other Satellite navigation constellations, Relative advantages of SBAS and GBAS, Wide Area Augmentation System (WAAS) architecture, its operation, advantages and limitations, GAGAN, EGNOS and MSAS, Local Area Augmentation System (LAAS): Operation, advantages, limitations and applications.

References:

1 B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, *"GPS Theory and Practice",* Springer Wien, new York, 2000.

2 Pratap Misra and Per Enge, *"Global Positioning System Signals, Measurements, and Performance,"* Ganga-Jamuna Press, Massachusetts, 2001.

3 Ahmed El-Rabbany, "*Introduction to GPS,"* Artech House, Boston, 2002.

4 Bradford W. Parkinson and James J. Spilker, *"Global Positioning System: Theory and Applications,*" Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington, 1996.

5 Elliot D. Kaplan, *"Understanding GPS Principles and Applications*", Artech House Boston, 1996.

6 A.Leick, *"GPS Satellite Surveying*", John Wiley and sons, 1990.

EC 314

RF MEMS
(PROGRAM SPECIFIC ELECTIVE – II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To impart knowledge on basics of MEMS and their applications in RF circuit design*
- *To study and understand various switching parameters and MEMS switch design process*
- *To know the how best the miniaturized antennas can be designed using MEMS technology*

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

1. *Understand the Concept of miniaturization and the need of MEMS in various applications*
2. *Understand the concepts of various actuation mechanisms of MEMS*
3. *Know the fundamental and technological possibilities and constraints when designing and implementing RF MEMS subsystems.*
4. *Know the antenna design techniques using MEMS technology*
5. *Understand Micro fabrication techniques*

UNIT – I

Microelectromechanical Systems (MEMS) And Radio Frequency MEMS: Introduction – Microfabrication for MEMS – Electromechanical transducers – Microsensing for MEMS – Materials for MEMS.

MEMS MaterialsandFabrication Techniques: Metals – Semiconductors – Thin films for MEMS and their deposition techniques – Materials for polymer MEMS – Bulk micromachining for silicon-based MEMS – Silicon surface micromaching – Microstereo lithography for polymer MEMS.

UNIT – II

RF MEMS Switches: Introduction – Switch parameters – Basics of switching – Switches for RF and microwave applications – Electrostatic switching – Approaches for low-actuation – voltage switches – thermal switching. Bistable micro relays and microactuators. –MEMS switch design, modeling and evaluation –MEMS switch design considerations.MEMS Inductors and Capacitors: Introduction – MEMS inductors – MEMS capacitors.

UNIT – III

Micromachined RF Filters and Phase Shifters: Introduction – Modeling of mechanical filters - Micromechanical filters –Micromachined phase shifters: Introduction – Types of phase shifters and their limitations – MEMS phase shifters.

UNIT – IV

Micromachined Antenna: Introduction - Overview of microstrip antenna – Micromachining techniques to improve antenna performance – Micromachining as a fabrication process for small antenna – Micromachined reconfigurable antenna.

UNIT – V

Micromachined Transmission Lines and Components: Introduction – Micromachined transmission lines and components – Design, fabrication and measurements. Integration and

Packaging for RF MEMS Devices: Role of MEMS packages, Types of MEMS packages, Multichip module packaging, Reliability issues, Thermal issues.

References:

1 Vijay K Varadan, Vinoy K J and Jose K A, *"RF MEMS and Their Applications* ", Published by John Wiley & Sons Ltd, England, reprinted April 2003.

2 Gabriel M Rebeiz, *"RF MEMS Theory, Design and Technology",* John Wiley & Sons Ltd, New Jersey, 2003.

3 Hector J De Los Santos,*"RF MEMS Circuit Design for Wireless communications",* Artech House, 2002.

EC 315

COMPUTATIONAL ELECTROMAGNETICS
(PROGRAM SPECIFIC ELECTIVE – II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand the basics of finite difference methods for solving Maxwell equations, bothstatic and electrodynamics*
- *To understand the basicsof finite element methods for solving scalar Helmholtz equation.*
- *To understand the determination of Green's function.*

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

1. *Able to utilize contemporary numerical approaches in Electromagnetics.*
2. *Able to formulate, and solve engineering problems related to RF-microwave circuits.*
3. *Able to formulate, and solve engineering problems of high-speed interconnects and MEMS, antenna analysis and design.*
4. *Able to apply Green's functions for free space and transmission lines,*
5. *Able to apply Green's functions for waveguides, and microstrips.*

UNIT – I

Fundamental Concepts: Integral equations versus differential equations, radiation and edge conditions, modal representation of fields in bounded and unbounded media.

UNIT – II

Green's Functions: Green's function technique for the solution of partial differential equations, classification of Green's functions, various methods for the determination of Green's functions including Fourier transform technique and Ohm-Rayleigh technique, dyadic Green's functions, determination of Green's functions for free space, transmission lines, waveguides, and microstrips.

UNIT – III

Integral Equations: Formulation of typical problems in terms of integral equations: wire antennas, scattering, apertures in conducting screens and waveguides, discontinuities in waveguides and microstrip lines; Solution of Integral equations: General Method of Moments (MoM) for the solution of integro-differential equations, choice of expansion and weighting functions, application of MoM to typical electromagnetic problems.

UNIT – IV

Finite Element Method: Typical finite elements, Solution of two-dimensional Laplace and Poisson's equations, solution of scalar Helmholtz equation.

UNIT – V

Finite-difference Time-domain Method: Finite differences, finite difference representation of Maxwell's equations and wave equation, numerical dispersion, Yee's finite difference algorithm, stability conditions, programming aspects, absorbing boundary conditions.

References:

1 Peterson, A.F, Ray, S.L. and Mittra, R., "*Computational Methods for Electromagnetics*",
Wiley-IEEE Press. 1998

2 Harrington, R.F., "*Field Computation by Moment Methods*", Wiley- IEEE Press. 1993.

3 Sadiku, M.N.O., "*Numerical Techniques in Electromagnetics*", 2nd Ed., CRC Press-2.

4 Ramesh Garg**,"** Analytical *and Computational Methods in Electromagnetics*" House,2008.

EC 100

RESEARCH METHODOLOGY IN ECE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- To know the motivation on research philosophy and processes in general.
- To be able to formulate the problem statement and prepare research plan for the problem under investigation through literature.
- To be able to apply various techniques for data analysis and patenting

Outcomes:

1. Students able to understand research methodology and problems
2. Able to define the techniques involved in defining problem
3. Able to Developing a Research plan and research set up
4. Able to analyze the collection of data and statistical analysis
5. Able to have knowledge on writing the report and patenting

UNIT – I

Objectives and Types of research: Objectives and Motivation of research- types of research-Research approaches – Significance of Research-Research Methods versus Methodology-Research and Scientific method- Importance of research methodology – Research process-criteria of good research- Problems encountered by Researchers in India-benefits to society in general.

UNIT – II

Research formulation: Defining and formulating the research problem, selecting the problem, importance of literature review in define a problem, literature review, primary and secondary sources, reviews, monograms, patents, research data bases web as a source, identifying gap areas from literature review and research data bases, devilment of working hypothesis

UNIT – III

Research Design and methods: Meaning of research design - need of research design-features of a gooddesign- important concepts relating to research design- different research designs- BasicPrinciples of experimental designs- Developing a Research plan-Exploration, descriptions diagnosis and experiment

UNIT – IV

Execution of the research and data collection: Aspect of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, strategies and tool, data analysis with statistical packages (sigma STAT, SPSS for student test t-test, ANOVA, etc.) hypothesis testing, generalization and interpretation.

UNIT – V

Reporting and thesis writing: Structure and components of scientific reports, types of report, technical report and thesis. Thesis writing-different steps and software tools (word processing) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Use of visual aids.

Patenting: The Basics of the Patent System, Patent Law, How to Read a Patent, Protecting Invention and Planning Patent Filing, Preparing Patent Application

References:

1	C.R.Kothari, "*Research methodology, Methods & technique*", New age international publishers,2004.
2	R.Ganesan, "*Research Methodology for Engineers*", MJP Publishers: Chennai, 2011.
3	P.Ramdass and A.Wilson Aruni, *"Research and Writing across the disciplines",* MJP Publishers, Chennai 2009
4	Matthew Y Ma,"Fundamentals of Patenting and Licensing for Scientists and Engineers" 2nd Edition 2015

AC 031

ENGLISH FOR ACADEMIC AND RESEARCH WRITING
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives: *To expose the students to...*

- *Features of Academic writing; different kinds of Academic writing*
- *Some academic writing skills; the research process; the structure of a research document*

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

1. *Academic writing features; Academic writing kinds; Important academic writing skills*
2. *The process of research; general research document structure*

UNIT – I
Features of Academic Writing
Language: Clear, Correct, Concise, Inclusive; **Tone**: Formal, Objective, Cautious; **Style**: Appropriate, Accurate, Organized; **Ethics**: Honesty, Integrity, Responsibility, Accountability

UNIT – II
Kinds of Academic Writing: Essays, Reports, Reviews, Abstracts, Proposals

UNIT – III
Academic Writing Skills
Paraphrasing; Summarizing; Quoting; Rewriting; Expansion

UNIT – IV
Research Process
Selection of Topic, Formulation of Hypothesis, Collection of Data, Analysis of Data, Interpretation of Data, Presentation of Data

UNIT – V
Structure of a Research Document
Title, Abstract, Introduction, Literature Survey, Methodology, Discussion, Findings/Results, Conclusion, Documenting Sources (IEEE style)

References:

1 Bailey, S. (2014). *Academic writing: A handbook for international students*. Routledge.
2 Gillett, A., Hammond, A., &Martala, M. (2009). *Inside track: Successful academic writing*. Essex: Pearson Education Limited.
3 Griffin, G. (2006). *Research methods for English studies*. Edinburgh: Edinburgh University Press.
4 Silyn-Roberts, Heather. (2013). *Writing for Science and Engineering: Papers, Presentations and Reports* (2nd Ed.). Elsevier.
5 Lipson, Charles (2011). *Cite right: A quick guide to citation styles; MLA, APA, Chicago, the sciences, professions, and more* (2nd Ed.). Chicago [u.a.]: University of Chicago Press.

AC 032

DISASTER MANAGEMENT
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
- *To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
- *To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

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

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

UNIT – I

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

UNIT – II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT – III

*Disasters Prone Areas in India:*Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT – IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluationof Risk: Application of Remote Sensing, Data From Meteorological and OtherAgencies, Media Reports: Governmental and Community Preparedness.

UNIT – V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and NationalDisaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment

and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT – VI

Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends inMitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

1 R. Nishith, Singh AK, *"Disaster Management in India: Perspectives, issues and strategies"*, New Royal Book Company.

2 Sahni, Pardeep (Eds.), *"Disaster Mitigation Experiences and Reflections"*, PHI, New Delhi.

3 Goel S. L., *"Disaster Administration and Management Text and Case Studies",* Deep & Deep Publication Pvt. Ltd., New Delhi.

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

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

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

1. *Understanding basic Sanskrit language*
2. *Ancient Sanskrit literature about science & technology can be understood*
3. *Being a logical language will help to develop logic in students*

UNIT – I

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

UNIT – II

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

UNIT – III

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

References:

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

AC 034

VALUE EDUCATION
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives: *Students will be able to*

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

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

1. *Knowledge of self-development*
2. *Learn the importance of Human values*
3. *Developing the overall personality*

UNIT – I

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

UNIT – II

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

UNIT – III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation.

UNIT – IV

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

References:

1 Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.

EC 351

MICROWAVE SYSTEMS LABORATORY-I

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

- *To become familiar with microwavebench set up and source characterization.*
- *To understand the antennaradiation characteristics determination using microwave bench setup, and understand the analog and digital communication using fiber optic cables.*
- *To study and explore various parameters of GNSS using GNSS receivers.*

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

1. *Able to demonstrate the characteristics of Microwave sources.*
2. *Able to Energize microwave bench and study the characteristics of antenna impedance*
3. *Able to understand the principles of optical fiber communications.*
4. *Able to measure the radiation pattern characteristics of Horn antenna and power characteristics of frequency scanned array antenna*
5. *Study and estimate various important parameters of different Satellite navigation constellations.*

Cycle -I

Experiments:

1. Microwave source characteristics-Reflex Klystron and Gunn oscillator
2. S-parameter Measurement of Microwave Passive devices
3. Radiation Pattern of Horn Antenna
4. Waveguide Discontinuities-Inductive and capacitive Diaphragms
5. Communication through Optical Fiber

Cycle - II

List of experiments:

1. Study of Hardware and Software aspects of Dual Frequency IGS (IRNSS/GPS/SBAS) Receiver.
2. Tracking and analysis of Standalone IRNSS and GPS satellites using IGS receiver in terms of Satellite visibility.
3. Estimation of True Range from Satellite to receiver for all the visible IRNSS satellites.
4. Conversion of geographic cartesian to geodetic coordinate's transformation of GPS and GALILEO constellations.
5. Study of Hardware and Software aspects and getting acquaintance with Triple frequency GPStation6 receiver.
6. Study of Hardware and Software aspects of NAVLAN IG3 Single frequency IRNSS/GPS/GLONASS Receiver.
7. Tracking and analysis of Standalone BeiDou satellites using GPStation6 receiver.

Note: The experiments will be decided and modified if necessary and conducted by the teacher concerned.

EC 361

SEMINAR – I

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

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

1. *Develop the habit of referring the journals for literature review.*
2. *Understand the gist of the research paper.*
3. *Identify the potential for further scope.*
4. *Present the work in an efficient manner.*
5. *Write the documentation in standard format.*

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

SEMESTER - II

EC 303

MICROWAVE CIRCUITS AND SYSTEMS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To become familiar with the characterization of microwave networks*
- *To acquaint with theoretical analysis of the characteristics of electromagnetic wavesin planar transmission lines.*
- *To know impedance matching concepts and to become familiar with microwave passive circuit analysis and design*

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

1. *Able to Characterize the reciprocal networks, lossless networks in terms of S-Parameters*
2. *Able to understand the behavior of most commonly used planar transmission lines such as microstrip line and strip line etc.*
3. *Able to Design impedance matching networks*
4. *Able to understand the operation and design of passive microwave devices such as power dividers, couplers and filters*
5. *Able to understand the microwave propagation in ferrites and use them in various applications*

UNIT – I

Introduction to micro wave Circuit concept: one port junction. Scattering matrix. Properties of [s]matrix, Relationship between [s], [z]and[y] parameters. Wave amplitude transmission matrix [A]. Relation between [A] and [s].

UNIT – II

Analysis of Microstrip line and strip line. Method of conformal Transformation. Characteristic parameters of Microstrip, strip lines. Introduction to slot line and coplanar waveguide. Impedance matching: Stub matching- Single and double stub using Smith chart solutions, Quarter wave transformer, Multi section transformer design, tapered lines-Exponential taper, triangular taper.

UNIT – III

Introduction to Coupled Microstrips, Even and odd mode analysis. Theory of coupled Microstrip Directional couplers. Calculations for a coupled pair of Microstrips. Branch line couplers. Eigenvalue method and its applications to branch line couplers, hybrid ring couplers and the Wilkinson power dividers/combiners

UNIT – IV

Lumped Elements for MIC‟s Design and fabrication of lumped elements, circuits using lumped elements Impedance transformers.

Microwave Planar Filters: Periodic structures, Filter design by the Image Parameter method, Filter design by the Insertion Loss method, Filter transformations, and Filter implementation.

UNIT – V

Micro wave propagation in ferrites. Principles of faraday rotation. Microstrip on Ferromagnetic substrates, Microstrip circulators. Isolators and phase shifters. Applications of MIC‟s.

References:

1 Collins. RE, "*Foundations for Microwave Engineering"*, McGraw Hill, 2nd edn, 1992.

2 Pozer.DM, *"Microwave engineering",* 2nd edn.John Wileyandsons, inc.,1999.

3 Gupta KC, and Amarjit Singh, "*Microwave Integrated circuits",* Wiley Eastern, 1974.

4 Hoffman R.K., *"Hand Book of Microwave integrated Circuits*", Artech House, Boston, 1987.

EC 304

PRINCIPLES OF RADAR ENGINEERING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To familiarize the basic concepts of a radar system in target detection.*
- *To know the features radar target models and clutter.*
- *To understand various types of radar systems and their applications.*

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

1. *Able to understand the radar fundamentals.*
2. *Able to understand the principle of operation of various radar systems.*
3. *Able to apply the knowledge in the design of a radar system*
4. *Able to characterize the target fluctuation*
5. *Able to understand the concepts of phased array radar*

UNIT – I

The radar range equation: Radar fundamentals, Derivation of range equation, Search radar equation, Jamming and radar range with jamming, Radar clutter and radar range with clutter.

UNIT – II

The theory of target detection: Noise and false alarms. Detection of one sample of signal with noise, Integration of pulse trains, Detection of fluctuating targets, CFAR, Optimum and matched filter Theory, Loss factors in detection.

UNIT – III

Targets and interference: Definition of radar cross section, Radar cross section of simple and complex objects, Spatial distribution of cross section. Bistatic cross section. CW and FM Radar: Doppler Effect. CW and FMCW Radar, Airborne Doppler Navigation, Multi frequency CW Radar.

UNIT – IV

MTI Radar: Delay line cancellers, Sub clutter Visibility, MTI using range gates and filters, Pulse Doppler radar, Non-coherent MTI radar, Tracking Radar: Different types of tracking techniques. Tracking in range, Tracking in Doppler. Search Acquisition radar, Comparison of Trackers.

UNIT – V

Electronically steered phased array antenna in radar: Basic concepts, Phase shifters, Frequency scan arrays, Array elements, Feeds for arrays, Simultaneous multiple beams from array antennas.

References:

1 David barton .k, *"Modern radar system analysis*", Artech house, 1988.
2 Fred nathanson e, *"Radar design principles signal processing and the environment*", McGraw Hill.1969.
3 Cook CE. Bernfield. M, *"Radar signals*" Academic press, 1967.
4 Skolnik, *"Introduction to radar systems*",McGraw hill, 2nd Edition 2003.

EC 316

SATELLITE AND MICROWAVE COMMUNICATIONS
(PROGRAM SPECIFIC ELECTIVE – III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To explain the basic principle involved in a transmission system.*
- *To make the students to understand about Tropospheric scatter communication system and the Earth Station Technology*
- *Highlight the importance of Mobile Satellite Communications and demonstrate the concepts related to Future Trends in Satellite Communication*

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

1. *Understand the principle and operation of transmission system.*
2. *Understand about Tropospheric scatter communication system*
3. *Estimate the significance of Earth Station Technology.*
4. *Use Mobile Satellite Communications in various applications.*
5. *Understand the new trends in Satellite communication*

UNIT – I

Introductory concepts: Transmission problem, simplified transmission system, the decibel and basic derived decibel unit, Neper, practical transmission, speech, SNR, Noise figure and noise temperature, CCITT modulation plan.

UNIT – II

LOS and Tropospheric scatter communication system: Link engineering, propagation characteristics in free space, Introduction to Tropospheric scatter communication system, phenomenon of tropospheric scatter, tropospheric fading, path loss calculations,

UNIT – III

Earth Station Technology: Introduction, Elements of an Earth Station, Types of Earth Stations, Equipment Reliability and Space Qualification, Redundancy.

UNIT – IV

Mobile Satellite Communications- Introduction, International Maritime Satellite (INMARSAT), and Mobile satellite Communications with Non-Geo Satellite, VSAT Systems: VSAT Network Configurations, VSAT System Elements, Advantages and Applications of VSAT Systems.

UNIT – V

Modern Developments and Future Trends-Introduction, Micro and Nano Satellites, Satellite Laser Communication, Air-Craft launching, Orbital refueling, Deep Space Communication, GNSS, removal of satellite debris.

References:

1 Roger L Free man, *"Telecommunication transmission handbook*", John Wiley, 4th Edition, 1998.

2 T.Pratt & C.W. Bostian, *"Satellite Communication Systems"*, PHI, 1st edition, 1986.

3 B.G.Evans, "*Satellite communication system edited",* 3rd edition, IET, U.K., 2008.

4 Dennis Roddy, *"Satellite Communication Systems"*, Mc Graw Hill publications, 4th Edition, 2006.

5 Wayne Tomasi,*"Advanced Electronics Communication System",* Pearson Education, 6th Edt, Apr 2003.

EC 317

PHASED ARRAY RADAR
(PROGRAM SPECIFIC ELECTIVE – III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand the principle of electronic scanning and its application to a phased-arrayradar system*
- *To understand the concepts of cell, grid and feeding techniques.*
- *To familiarize with the design of frequency scanned array and concepts of beam positioning*

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

1. *Able to understand the basic concepts of radar beam steering and determine the direction of a resultant beam.*
2. *Able to understand the advantage and applications of an electronically scanned system.*
3. *Able to understand the concepts of frequency scanned array*
4. *Able to understand the role of phase shifters and feed networks in the frequency scanned array design.*
5. *Able to design planar array antenna with scanning capabilities*

UNIT – I

Conventional scanning techniques, Mechanical versus electronic scanning, Techniques of Electronic scanning, Frequency, Phase and time delay scanning principle, Hybrid scanning techniques.

UNIT – II

Array Theory, Linear and Planner arrays, various grid configuration, Concept of cell and grid, Calculation of minimum number of elements, Radiation pattern, Grating lobe formation, Rectangular and triangular grid design of arrays.

UNIT – III

Feed Networks for phased Arrays, Corporate Feed, Lens and Reflect feed Techniques, Optimum f/d ratio basic building block for corporate feed network, Series, Parallel feed networks, Comparison of various feeding techniques, Antenna Array Architecture, Brick/ Tile Type construction

UNIT – IV

Frequency scanned array design, Snake feed, Frequency-phase scanning, Phase scanning, Digital phase shifter PIN diode and Ferrite phase shifters for phased arrays, Beam pointing errors due to digitalization, Beam pointing accuracy.

UNIT – V

Search patterns, Calculation of search frame time, Airborne phased array design, Electronic scanning radar parameter calculation, Application of phased arrays, Phased Array Radar Systems, Active Phased Array, TR/ATR Modules.

References:

1 Olliner & knittel, "*Phased Array Radar",* Artech House, 1972.
2 Kahrilas, PJ, *"Electronic Scanning Radar Systems Design Handbook*", Artech House, 1976.
3 Skolnik, MI, *"Radar Handbook",* Mcgraw Hillso, NY, 1970.
4 Hansen, RC, *"Significant Phased Array"* Papers.
5 Galati, G, *"Advanced Radar Technique and Systems",* Peter Peregrims Ltd, London, 1993.

EC 318

AD-HOC WIRELESS NETWORKS
(PROGRAM SPECIFIC ELECTIVE – III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *An overview of ad hoc wireless networks, issues and applications.*
- *The design issues of MAC layered protocols for adhoc networks and finding the solutions and various routing mechanisms for adhoc wireless networks*
- *Designing issues at Transport layer of wireless network model and study of network security issues, key management and their solutions.*

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

1. *Understand the various ad hoc wireless networks and their standards.*
2. *Know the design issues and applications of various ad hoc wireless networks.*
3. *Analyze and design the MAC protocols for different applications of adhoc wireless networks.*
4. *Analyze and design different routing protocols for different adhoc networks.*
5. *Know and analyze the transport layered issues and security management for adhoc networks.*

UNIT – I

Ad-hoc Wireless Networks: Fundamentals of Wireless Communication Technology, Characteristics of the Wireless Channel, IEEE 802 Networking Standard, Wireless networks overview Introduction to Ad-hoc wireless networks, Cellular and Ad-hoc wireless networks, Applications of Ad-hoc wireless networks, Issues in Ad-hoc wireless networks, Ad-hoc wireless Internet

UNIT – II

MAC Protocols for Ad-hoc wireless networks: Issues in Designing a MAC protocol for Ad-hoc Wireless Networks, Design goals of a MAC protocol for Ad Hoc Wireless Networks, Classifications of MAC protocols, Contention –based protocols, Contention-based protocols with reservation Mechanisms, Contention –based MAC protocols with Scheduling Mechanisms, MAC protocols that use Directional Antennas, Other MAC protocols.

UNIT – III

*Routing protocols for Ad-hoc wireless networks***:** Issues in Designing a Routing protocol for Ad Hoc Wireless Networks, Classification of Routing protocols, Table-Driven Routing protocols, On-Demand Routing protocols, Hybrid Routing protocols, Routing protocols with Efficient Flooding Mechanisms, Hierarchical Routing protocols, Power –Aware Routing protocols.

UNIT – IV

Transportation Layer Protocols for Ad-hoc wireless networks: Introduction, Issues in Designing a Transport Layer protocol for Ad-hoc Wireless Networks, Design goals of a Transport Layer Protocol for Ad hoc Wireless Networks, Classification ofTransport Layer Solutions, TCP over Ad hoc Wireless networks, Other Transport Layer protocol for Ad hoc Wireless Networks.

UNIT – V

Security Protocols for Ad-hoc wireless networks: Security in Ad-hoc wireless networks, Network security requirements, Issues and challenges in Security provisioning, Network Security attacks, Key management, Secure routing in Ad-hoc wireless networks

References:

1 C. Siva Ram Murthy and B.S. Manoj, "*Ad Hoc Wireless Networks: Architectures and protocols"*, 2004, PHI

2 George Aggelou, *"Mobile Ad Hoc Networks",* Tata McGraw-Hill, 2009.

3 C.K.Toh , *"Ad hoc Mobile Wireless Networks: Protocols & Systems",* 1st Ed.Pearson Education. 2002.

4 Jagannathan and Sarangapani, *"Wireless Ad-hoc and Sensor Networks: Protocols, Performance and Control*", 1st Edition, CRC Press, 2007.

5 Ozan K. Tonguz, Gianluigi Ferrari, *"AD HOC Wireless Networks: A Communication-Theoretic Perspective*", Wiley Student Edition, 2009

EC319

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY
(PROGRAM SPECIFIC ELECTIVE – IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To study the electromagnetic interference control techniques.*
- *To learn electromagnetic compatibility issues with regard to the design of PCBS and discuss electromagnetic interference measurements and standards.*
- *To instil knowledge on the EMI coupling mechanism and its mitigation techniques and impart comprehensive insight about the current EMC standards and about various measurement techniques.*

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

1. *Be able to explain the requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system.*
2. *Have an ability to analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding etc.*
3. *Have an ability to analyze, measure and evaluate radiated and conducted emissions to examine the compatibility.*
4. *Find solution to EMI Sources, EMI problem in Subsystem and system level design.*
5. *Find solution to EMI Sources, EMI problems in PCB level design*

UNIT – I

Introduction and History of EMI-EMC, Sources & effects of EMI – Intersystem & Intra system, Electromagnetic Environment Effects (E3), Common EMI measurement units. Time domain & frequency domain representation of periodic, non-periodic and digital waveforms.

UNIT – II

Conducted Emission & Susceptibility, Radiated Emission & Susceptibility, ESD, Introduction of Commercial & Military EMI Standards, Measurement of EMI, Shielded Enclosure, Antennas, Probes Equipment & Accessories used in EMI measurement.

UNIT – III

EMI Mitigation Techniques, Grounding, Shielding, Filtering & Bonding, EMI Suppression Components like EMI Filters (DC/AC), RFI Filters, EMI Gaskets, RF absorbing material, Transient Voltage Suppressors, Honey-comb vents etc., Cables, Connectors.

UNIT – IV

Sub-system and System level EMC, EMC Design of analog and digital Sub-systems, Mixed Signal PCB layout for better EMC, Analog and Digital grounds, EMC of A/D & D/A Converters, EMC of DC-DC Converters and Power Supplies, EMC Design Guidelines , Introduction to Signal Integrity, .

UNIT – V

Introduction to Numerical EMI & EMC Simulation Techniques, Survey of Commercially available EMC Software, Introduction to Intentional EMI, EMP, Electromagnetic Weapons.

References:

1 Clayton R. Paul **"***Introduction to Electromagnetic Compatibility***"** Wiley Publication.
2 Dr. V.P. Kodali, "*Engineering Electromagnetic Compatibility*" IEEE Press,1996.
3 Henry W. Ott, *"Electromagnetic Compatibility Engineering"* Wiley Publication**.**

EC 320

OPTICAL COMMUNICATIONS AND NETWORKS
(PROGRAM SPECIFIC ELECTIVE – IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To know the basic geometric structures of Optical fibres, Light laws, modes of operation and losses in fibres.*
- *To know the physical principles of optical sources and optical detectors and develop the design models and design the analog and digital optical links, the noise effects and error control techniques.*
- *To understand the working of various optical components, WDM concepts and knowledge about Soliton Pulses and to know the design aspects of various Optical networks and their applications*

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

1. *Understand and analyze the design principles of Optical fibres and their losses.*
2. *Analyze the design aspects of various types of Optical sources and detectors.*
3. *Analyze and design the optical links for different applications.*
4. *Know the working of WDM systems and various optical components for different applications.*
5. *Choose the optical networks for various applications.*

UNIT – I

Optical Fibres: Overview of Optical fibre communications, Elements of an Optical fibre transmission Link, Nature of light, Basic optical laws and definitions, Modes and configurations, Single & Multi mode step index and Graded index Fibres, Fibre materials. *Signal degradation in Optical Fibres:* Attenuation, Signal Distortion in Optical Waveguides Dispersion, Pulse broadening in graded index fibres, Mode coupling, Design optimization of single mode Fibres.

UNIT – II

Optical Sources: Semiconductors physics, LEDs and Laser diodes, Linearity of sources, Modal, Partition and reflection noise.

Photo detectors: Physical principles of PIN and APD, Photo detector noise, detector response time, Avalanche multiplication noise, Temperature effect on avalanche gain, Comparison of Photo detectors.

UNIT – III

Optical Receiver Operation: Fundamental Receiver operation, Digital receiver performance calculations, Preamplifiers types, Analog receivers.

Digital Transmission Systems: Point to point links, Line coding, Error correction, Noise effects on system performance, Overview of Analog links, Carrier-to-noise ratio.

UNIT – IV

WDM: Concepts and components, Operational principles of WDM, Passive components, Tunable sources, Tunable filters, Introduction of optical amplifiers, Soliton Pulses.

UNIT – V

Optical Networks: Basic Networks, SONET/SDH, Broadcast and select WDM networks, Wavelength Routed Networks, Nonlinear effects on Network Performance, Performance of EDFA+WDM systems, Optical CDMA, Ultrahigh capacity Networks.

References:

1 Djafar K.mynbaev Lowell l.Scheiner, "*Fibre Optic Communications Technology",* Pearson Education Asia, 2006.

2 Senior John M. "*Optical Fibre Communications Principles and Practice",* Prentice Hall India, second edition, 1996.

3 3. Keiser Gerd, "*Optical Fibre Communications",* Mc GrawHill, Third edition, 1991.

4 Govind P.agarwal, *"Fiber-Optic Communication Systems*", Third edition, John Wiley & Sons, 2002.

5 5. Joseph C. Palais, *"Fibre Optic Communications*", Fifth edition, Pearson Education, 2004.

EC 221

OPTIMIZATION TECHNIQUES
(PROGRAM SPECIFIC ELECTIVE – IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming*
- *Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.*
- *To explain the concept of Dynamic programming and its applications to project implementation.*

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

1. *Explain the need of optimization of engineering systems*
2. *Understand optimization of electrical and electronics engineering problems*
3. *Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem*
4. *Apply unconstrained optimization and constrained non-linear programming and dynamic programming*
5. *Formulate optimization problems.*

UNIT – I

Use of optimization methods. Introduction to classical optimization techniques, motivation to the simplex method, simplex algorithm, sensitivity analysis.

UNIT – II

Search methods - Unrestricted search, exhaustive search, Fibonocci method, Golden section method, Direct search method, Random search methods, Univariate method, simplex method, Pattern search method.

UNIT – III

Descent methods, Gradient of function, steepest decent method, conjugate gradient method. Characteristics of constrained problem, Direct methods, The complex method, cutting plane method.

UNIT – IV

Review of a global optimization techniques such as Monte Carlo method, Simulated annealing and Tunneling algorithm.

UNIT – V

Generic algorithm - Selection process, Crossover, Mutation, Schema theorem, comparison between binary and floating-point implementation.

References:

1. SS Rao, *"Optimization techniques*", PHI, 1989
2. Zhigmiew Michelewicz, *"Genetic algorithms + data structures = Evaluation programs"*, Springer Verlog - 1992.
3. Merrium C. W., *"Optimization theory and the design of feedback control systems"*, McGraw Hill, 1964.
4. Weldo D.J., *"Optimum seeking method",* PHI, 1964.

AC 035

STRESS MANAGEMENT BY YOGA
(AUDIT COURSE –II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *To achieve overall health of body and mind.*
- *To overcome stress.*

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

1. *Develop healthy mind in a healthy body thus improving social health also*
2. *Improve efficiency.*

UNIT – I

Introduction: Definition of **Stress** – Types of stress : Acute and chronic - Stressors – Definition of **Yoga** from various sources – Types of yoga – Karma yoga, Gnana yoga, Bhakti yoga and Raja yoga – Concept of Bhagavad Geeta - Yoga versus exercise –Basics of Physiology and Psycholoy – Brain and its parts – CNS and PNS – HPA axis – Sympethetic and Para sympethetic nervous systems – Fight and Flight mechanism - Relationship between stress and yoga.

UNIT – II

Ashtanga Yoga: Do`s and Don'ts in life: i) **Yam** - Ahinsa, satya, astheya, bramhacharya and aparigraha ii) **Niyam** -Shaucha, santosh, tapa, swadhyay, ishwarpranidhan -iii) **Asana** iv) **Pranayama** v) **Prathyahara** vi) **Dharana** vii) **Dhyana** viii) **Samadhi** – Illustrations of eight steps of Ashtanga yoga.

UNIT – III

*Asana and Stress:*Definition of Asana from Pathanjali – Origin of various names of asanas - Various yog poses and their benefits for mind & body – Sequence of performing asanas: Standing, sitting, lying down on stomach, lying down on back and inverted postures – Activation of Annamaya kosha – Effect on various chakras, systems and glands thereby controlling the stress levels through the practice of asanas

UNIT – IV

*Pranayama and Stress:*Definition of pranayama from Shankaracharya - Regularization of breathing techniques and its effects - Types of pranayama – Heat generating and cold generating techniques – Pranayama versus chakras and systems – Breathing techniques versus seasons - Anger and breathing rate – Activation of pranamaya kosha – Pranayama as the bridge between mind and body – Stress control through pranayama.

UNIT – V

*Dhyana and Stress:*Distinction between Dhyana and Dharana– Preparation for Dhyana through prathyahara and dharana – Activation of Vignanamaya kosha – Types of mind: conscious, superconscious and subconscious – Activation of manomaya kosha through Dhyana – Silencing the mind thereby controlling the stress levels

References:

1 '*Yogic Asanas for Group Tarining-Part-I*' : Janardan Swami Yogabhyasi Mandal, Nagpur
2 "*Rajayoga or conquering the Internal Nature*" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3 Light on yoga by BKS Iyengar
4 "*The search for happiness and bliss*" by Swami Sarvapriyananda on you tube – https://youtu.be/xfywJTPkw7Y
5 "*Mastering the mind*" by Swamini Vimalananda on you tube - https://youtu.be/EXniWH9DMF8

AC 036

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (AUDIT COURSE –II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

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

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

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

UNIT – I

Neetisatakam-Holistic development of personality

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

UNIT – II

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

UNIT – III

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

References:

1 Swami Swarupananda Advaita Ashram "*Srimad Bhagavad Gita",* (Publication Department), Kolkata

2 P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi

AC 037

CONSTITUTION OF INDIA
(AUDIT COURSE –II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

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

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

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

UNIT – I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working)

UNIT – II

Philosophy of the Indian Constitution: Preamble and Salient Features

UNIT – III

• **Contours of Constitutional Rights & Duties:**
  • Fundamental Rights
  • Right to Equality
  • Right to Freedom
  • Right against Exploitation
  • Right to Freedom of Religion
  • Cultural and Educational Rights
  • Right to Constitutional Remedies
  • Directive Principles of State Policy
  • Fundamental Duties.

UNIT – IV

• Organs of Governance:
  • Parliament
  • Composition
  • Qualifications and Disqualifications

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

UNIT – V

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

UNIT-VI

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

References:

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

AC 038

PEDAGOGY STUDIES
(AUDIT COURSE –II)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.*
- *Identify critical evidence gaps to guide the development.*

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

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

UNIT – I

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

UNIT – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT – IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT – V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References:

1 Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.

2 Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

3 Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.

4 Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"*International Journal Educational Development, 33 (3): 272- 282, 2013.

5 Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.

6 Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

7 www.pratham.org/images/resource%20working%20paper%202.pdf.

EC352

MICROWAVE SYSTEMS LABORATORY-II

Instruction: 3 periods per week *Duration of SEE: 3hr*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

- *To get acquaint with RF test and measurement equipment*
- *To get acquaint with EM Simulation Software*
- *To become familiar with the Design and simulation of passive RF subsystems*

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

1. *Able to acquire the Knowledge on RF Test and measurement instruments*
2. *Able to acquire the knowledge to use RF CAD software*
3. *Able to Design RF subsystems*
4. *Able to Test, analyze and validate the performance of RF components and systems*

Experiments

1. Calibration with Vector Network Analyzer
2. Study of Spectrum Analyzer
3. Study of non-ideal behavior of lumped circuit components using Network Analyzer
4. Characterization of Micro strip Filters, Couplers and Resonators using Spectrum Analyzer and Network Analyzer.
5. Software simulation and design of passive Microwave Components and printed antennas using
   MathWorks MATLAB
   CST Microwave Studio
   Ansys HFSS
   Keysight Advanced Design System
   AWR Microwave office
   SONNET High Frequency EM simulator
6. Software simulation of MEMS switches, phase shifters using COMSOL Multi physics.

Note: The experiments will be decided and modified if necessary and conducted by the teacher concerned.

SEMINAR – II

EC 362

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

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

1. *Develop the habit of referring the journals for literature review.*
2. *Understand the gist of the research paper.*
3. *Identify the potential for further scope.*
4. *Present the work in an efficient manner.*
5. *Write the documentation in standard format.*

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

EC 070

MINI PROJECT

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 3

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

1. *Formulate a specific problem and give solution*
2. *Develop model/models either theoretical/practical/numerical form*
3. *Solve, interpret/correlate the results and discussions*
4. *Conclude the results obtained*
5. *Write the documentation in standard format*

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

SEMESTER - III

EC322

RADAR SIGNAL PROCESSING
(PROGRAM SPECIFIC ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To review the Radar fundamentals,*
- *To know the sampling criteria of Pulsed radar signals and learn various radars like MTI, Doppler and tracking radars and their comparison*
- *To analysis the radar signals using ambiguity function and understand various technologies involved in the design of radar transmitters and receivers.*

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

1. *Know how a radar is built and understand the principles of behavior*
2. *Understand the basic principles of signal processing done in a radar.*
3. *Be able to estimate the performance of a radar based on parameters provided.*
4. *Be able to assess what type of radar is suitable for which task (choice of waveforms, frequency bands, etc.*
5. *Be able to use numerical tools to calculate radar performance and to simulate the signal processing in a radar.*

UNIT – I

A Preview of Basic Radar Signal Processing, Radar Literature, Signal Models, components of a Radar Signal, Amplitude Models, clutter, Noise Model and Signal -to -Noise Ratio, Jamming, Frequency Models-The Doppler Shift, Spatial Models, Spectral Model.

UNIT – II

Sampling and Quantization of Pulsed Radar Signals, Domains and Criteria for Sampling Radar Signals, Sampling in the Fast Time Dimension, Sampling in Slow Time – Selecting the Pulse Repetition Interval, Sampling the Doppler Spectrum, Sampling in the Spatial and Angle Dimensions, Quantization, I/Q Imbalance and Digital I/Q

UNIT – III

Radar waveforms: The waveform Matched filter, Matched filter for Moving Targets, Radar Ambiguity Function and Ambiguity Diagram-Principles and Properties; Specific Cases – Ideal Case, Single Pulse of Sine Wave, Periodic Pulse Train, Single Linear FM Pulse.

UNIT – IV

Doppler Processing, Alternate Forms of the Doppler Spectrum, Moving Target Indication (MTI), Pulse Doppler Processing, Pulse Pair Processing, Additional Doppler Processing Issues, Clutter Mapping and the Moving Target Detector, MTI for moving platforms.

UNIT – V

Pulse Compression in Radar Signals: Introduction, Significance, Types, Frequency Modulated Pulse compression wave forms, Range side lobe control for FM waveforms, Phase modulated pulse compression wave forms, Costas Frequency codes.

References:

1 Mark A. Richards, *"Fundamentals of Radar Signal Processing*",McGraw Hill
2 M.I. Skolnik, "*Introduction to Radar Systems*", 3rd Edition, 2001, TMH.
3 R. Nitzberg, "*Radar Signal Processing and Adaptive Systems*", 1999, Artech House.
4 F.E. Nathanson, "*Radar Design Principles*", 1st Edition, 1969, McGraw Hill.

EC323

MICROWAVE SOLID STATE DEVICES AND APPLICATIONS
(PROGRAM SPECIFIC ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand operating characteristics of Microwave BJTs, GaAs FETs, low noise and power GaAs FETs and their applications.*
- *To understand FET working principle and its applications as attenuators and phase shifters.*
- *To learn the Microwave Mixers design using diodes and FETs and microwave Oscillators design using IMPATT diodes and FETs.*

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

1. *Understand the working principles of the Microwave solid state devices (Microwave BJTs. GaAs FETs, low noise and power GaAs FETs, IMPATT Diodes)*
2. *Choose a suitable microwave solid state device for a particular application.*
3. *Understand the use of microwave semiconductor devices inRF Switches, Phase shifter and attenuators.*
4. *Understand the use of microwave semiconductor devices in microwave amplifiers and oscillators.*
5. *Understand the use of microwave semiconductor devices in design of microwave, mixers.*

UNIT – I

Introduction to two terminal microwave devices. Microwave BJTs. GaAs FETs, low noise and power GaAs FETs and their applications. DC biasing, Z and Y smith charts and impedance matching circuits.

UNIT – II

RF Switches, Phase shifter and attenuators: SPST and SPDT design using FETs, FET based attenuators and phase shifters. Characterization of Switches, attenuators and phase shifters

UNIT – III

Amplifiers - Microwave transistor 'S' parameters.
Power gain equations, stability, impedance matching, constant gain and
noise figure circles; Small signal, low noise, high-power and broadband amplifier designs.
Characterization of amplifiers.

UNIT – IV

Oscillators: Negative resistance concept, types of resonators, oscillator condition. One port, two port, YIG dielectric oscillators, broad band oscillator, Gunn diode oscillator design, and wave guide cavity IMPATT oscillator design. FET oscillator design. Characterization of oscillators.

UNIT – V

Microwave Mixers design: Diode mixer theory, single diode mixers; single balanced, double balanced mixers.FET mixer theory, balanced FET mixers, and special mixer circuits. Characterization of Mixers.

References:

1 S.Y. Liao, "*Microwave Circuit Analysis and Amplifier Design",* Prentice Hall, 1987.
2 G.D. Vendelin, A.M. Pavio, U.L. Rohde, *"Microwave Circuit Design, Using Linear and Non-linear Techniques*", John Wiley, 1990.
3 S.Y.Liao, *"Microwave Devices and Circuits",* Third addition, , Prentice Hall.
4 Guillermo and Gonzalez, *"Microwave Transistor Amplifiers: Analysis and Design"*, (2nd Edition), 1996
5 Stephen A. Maas, *"Microwave Mixers",*(Artech House Antennas and Propagation Library) (Artech House Microwave Library) 1993
6 Inder J. Bahl, "*Control Components Using Si, GaAs, and GaN Technologies*"

EC324

SOFTWARE DEFINED RADIO
(PROGRAM SPECIFIC ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To provide fundamental concepts in SDR.*
- *To explore the reconfigurable features of modern radio communication systems.*
- *To demonstrate SDR on any DSPs and FPGAs.*

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

1. *Understand the basic architecture and design principles of SDR.*
2. *Analyze the parameters of analog RF components as front end block in implementation of SDR.*
3. *Understand the concepts of digital converter and frequency converter fundamentals.*
4. *Understand the digital hardware architectures and development methods.*
5. *Implement SDR on available hardware devices like DSPs and FPGAs.*

UNIT – I

Introduction to Software Defined Radio: A Traditional Hardware Radio Architecture, Signal Processing Hardware History, Software Defined Radio Project Complexity. A Basic Software Defined Radio Architecture: 2G Radio Architectures, Hybrid Radio Architecture, Basic Software Defined Radio Block Diagram, System Level Functioning Partitioning, Digital Frequency Conversion Partitioning.

UNIT – II

RF System Design: Introduction- Noise and Channel Capacity, Link Budget, Receiver Requirements, Multicarrier Power Amplifiers, Signal Processing Capacity Tradeoff.

UNIT – III

Analog-to-Digital and Digital-to-Analog Conversion: Digital Conversion Fundamentals, Sample Rate, Bandpass Sampling, Oversampling- Antialias Filtering, Quantization, ADC Techniques-Successive Approximation, Figure of Merit-DACs, DAC Noise Budget, ADC Noise Budget.

UNIT – IV

Digital Frequency Up- and Down Converters: Introduction- Frequency Converter Fundamentals, Digital NCO, Digital Mixers, Digital Filters, Halfband Filters, CIC Filters, Decimation, Interpolation, and Multirate Processing,DUCs, Cascading Digital Converters and Digital Frequency Converters.

UNIT – V

Hardware and Software Components: SDR Requirements for Processing Power- DSPs- DSP Devices- DSP CompilersReconfigurable Processors-Adaptive Computing Machine- FPGAs, Major Software Architecture Choices, Hardware – Specific Software Architecture, Software Standards for Software Radio, Software Design Patterns, Component Choices, Real Time Operating Systems, High Level Software Languages, Hardware Languages.

References:

1 Paul Burns, "*Software Defined Radio for 3G",* Artech House, 2002
2 Tony J Rouphael, "*RF and DSP for SDR",* Elsevier Newnes Press, 2008
3 Jouko Vanakka, *"Digital Synthesizers and Transmitter for Software Radio*", Springer, 2005

OE 941

BUSINESS ANALYTICS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

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

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

UNIT – I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT – II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT – III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT – IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. *Clustering:* Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, *Prescriptive Analytics* - Linear Programming(LP) and LP model building,

UNIT – V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

References:

1 U Dinesh Kumar, "*Data Analytics*", Wiley Publications, 1st Edition, 2017.
2 Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "*Business analytics Principles, Concepts, and Applications with SAS*", Associate Publishers, 2015.
3 S. Christian Albright, Wayne L. Winston, "*Business Analytics - Data Analysis and Decision Making"*, 5th Edition, Cengage, 2015.
4 https://onlinecourses.nptel.ac.in/noc18-mg11/preview
5 https://nptel.ac.in/courses/110105089/

OE942

INDUSTRIAL SAFETY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

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

UNIT–II

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

UNIT–III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT–IV

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

UNIT–V

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

Suggested Reading:

1. H. P. Garg, "Maintenance Engineering", S. Chand and Company
2. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

OE 943

OPERATION RESEARCH
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Introduce the concepts of optimization techniques*
- *Formulation of LPP models*
- *Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.*

Outcomes:

1. *Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.*
2. *Students should able to apply the concept of non-linear programming*
3. *Students should able to carry out sensitivity analysis*
4. *Student should able to model the real world problem and simulate it.*
5. *Student should able to apply graph theory, competitive models, and game theory simulations.*

UNIT I

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

UNIT II

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

UNIT III:

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

UNIT IV

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

UNIT V

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

Suggested Reading::

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

OE944

COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduce the concepts of cost management, inventory valuation , decision making*
- *Fundamentals of cost overruns, project execution and technical activities*
- *Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM*

Course Outcomes:

1. *Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.*
2. *Ability to appreciative detailed engineering activities of the project and execution of projects*
3. *Preparation of project report and network diagram*
4. *Able to plan Cost Behavior, Profit Planning, Enterprise Resource Planning, Total Quality Management.*
5. *Applications of various quantitative techniques for cost management*

UNIT-I

Project Management: Introduction to project managements, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling.

UNIT-II

Project Planning and Scheduling: Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

UNIT-III

Project Monitoring and Cost Analysis: introduction-Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making, Time cost tradeoff-Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

UNIT-IV

Resources Management and Costing-Variance Analysis: Planning, Enterprise Resource Planning, Resource scheduling and levelling. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Standard Costing and Variance Analysis. Pricing strategies: Pareto

Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement

UNIT-V

Budgetary Control:: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading:

1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14 edition (2012),
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th Revised edition (1 February 1987)
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting" , Pearson; 2 edition (18 October 1996)
4. K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata McGraw-Hill Education. (2004).
5. Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India; 2 edition (2015)

OE 945

COMPOSITE MATERIALS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To understand the fundamentals of composite materials and the role of matrix and reinforcement.*
- *To know the principles of manufacturing composite*
- *To understand the strength and failure criteria of lamina and laminate.*

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

1. *Define a composite, identify the matrix and reinforcement and highlighting the features and application of different composite materials.*
2. *Classify composites, illustrate the mechanical behaviour of composites and predict properties using micromechanics principles.*
3. *Illustrate the manufacturing of metal matrix composites and outline the properties and applications.*
4. *Illustrate the manufacturing of Polymer matrix composites and outline the properties and applications.*
5. *Apply various failure criteria to assess the strength of lamina and laminates.*

UNIT – I

Introduction: Definition- Classification and characteristics of composite materials. Advantages and applications of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, distribution, volume fraction) on overall composite performance.

UNIT – II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers and Boron fibers. Properties and applications of whiskers, particulate reinforcements. Mechanical Behaviour of composites: Rule of Mixtures, Inverse rule of mixtures. Isostrain and Isostress condition.

UNIT – III

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

UNIT – IV

***Manufacturing of Polymer Matrix Composites*:** Preparation of Moulding compounds and prepregs-hand layup method-Autoclave method-Filament winding method-Compression moulding-Reaction injection moulding, Properties and applications.

UNIT – V

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

References:

1 *Material Science and Technology*- Vol 13- Composites by R.W. Cahn-VCH, West Germany.
2 *Materials Science and Engineering, An Introduction*. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley &Sons, NY, Indian edition, 2007.
3 *Composite Materials*- K. K. Chwala.
4 *Composite Materials Science and Applications*-Deborah D.L. Chung.
5 *Composite Materials Design and Applications*-Danial Gay, Suong V. Hoa and Stwphen W. Tsai.

OE 946

WASTE TO ENERGY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion.*

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

1. *Understand the concept of conservation of waste*
2. *Identify the different forms of wastage*
3. *Choose the best way for conservation to produce energy from waste*
4. *Explore the ways and means of combustion of biomass*
5. *Develop a healthy environment for the mankind*

UNIT – I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based,Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

References:

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

OE947

INTERNET OF THINGS
(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

Course Objectives:

- To understand the concepts of Internet of Things and able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards.
- To know about data handling and analytics in SDN.

Course Outcomes:

After Completion of the course Student will be able to:

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

UNIT – I

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

UNIT – II

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino,

UNIT – III

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi

UNIT - IV

Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,

UNIT - V

Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Suggested Readings:

1. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", by PethuruRaj and Anupama C. Raman (CRC Press).
2. “Make sensors”: Terokarvinen, kemo, karvinen and villeyvaltokari, 1st edition, maker media, 2014.
3. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti Vijay Madisetti,
4. ArshdeepBahga, “Internet of Things: A Hands-On Approach”
5. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
6. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

OE948

CYBER SECURITY

(Open Elective)

Instruction: 3periods per week
Duration of SEE: 3 hours
CIE: 30 marks
SEE: 70 marks
Credits: 3

Course Objectives

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

Course Outcomes:

After completion of this course, the students shall be able to:

1. Understand the various network threats.
2. Analyze the forensic tools for evidence collection.
3. Apply the firewalls for threat analysis.

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

EC 381

MAJOR PROJECT PHASE - I

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits: 10

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

1. *Exposed to self-learning various topics.*
2. *Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.*
3. *Learn to write technical reports.*
4. *Develop oral and written communication skills to present.*
5. *Defend their work in front of technically qualified audience*

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

SEMESTER - IV

EC 382

MAJOR PROJECT PHASE - II

Instruction: 32 periods per week *Duration of SEE: --*
CIE: -- *SEE: 200 marks*
Credits: 16

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

1. *Use different experimental techniques and will be able to use different software/ computational /analytical tools.*
2. *Design and develop an experimental set up/ equipment/test rig.*
3. *Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analysing them.*
4. *Either work in a research environment or in an industrial environment.*
5. *Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.*

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce