SEMESTER VIII

Code	Course of Study	L	T	P	C
MB790	Industrial Economics, Management Concepts & Practices	3	0	0	3
EC402	Broadband Access Technologies	3	0	0	3
	Elective-4	3	0	0	3
	Elective-5	3	0	0	3
EC498	Project	0	0	12	6
	TOTAL	**12**	**0**	**12**	**18**

SEMESTER-VIII

Code	Course of Study	L	T	P	C
EC452	Pattern Recognition	3	0	0	3
EC454	Principles of Radar	3	0	0	3
EC456	Satellite Communication	3	0	0	3
EC458	Design of Cognitive Radio	3	0	0	3
EC460	Introduction to MEMS	3	0	0	3
EC462	Biomedical Signal and Image Processing	3	0	0	3
EC464	Biomedical Instrumentation	3	0	0	3
EC466	RF Engineering	3	0	0	3

MB790: INDUSTRIAL ECONOMICS, MANAGEMENT CONCEPTS & PRACTICES (3 – 0 - 0) 3

Pre-Requisite: None

Objective:

This course is intended for the students to understand the economic and management concepts that are in vogue in industries.

Topics Covered:

Unit-1: Microeconomics

Microeconomics, Demand and supply, Forecasting techniques, Cost and revenues, Competitive nature of firms.

Unit-2: Keynesian economics

Keynesian economics, Aggregate demand and supply, Employment determination, National income, Trade cycle, Inflation, Index numbers.

Unit-3: Introduction of Management principles

Introduction to management, evolution of scientific management, modern management principles. Elements of management, planning, organizing, staffing, directing, coordinating, reporting, budgeting.

Unit-4: Marketing and HR Management

Core concepts of marketing, Significance of HRM, HR planning job evaluation, Recruitment and selection, Placement and Training, Performance appraisal, Compensation, Industrial relations.

Unit 5: Financial Management

Financial management, objectives, scope, techniques of investment analysis, payback period, accounting rate of return, working capital, cost of capital, Sources of financing.

Course Outcomes:

1. Know the concepts of Microeconomics and Keynesian economics.
2. The learners get equipped with the nuances of management functions
3. The students gain the insights of Marketing strategies
4. The learners become better people managers.

Text Books:

1. M. Adhikari, Business Economics, Excel Books, 2004
2. S. K. Misra &V. K. Puri, Economic Environment of Business, HPH, 2003
3. P. Kotler, Marketing Management (12/e), Pearson, 2005.
4. L.M. Prasad, Priciples and Practice of Management, S. Chand& Sons.

Reference Books:

1. Dewett, K.K:Modern Economic Theory,Chand.S&co,1998.
2. Gupta C.B: Business Organisation and Management, Chand, S. & co,1998.
3. Philip Kotler: Marking Management, PHI, 1999.
4. P. Chandra, Financial Management Theory and Practice (3/e), TMH, 2004.
5. K. Ashwathappa, Human Resources and Personnel Management (3/e), TMH, 2005.
6. E.S. Buffa& R.K. Sarin, Modern Production/Operation Management (8/e), Wiley, 1994.

EC402 BROADBAND ACCESS TECHNOLOGIES (3-0-0) 3

Pre-Requisite:EC401

Objective:

To impart fundamentals and latest technologies related to the design of broadband last mile-Access technologies for multimedia communication

Topics Covered:

Unit -1: Introduction to Broadband technologies

Phone line modem-ISDN.Broadband technologies. Cable, DLS, fiber and wireless access technologies.

Unit -2: Digital subscriber lines

ADSL,RADSL,IDSL,HDSL,SDSL,VDSL, Standards for XDSL and comparison.

Unit -3: Cable modems

Cable modems,DOCSIS, Hub operation, Access control, Framing, Security, data link and higher layers. ATM and IP-centric modem.

Unit -4: Fiber access technologies and architectures

Hybrid fiber-coax systems, SDV, EPON, GPON. FTTX comparison.

Unit -5: Broadband wireless systems

Direct broadcast satellite.MMDS.LMDS.WIDIS. 3G wireless systems . IMT2000.

Course Outcomes:
Students are able to

1. Recall and identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system

2. Illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL
3. Summarize the versions of cable network standard and MAC protocols for HFC networks Distinguish he cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks
4. Outline the types of broadband wireless access technologies and their characteristics.

Text Books:

1. NikilJayant, Broadband last mile - Taylor and Francis group, 2005
2. N. Ransom & A.A. Azzam, Broadband Access Technologies, McGraw Hill, 1999.
3. M.P. Clarke, Wireless Access Network, Wiley, 2000.

Reference Books:

1. W.J. Woralski, ADSL and DSL Technologies, McGraw Hill, 1998.
2. S. Mervana& C. Le, Design and Implementation of DSL-based Access Solutions, Cisco Press, 2001.
3. W. Vermillion, End-to-End DSL Architecture, Cisco Press, 2003.

EC452 PATTERN RECOGNITION (3-0-0-3)

Objectives:

1. This course is named due to its historical reasons. The term Machine Learning is more widely used to denote the general body of statistical techniques for automatically detecting and modelling patterns in data. *Pattern Recognition* may at times refer to the use of a more conventional subset of these techniques, such as Neural Networks.
2. This course is used as an introduction to Machine Learning.
3. The course is tell about things involves understanding the principles behind machine learning machine learning.
4. Over time of this course we will consider the issues of representation, modelling, learning through conditioning, inference through marginalisation, inference and learning algorithms and application to data.

Topics Covered:

Unit-1: Introduction

Introduction: Pattern Similarity and PR Tasks (Classification, Regression and Description) - Classes Patterns and Features - PR approaches (Data Clustering, Statistical Classifier -Neural network)

Unit-2: Revision of Probability Theory and Distributions

Probability densities - Expectations and covariance - Bayesian probabilities - The Gaussian distribution - Decision Theory - Minimizing the misclassification rate - Relative entropy and mutual information - The beta distribution - Gaussian distribution - Bayes' theorem for Gaussian variables

Unit-3: Supervised Learning

Linear Regression Models: Linear Basis Function Models - Bias-Variance Decomposition - Bayesian Linear Regression - Bayesian Model Comparison

Unit-4: Linear Discriminant Analysis

Discriminant Functions -Probabilistic Generative Models - Probabilistic Discriminative Models- Neural Networks: Deep Learning: Feed-forward Network Functions - Network Training - Error Back propagation -Kernels, Support Vector Machines -Naïve Bayes - Graphical Models: Bayesian Networks - Conditional Independence - Markov Random Fields

Unit-5: Unsupervised Learning

Clustering, Mixture Models, Expectation-Maximisation: *K*-means Clustering, Mixtures of Gaussians, Latent Variables, Component Analysis: Principal Component Analysis, Probabilistic PCA, Kernel PCA, SVD, Hidden Markov Models: Markov Models, Hidden Markov Models

Course Outcome:

1. Students will learn about pattern recognition techniques by machines
2. Learn the applications about pattern Recognition

Text Books:

1. Pattern Recognition Concepts, Methods and Application,J. P. Marques De Sa,Springer. 2001
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006

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EC454 PRINCIPLES OF RADAR (3-0-0) 3

Pre-Requisite:EC301&EC307

Objective :

To expose the students to the working principles of a radar from a signal processing perspective.

Topics Covered :

Unit-1: Introduction

Radar equation.Radar cross section.Cross section of small targets.Target scattering matrices.Area and volume targets.

Unit-2: Radar signals

Radar signals. Ambiguity function and its properties.Uncertainty principle. Pulse compression. linear FM pulse. Pulse compression by Costas FM and binary phase coding.

Unit-3: Radar detection

Optimum Bayesian decision rules.Detection criteria for different target models.

Unit-4: Range and Doppler measurements

Range and Doppler measurements and tracking, Range and Doppler frequency resolutions.Optimum receivers. Optimum filters for Doppler measurements. Coherent and non coherent implementations.

Unit -5: Angle measurement and tracking

Angle measurement and tracking by conical scan and mono pulse. Optimum mono pulse systems.

Course Outcomes :

1. At the end of learning the course, one should be able to apply his mind in developing radar for any given frequency and apply practically.
2. Students are expected to be familiar with various radar detection and tracking systems.

Text Books:

1. P.Z. Peebles, Radar Principles, Wiley, 1998.

2. Merrill I. Skolink, Introduction to Radar Systems, (3/e), Tata MG Graw Hill, 2001

Reference Books:

1. N. Levanon, Radar Signals, Wiley, 2005.
2. D. Wehnar: High Resolution, Artech HouseRadar (1987).
3. D.K. Barton: Radar systems Analysis, Prentice Hall(1976).

EC456 SATELLITE COMMUNICATION (3-0-0)3

Pre-Requisite: EC302

Objective:

To impart knowledge on various aspects in the design of systems for satellitecommunication.

Topics Covered :

Unit-1: Orbital Mechanics
Frequency allocation for Satellite services - Elements of orbital mechanics - Equations of motion - Orbital perturbations - Inclined orbits - Two line Element -Polar Orbit - Geostationary orbit - Tracking and orbit determination.

Unit-2 Space System
Orbital correction/control – Attitude Control - Station keeping - Thermal Control - TT&C Systems – Transponders - Antenna and tracking systems -Satellite launch systems - Multistage rocket launchers and their performance.

Unit-3: Elements of communication satellite design.
Spacecraft subsystems - Reliability considerations - Spacecraft integration.

Unit-4: Multiple access techniques
FDMA,TDMA,CDMA. Random access techniques - Satellite onboard processing.

Unit-5: Satellite link design
Performance requirements and standards - Design of satellite links – Effects of Rain – DOMSAT – INSAT - INTELSAT and INMARSAT. Satellite based personal communication - Earth station design – Configurations -Satellite broadcasting, GPS, Remote Sensing

Course outcomes:
Students are able to

1. Able to understand how analog and digital technologies are used for satellite communication networks.
2. Able to understand the radio propagation channel for Earth station to satellite.

Text Books:

- D. Roddy, “Satellite Communication”, 4thedition, McGraw- Hill, 2009.
- T. Pratt & C.W. Bostain, “Satellite Communication”, 2nd edition, Wiley Publishers, 2008.

Reference Book:

- B.N. Agrawal, Design of Geo-synchronous Spacecraft, Prentice- Hall,1986.

EC458 DESIGN OF COGNITIVE RADIO(3-0-0)3

Pre-Requisite: EC201& EC202

Objective:

This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

Topics Covered:

Unit-1: Filter banks-uniform filter bank. direct and DFT approaches. Introduction to ADSL Modem.Discrete multitone modulation and its realization using DFT. QMF.STFT.Computation of DWT using filter banks.

Unit-2: DDFS- ROM LUT approach. Spurious signals, jitter. Computation of special functions using CORDIC.Vector and rotation mode of CORDIC.CORDIC architectures.

Unit-3: Block diagram of a software radio. Digital down converters and demodulators Universal modulator and demodulator using CORDIC. Incoherent demodulation - digital approach for I and Q generation, special sampling schemes. CIC filters. Residue number system and high speed filters using RNS. Down conversion using discrete Hilbert transform. Under sampling receivers, Coherent demodulation schemes.

Unit-4: Concept of Cognitive Radio, Benefits of Using SDR, Problems Faced by SDR, Cognitive Networks, Cognitive Radio Architecture. Cognitive Radio Design, Cognitive Engine Design,

Unit-5: Basic OFDM System Model, OFDM based cognitive radio, Cognitive OFDM Systems, MIMO channel estimation, Multi-band OFDM, MIMO-OFDM synchronization and frequency offset estimation. Spectrum Sensing to detect Specific Primary System, Spectrum Sensing for Cognitive OFDMA Systems.

Course Outcomes:

Students are able to

1. Gain knowledge on multirate systems.
2. Develop the ability to analyze, design, and implement any application using FPGA.
3. Be aware of how signal processing concepts can be used for efficient FPGA based system design.
4. Understand the rapid advances in Cognitive radio technologies.
5. Explore DDFS, CORDIC and its application.

Text Books:

1. *S. K. Mitra, Digital Signal processing, McGrawHill, 1998*
2. *J. H. Reed, Software Radio, Pearson, 2002.*
3. *U. Meyer-Baese , Digital Signal Processing with FPGAs, Springer, 2001.*
4. *Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems by HüseyinArslan, University of South Florida, USA, Springer.*

Reference Books:

1. *Cognitive Radio Networks by Kwang-Cheng Chen, Ramjee Prasad, Wiley, 2009-06-15.*
2. *Artificial Intelligence in Wireless Communications by Thomas W. Rondeau, Charles W. Bostian.*

EC460 INTRODUCTION TO MEMS (3-0-3-3)

Pre-Requisite: EC207
Objective:

Micro **E**lectro **M**echanical **S**ystems (MEMS) are miniature devices that are widely used in consumer products such as accelerometers used in cars to activate the airbags and in smart phones to flip images and play video games. This course will introduce the basics of MEMS design, fabrication, sensing and actuation mechanisms, characterization and reliability testing. The MEMS concepts are reinforced through labs that involve design and simulation of MEMS devices using an advanced MEMS simulation tool and testing of actual MEMS devices. The applications and challenges of existing MEMS devices will be discussed.

Topics Covered:

Unit-1: Microfabrication: Silicon as MEMS material, Silicon doping and oxidation, Deposition and etching

Unit-2: Micromachnining: Bulk micromachining, wet etching, Bulk micromachining-dry etching, Surface micromachining-processes, LIGA and electroplating

Unit-3: Actuation and Sensing:Elelctrostatic actuation (parallel plate), Elelctrostatic actuation (comb drive), Elelctrostatic sensing, Piezoelectric sensing ,Thermoelectric sensing and actuation

Unit-4: Design and Modeling: Design considerations, Scaling in miniaturization, Finite Element analysis, Packaging & Assembly: wire bonding and encapsulation, Surface bonding and 3D packaging, Wafer level packaging, Signal integrity

Unit-5: MEMS Testing and Reliabilities: Accelerated testing, MEMS characterization: characterization techniques, Applications: Acoustic MEMS: Microphones, Opitcal MEMS: micromirrors, Microfluidics

Laboratories:

Lab 1: CoventorWare/ANSYS/COMSOL/INTELLISUITE: build a 3D model and Silicon doping and oxidation

Lab 2: CoventorWare/ANSYS/COMSOL/INTELLISUITE: model and stress analysis using MemMech, Spring MM, meshing study

Lab 3: Electrical analysis of comb drives Surface micromachining-stiction, residual stress

Lab 4: Coupled Electro-thermal-mechanical analysis: Thermal actuator

Lab 5: Micro-mirror design, Piezoelectric actuation

Lab 6: piezoelectric frequency sensor design

Lab7: MEMS testing

Lab 8: MEMS switch as logic gates

Lab 9: project assignment – RF MEMS

Lab 10: Lab on a chip demo/project

Course Outcomes:
Upon completion of this course, you will have gained the following:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3. An ability to identify, formulate, and solve engineering problems
4. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Textbooks:

1. Fundamental of MEMS by N.P.G.S Mahalik, TMH
2. Foundations of MEMS by Chang Liu (2nd edition), 2012, PHI

Reference Books:

1. MEMS and Microsystems (2nd edition) by Tai-Ran Hsu, 2008. Wielly& sons
2. Microsystem design by Stephen Senturia, Springers

EC462 BIOMEDICAL SIGNAL AND IMAGE PROCESSING (3-0-1-3)

Pre-Requisite: EC201& EC456

Objective:

1. This course emphasis on fundamentals of digital signal processing and problems in biomedical research and clinical medicine, which includes principles and algorithms for processing both

deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modelling.
2. The aim of the course is a series of labs that provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. The labs are done in MATLAB® during weekly lab sessions that take place in an electronic classroom. Lectures cover signal processing topics relevant to the lab exercises, as well as background on the biological signals processed in the labs.

Topics Covered:

Unit-1: Biomedical Signals and Images

ECG - Speech Signals - Speech Coding - Imaging Modalities - X-ray – MRI – fMRI - Fundus Image

Unit-2: Fundamentals of Deterministic Signal and Image Processing

Data Acquisition - Digital Filtering - DTFT -DFT - Image Processing

Unit-3: Probability and Random Signals

PDFs Classification: Bayes' rule - detection, statistical classification - Time averages - Ensemble averages - Autocorrelation Functions - Cross-correlation Functions - Random signals and linear systems - power spectra - cross spectra - Wiener filters - Blind source separation - PCA – EVD – SVD - ICA

Unit-4: Image Segmentation and Registration

Image Segmentation (statistical classification, morphological operators, connected components) - Image Registration (Rigid and non-rigid transformations, objective functions, Joint entropy, optimization methods)

Unit-5: Laboratory Projects
Tools: MATLAB

1. ECG Filtering and Frequency Analysis of the Electro-gram Design filter to remove noise from electrocardiogram (ECG) signals and then design a system to detect life-threatening ventricular arrhythmias. The detector is tested on normal and abnormal ECG signals.
2. Speech Coding Implement, test, and compare two speech analysis-synthesis systems. These systems utilize a pitch detector and a speech synthesizer based on the source-filter model of speech production.
3. Image Segmentation Process clinical MRI scans of the human brain to reduce noise, label tissue types, extract brain contours, and visualize 3-D anatomical structures.
4. Image Registration Explore the co-registration of medical images, focusing on 2-D to 2-D (slice to slice) registration and using non-linear optimization methods to maximize various measures of image alignment.
5. ECG: Blind Source Separation Separate fetal and maternal ECG signals using techniques based on second- and higher-order statistical methods. Techniques include Wiener filtering, principal component analysis, and independent component analysis.

Outcomes:

1. After studying this course student will learn about the biomedical signals and the method for processing them for the wellbeing of the human being.
2. Students will learn more about the signal processing tools.

Text Books:

1. Clifford, G., F. Azuajae, and P. McSharry. *Advanced Methods and Tools for ECG Data Analysis*. Norwood, MA: Artech House, 2006. ISBN: 9871580539661.
2. Rabiner, L. R., and R. W. Schafer. *Digital Processing of Speech Signals*. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.
3. Gonzalez, R., and R. E. Woods. *Digital Image Processing*. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN: 9780201180756.
4. Epstein, C. L. *Mathematics of Medical Imaging*. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 9780130675484.

Reference Books:

1. Webb, S. *The Physics of Medical Imaging*. New York, NY: Taylor & Francis, 1988. ISBN: 9780852743492.

2.Westbrook, C., C. Kaut Roth, and T. Talbot. *MRI in Practice*. 3rd ed. Malden, MA: Blackwell Science, Inc., 2005. ISBN: 9781405127875

2. Macovski, A. *Medical Imaging Systems*. Upper Saddle River, NJ: Prentice Hall, 1983. ISBN: 9780135726853

EC464 BIOMEDICAL INSTRUMENTATION (3-0-1-3)

Pre-Requisite: EC201& EC456

Objective:

To introduce the student to the various sensing and measurement devices of electrical origin and provide awareness of electrical safety of medical equipments.

Topics Covered :

Unit-1 Physiology and Transducers

Cell and its structure – Resting and Action Potential – Nervous system: Functional organisation of the nervous system – Structure of nervous system, neurons - synapse – transmitters and neural communication – Cardiovascular system – respiratory system – Basic components of a biomedical system - Transducers – selection criteria – Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors.

Unit-2 Electro-Physiological Measurements

Electrodes –Limb electrodes –floating electrodes – pregelled disposable electrodes - Micro, needle and surface electrodes – Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier.
ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms.
Electrical safety in medical environment: shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipments

Unit-3 Non-Electrical Parameter Measurements

Measurement of blood pressure– Cardiac output – Heart rate – Heart sound –Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers : pH of blood –measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.

Unit-4 Medical Imaging

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Gamma camera – Thermography – Different types of biotelemetry systems and patient monitoring – Introduction to Biometric systems

Unit-5 Assisting and Therapeutic Equipments

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy

Course Outcomes :

1. Able to get an acquaintance of the physiology of the heart, lung, blood circulation and circulation respiration. Biomedical applications of different transducers used.
2. Able to get the latest ideas on devices of non-electrical devices.
3. Able to bring out the important and modern methods of imaging techniques.
4. Able to understand the latest knowledge of medical assistance / techniques and therapeutic equipments.

Text Books:

1.R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', McGraw Hill Publishing Co Ltd. 2003.
2.Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002.

Reference Books:

1. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
2. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
3. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
4. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2000.

EC466 RF Engineering

Objectives: The objective of the paper is to facilitate the student with the basics of field theory and fundamentals of antennas, types of antennas and propagation aspects of RF energy. These aspects are required for understanding of wireless communications and lay emphasis on principles and

methods used in mobile antennas. The prerequisites are to have basic understanding of Field theory.

Unit – 1: Radiation fields of wire antennas

Concept of vector potential. Modification for time varying retarded case. Fields associated with Hertzian dipole. Power radiated and radiation resistance of current element. Radiation resistance of elementary dipole with linear current distribution. Radiation from half-wave dipole and quarter – wave monopole. Assumed current distribution for wire antennas. Use of capacity hat and loading coil for short antennas.

Unit –2 Antenna Fundamentals and Antenna Arrays:

Definitions: Radiation intensity. Directives gain. Directivity. Power gain. Beam Width. Band Width. Gain and radiation resistance of current element. Half-wave dipole and folded dipole. Reciprocity principle. Effective length and Effective area. Relation between gain effective length and radiation resistance. Loop Antennas: Radiation from small loop and its radiation resistance. Radiation from a loop with circumference equal to a wavelength and resultant circular polarization on axis. Aelical Antenna. Normal mode and axial mode operation. Antenna Arrays: Expression for electric field from two and three element arrays. Uniform linear array. Method of pattern multiplication. Binomial array. Use of method of images for antennas above ground.

Unit 3Traveling wave (wideband) antennas:

Radiation from a traveling wave on a wire. Analysis of Rhombic antenna. Design of Rhombic antennas. Coupled Antennas: Self and mutual impedance of antennas. Two and Three element Yagi antennas. Log periodic antenna. Reason for feeding from end with shorter dipoles and need for transposing the lines. Effects of decreasing. Aperture and Lens Antennas: Radiation from an elemental area of a plane wave (Huygen's Source). Radiation from the open end of a coaxial line. Radiation from a rectangular aperture treated as an array of Huygen's sources. Equivalence of fields of a slot and complementary dipole. Relation between dipole and slot impedances.

Unit 4 Method of feeding slot antennas.

Thin slot in an infinite cylinder. Field on the axis of an e-plane sectoral horn. Radiation form circular aperture. Beam width and effective area. Reflector type of antennas (dish antennas). Dielectric lens and metal plane lens antennas. Lumeberg lens. Spherical waves and biconical Antenna.

Unit 5 Propagation:

The three basic types of propagation; ground wave, space wave and sky wave propagation. Sky wave propagation: Structure of the ionosphere. Effective dielectric constant of ionized region. Mechanism of refraction. Refractive index. Critical frequency. Skip distance. Effect of earth's magnetic field. Energy loss in the ionosphere due to collisions. Maximum usable frequency. Fading and Diversity reception. Space wave propagation: Reflection from ground for vertically and horizontally polarized waves. Reflection characteristics of earth. Resultant of direct and reflected ray at the receiver. Duct propagation. Ground wave propagation: Attenuation characteristics for ground wave propagation. Calculation of field strength at a distance.

Course outcomes: The expected outcome after learning this course is that a student must be able to understand the concepts of RF Engineering and propagation aspects of RF energy.

Text book

E.C. Jordan and Balmain, "Electro Magnetic Waves and Radiating Systems", PHI.

References:

1. John D. Kraus and Ronalatory Markefka, "Antennas", Tata McGraw-Hill Book Company.

2. R.E. Collins, "Antennas and Radio Propagation", McGraw-Hill.

3. Ballany, "Antenna Theory", John Wiley & Sons, Second Edition.