M.E. (MICROWAVE ENGINEERING)

First Semester

Theory courses

Course No.	Course	L	T	P	Credits
MEC1005	Electromagnetic Interference & Electromagnetic Compatibility	3	0	0	3
MEC1021	Antennas and Diversity	3	0	0	3
MEC1131	Advanced Electromagnetic Engineering	3	1	0	4
	Elective – I	3	0	0	3
	Breadth Paper I	3	0	0	3

List of Electives –

MEC2017	Optical Wireless Communication
MEC1103	VLSI Design and Applications
MEC1019	Microelectronic devices and Circuits
MEC1035	Introduction to Software Defined Radio
MEC1137	Radar Signal Analysis
MEC1041	Satellite Based Wireless Communication

Sessional / Laboratory

MEC1022	Antenna Lab.	0	0	3	2
	Elective – II	0	0	3	2

List of Electives –

MEC1004	VLSI Design Lab.
MEC1006	EMI/EMC Lab

	Total Credits	20.0

Second Semester (Microwave Engg)

Theory Courses:

No.	Title	L T P	Credits
MEC2019	Micro-Electro-Mechanical-Systems	3 0 0	3
MEC2125	Numerical Techniques in Electromagnetics	3 0 0	3
MEC2029	RF Circuit Design	3 1 0	4
	Elective-III	3 0 0	3
	Breadth Paper II	3 0 0	3

List of Electives(Choose any one from the following)

MEC2113	Real Time Embedded System Design
MEC2015	Optical Networking & DWDM
MEC2127	Microwave Integrated Circuits
MEC2137	Wireless Networks
MEC2141	Wireless Signal Propagation & Fading
MEC 2171	Microwave Measurement and Materials Characterization

Sessional Courses:

MEC2026	Computational Electromagnetics Lab	0 0 3	2
	Elective – IV	0 0 3	2

List of Electives(Choose any one from the following)

MEC2014	Embedded System Lab.
MEC2028	Microwave Integrated Circuit Lab

20.0

Third Semester

Course No.	Course	Credits
MEC 3001	Thesis	15

Fourth Semester

Course No.	Course	Credits
MEC3001	Thesis	20

75 Credits

MEC1005 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY

Module -1:

Introduction:

A brief history of EMI/EMC, Analysis of EMI, Type of Noise and Interference, Electromagnetic Compatibility, Radiated Emission and susceptibility, Conducted Emission and Susceptibility, Benefits of good EMC Design, Brief description of EMC regulations, Examples of EMC related problems.

Module -2 :

EMC requirements for Electronic Systems:

Government regulations, Requirement for Commercial products and Military products, Radiated Emission limits for Class A, Class B, FCC and CISPR, measurement of Emissions for verification of compliance: Radiated Emission and Conducted Emissions, Typical product emissions, Additional product requirements, design constraints for products, Advantages of EMC Design.

Module -3 :

Conducted Emission and Susceptibility:

Measurement of Conducted emission: LISN, Common and Differential mode currents, Power supply filters: Basic properties of filters, A generic power supply filter topology, Effect of filter elements on common and differential mode currents, Separation of conducted emissions into common and differential mode components for diagnostic purpose, Power supplies: Linear and SMPS, Effect of Power Supply Components on Conducted emissions, Power Supply and Filter placement, Conducted Susceptibility.

Module -4:

Radiated Emission and Susceptibility:

Simple Emission models for wires and PCB lands: Differential mode versus Common mode currents, Differential mode current emission model, Common mode current emission model, Current probes, Simple susceptibility models for wires and PCB lands: Shielded cables and surface transfer impedance.

Module -5 :

Cross talk:

Three conductor transmission lines and crosstalk, Transmission line equations for lossless lines, The per unit length parameters: Homogeneous versus Inhomogeneous media, Wide separation approximation for wires, Numerical methods for other structures, The Inductive-Capacitive Coupling Approximation model: Frequency domain Inductive-Capacitive coupling model, Time domain Inductive-Capacitive coupling model, Lumped circuit approximate models. Shielded

Wires: Per unit length parameters, Inductive and Capacitive Coupling, Effect of Shield grounding, Effect of pigtails, Effects of Multiple shields, MTL model predictions, Twisted wires: Per unit length parameters, Inductive and Capacitive Coupling, Effects of Twist, Effects of Balancing.

Module -6:

Shielding:

Shielding Effectiveness, Far field Sources: Exact solution, Approximate solution, Near field sources: Near field versus far field, Electric sources, Magnetic sources, Low frequency, magnetic fielding shielding, Effect of Apertures.

Module -7:

System Design for EMC:

Shielding and Grounding, PCB Design, System configuration and design, Electrostatic Discharge, Diagnostic tools.

Text Books:

1. Paul, C., *Introduction to Electromagnetic Compatibility*, John Wiley & Sons, 1992.
2. Kennedy, G., *Electronic Communications Systems*, McGraw-Hill, 1970.
3. Ott, H. W., *Noise Reduction Techniques in Electronic Systems*, John Wiley & Sons, second edition, 1988.

MEC 1021 ANTENNAS AND DIVERSITY

Module -1:

Aperture Antennas:

Radiation Equations, Rectangular Apertures: Uniform Distribution on an infinite ground plane, Uniform distribution in Space, Circular Apertures: Uniform Distribution on an infinite ground plane, Design Considerations.

Module -2:

Antennas for Wireless Communication I:

Helical, Normal mode, Axial mode, Design procedure, feed design for helical antenna, Horn Antenna; E-Plane, H-Plane, Pyramidal horn, Whip antenna, Discone antenna

Module -3:

Antennas for Wireless Communication II:

Microstrip antenna – Basic Characteristics, Feeding Methods, Method of analysis, Transmission line model and cavity model for rectangular patch antenna, Circular Patch Antenna, Inverted F Antenna, Planar Spiral Antenna..

Module -4:

Antenna Arrays:

Two element and N-element arrays, Linear array with uniform, Binomial distribution and Tchebyscheff distribution, Planar array, Phased array, Adaptive arrays.

Module -5:

Diversity Schemes:

Macroscopic diversity scheme, Microscopic diversity scheme – Space diversity, Field diversity, Polarization diversity, Angle diversity, Frequency diversity and time diversity scheme.

Module -6:

Combining Techniques:

Combining techniques for Macroscopic diversity, Combining techniques for Microscopic diversity – Selective combining, Switched combining, Maximal ratio combining, equal gain combining and feed combining technique.

Module -7:

Smart Antenna :

Introduction, Benefits of Smart Antennas, Structures for Beamforming Systems, Strategies for the coverage and Capacity Improvement, Smart Antenna Algorithms.

Text Books:

1. Antenna Theory , Analysis and Design, 2/E, . A. Balanis, John Wiley.

2. Wireless Communications, Principles and Practices, Rappaport, PHI
3. Software Radio A Modern Approach to Radio Engineering, J. H. Reed, Pearson Education.
4. Smart Antenna, T. K. Sarkar

Reference Books:

1. Antennas, J. D. Kraus, TMH
2. Microstrip Antenna Design Handbook, R. Garg, Bhal and Bhartia, Artech House

MEC 1131 ADVANCED ELECTROMAGNETIC ENGINEERING

Module –1 :
Plane Wave Functions I:
The Wave Functions, Plane Waves, Rectangular Waveguide, Alternative Mode Sets, The Rectangular Cavity.

Module –2 :
Plane Wave Functions II:
Partially Filled Waveguide, Dielectric Slab Waveguide, Surface Guided Waves, Modal Expansion of Fields.

Module –3 :
Cylinderical Wave Functions I:
The Wave Functions, Circular Waveguide, Radial Waveguides, Circular Cavity, Other Guided Waves.

Module –4 :
Cylinderical Wave Functions II:
Sources of Cylindrical Waves, Two Dimensional Radiation, Wave Transformations, Scattering by Cylinders.

Module –5 :
Spherical Wave Functions I:
The Wave Functions, Spherical Cavity, Orthogonality Relationships, Space as a Waveguide.

Module –6:
Spherical Wave Functions II:
Other Radial Waveguides, Other Resonators, Sources of Spherical Waves, Wave Transformations, Scattering by Spheres.

Module –7:
Perturbational and Variational Techniques:
Perturbation of Cavity Walls, Cavity Material Perturbations, Waveguide Perturbations, Stationary Formulas for Cavities.

Text Books:

1. Time Harmonic Electromagnetic Fields; By Roger F. Harrington; McGraw Hill Book Company; 1961.

Reference Books:

1. Foundations for Microwave Engineering; Second Edition; By Robert E. Collin; McGraw Hill International Edition; 1992.
2. Microwave Engineering; Second Edition; by David M. Pozar; John Wiley & Sons; Inc. Copyright 2001.

MEC2017 OPTICAL WIRELESS COMMUNICATION

Module-1:

Introduction to optical wireless communication, Optical Wireless channels, Light sources, Modulators, Detector, Atmospheric transmission limitations, Effect of Rain, Fog, and Mist, Scintillation.

Module-2:

Geometrical Optics and Ray Tracing. Optical Path Length and Fermat's Principle. The Etendue or Lagrange Invariant. The Edge Ray Principle, Ray Matrices, Gaussian Beam, Telescope, beam expander, Optical filter and anti reflection coating.

Module-3:

Overview of Optical Concentrators. Wireless IR Receiver Requirements, DTIRC Characteristics. Comparison of Concentrators. Practical Issues. Other Shapes of DTIRCs. Tracking system, Laser beam steering device.

Module-4:

Optical Wireless Transmitter Design, Transmitter Design Considerations, Optical Source Characteristics. Types of Optical Modulation. Driver Circuit Design Concepts. Current Steering Output Circuit, Back Termination Circuit, Predriver, Data Retiming, Automatic Power Control, Transmitters Linearization Techniques.

Module-5:

Optical wireless receiver design, Receiver Design Considerations, Photodetection in Reverse-biased Diodes. Choosing the Photodetector, Receiver Noise Consideration, Bit Error Rate and Sensitivity, Bandwidth, Signal Amplification Techniques, Receiver Main Amplifier (RMA). Transceiver Circuit Implementation Technologies:

Module-6:

Modulation and Multiple Access Techniques, Modulation Techniques Comparison. Modulation Schemes in the Presence of Noise, Modulation Schemes in the Presence of Multipath Distortion. Multiple Access Techniques.

Module-7:

IrDA PROTOCOLS. Wireless Protocol Standards. The Infrared Data Association. IrDA Standard Overview. The Physical Layer Protocol. Framer/Driver. IrLAP. IrLMP. Information Access Service and Protocol. Tiny Transport Protocol. Session and

Application Layer Protocols. WIRELESS IR NETWORKING. Introduction to Wireless IR Networking. Network Architecture. Optical Wireless Network Specifications. The Ad Hoc Network. Quality of Service (QoS). MIMO Wireless optical channel, Pixelated Wireless optical channel, Future Infrared Networking.

Text Books:

1. "Optical and Wireless Communications", Sadiku, Matthew N. O. CRC Press
2. "Optical Wireless Communications: IR for Wireless Connectivity" Ramirez-Iniguez, Roberto Idrus, Sevia M., Auerbach Publications.

Ref. Books:

1. "Microwave Photonics", Chi Lee, CRC Press, 2006.
2. "Wireless Optical Communication Systems" Steve Hranilovic, Springer.

MEC 1103 VLSI DESIGN AND APPLICATIONS

Module -1:

Introduction to VLSI:

Fundamental of VLSI, CMOS Devices Modeling, Simple MOS Large Signal Model (SPICE) Parameters, Small Signal Model for the MOS Transistor, Computer Simulation Model, Sub threshold MOS Model, MOS Switch, MOS Diode/ Active resistor, Current Sink and Sources, Current Mirrors, Current and Voltage Reference, Bandgap Reference, Differential Amps, Cascode Amps, Current Amps.

Module -2:

CMOS Operational Amplifiers and Comparators:

Design of CMOS Op Amps, Compensation of Op Amps, Design of Two stage Op Amps, Power Rejection Ratio of Two Stage Op Amps, Cascode of Op Amps, Buffered Op Amps, High Speed/ Frequency Op Amps, Differential Output Op Amps, Micro Power Op Amps, Low Noise and Low Voltage Op Amp, Characteristics of Comparator, Two stage Open Loop Comparators, Discrete Time Comparators, High Speed Comparators.

Module -3:

Switched Capacitor Circuits, D/A and A/D:

Switched Capacitor Circuits, Amplifiers and Integrators, Two Phase Switched Capacitor Circuits, First and Second Order Switched Capacitor Circuits, Switched Capacitor Filters, Comparative study of D/A, Parallel and Serial Digital Analog Converters, Serial Analog-Digital Converter, Medium, High Speed Analog-Digital Converter, Over sampling Converter.

Module -4:

Layout Design of CMOS Cell:

Schematic and Layout Design of Basic Gates and Universal Gates & Flip-Flop, Layout Representation, CMOS-N-Well Rules, Design Rules, Backgrounder, Layout Assignments, Latch-Up Problems, Analogue Design Layout Considerations, Transistor Design, Centroid Design, Capacitor Matching, Resistor Layout, Noise Considerations.

Module -5:

VLSI Design Issues:

Design Captures Tools, HDL Design, Schematic Design, Layout design, Floor planning, Chip Composition, Design Verification Tools, Circuit Level Simulation, and Logic Level Simulation, Mixed Mode Simulators. Timing Verification, Network Isomorphism, Netlist Comparison, Layout Extraction, Back Annotation, Design Rule Verification, Pattern

Generation, Data Sheets, Pin-out, Description Operation, DC Specification, AC Specification, Package Diagram.

Module –6 :

Digital Subsystem Design:

Design of Universal Gate using Pseudo-nMOS Logic, Clocked CMOS Single Bit Adder, Parallel Adder, Transmissions Gate Adders, Carry Look Ahead Adders, Other High Speed Adders, Multipliers, Asynchronous Counter, Synchronous Counter, SRAM Arrays, DRAM, ROM Array, Finite Stets Machines, Multilevel Logic.

Module –7 :

Design Economics and Testing:

NRE's, Engineering Costs, Prototype Manufacturing Cost, Recurring Costs, Fixed Costs , Schedule , Processor Example, Need for Testing, Functionality Tests, Manufacturing Tests, Manufacturing Tests Principles, Fault Modules, Struck-at-Faults, SC and OC Faults, Observability, Controllability, Fault Coverage, ATPG, Delay Fault, Testing, Scan Based Techniques, BLIBO, IDDQ Testing.

Text Books:

1. "CMOS Analog Circuit Design" by Phillip E. Allen Douglas R. Holberg, Second Edition.
2. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi.
3. Analogue Integrated Circuit Design, John. D. and Mortin K, John Wiley and Sons, 1997.
4. Principle of CMOS VLSI Design A System Prospective, Weste Neil, H E & Eshtaghian K, Pearson Edu. 1993.
5. Digital Integrated Circuit Design, Ken Martin, Oxford University Press, 2000.
6. "Introduction to VLSI Circuits and Systems" by John P. Uyemura, Willey Student Addition.

Reference Book:

1- "CMOS Digital Logic Design with VHDL & Verilog (Theory & Practical)," by Vijay Nath, ACM Learning, New Delhi, 2011.

MEC1019 MICROELECTRONIC DEVICES AND CIRCUITS

Module –1:
Introduction to IC Technology, Overview of MOS and BJT, Threshold Voltage, Body effect, basic DC equations, 2nd order Effect, MOS model, small-signal AC characteristics, CMOS inverter and its DC characteristics, static load MOS inverter, Silicon semiconductor technology, wafer processing, oxidation, epitaxy, deposition, ion implantation, CMOS technology, N-Well and P-Well process and SOI.

Module –2:
Fault Modeling and Simulation, Testability, Analysis Technique, Ad-hoc Methods and General guidelines, Scan Technique, Boundary Scan, Built in Self Test Analog Test Buses, Design for Electron Beam Testability, Physics of Interconnects in VLSI, Scaling of Interconnects, A Model for Estimating Wiring Density, A Configurable Architecture for Prototyping Analog Circuits.

Module – 3:
Mixed signal VLSI chip basic CMOS circuits, CMOS gate transistor sizing, Power Dissipation, Scaling of MOS Transistor Dimension, MOSFET and BJT Current Mirrors and its applications, Basic Gain Stage, Gain boosting techniques, Super MOS transistor, Primitive analog cell, Linear voltage – current converters, MOS multipliers and resistors, CMOS Bipolar and low voltage, BiCMOS, Op- Amp Design, Instrumentation Design, and Low Voltage Filter, BJT and MOS current mirror circuits and its applications.

Module –4:
CMOS Logic gate design, Fan-in and Fan-out, typical NAND and NOR delays, Transistor sizing, CMOS logic structure, DC analysis of Complementary Logic, BiCMOS logic, Pseudo NMOS, dynamic CMOS logic, Clocked CMOS logic, Pass transistor, CMOS Domino Logic, NP domino logic, Cascode voltage switch logic, source-follower pull-up logic (SFPL), clocking strategy and IO structure.

Module – 5:
Single-ended and differential operations, Basic differential pair: qualitative analysis and quantitative analysis, Common mode response, Differential pair with MOS loads, Gilbert Cell. General considerations, performance parameters, One-stage Op Amps, two-state Op Amps, Gain boosting, comparison, Common mode feed back, Input range limitations, Slew Rate, Power supply rejection, Noise in Op Amps,Operational Transconductance Amplifier(OTA) and its applications.

Module – 6:
Review of Statistical Concepts, Statistical Device Modeling, Statistical Circuit Simulation, Automation, Analog Circuit Design, Automatic Analog Layout, CMOS Transistor Layout, R and C Layout, Analog Cell Layout, Mixed Analog - Digital Layout

Module – 7:

Introduction to Circuit Modeling Tools, Circuit Descriptions, DC Circuit Analysis, AC Circuit Analysis, Transient Analysis, Advance SPICE Command and Analysis, Diode, JFET and MOSFET (Model, Statement and Parameter).

TEXT BOOKS:

1. Randoll L. Geiger, Phillip E. Allen, Noel K. Strader "VLSI Design Techniques for Analog and Digital Circuits", Mc Graw Hill International company, 1990.
2. Malcom R. Haskard, Lan C May, "Analog VLSI Design NMOS and CMOS", Prentice Hall, 1998.
3. R. Jacob Baker, Harry W. LI., & David K. Boyce., "CMOS Circuit Design". 3rd Indian reprint, PHI, 2000.
4. Microelectronic Circuits, 5th Edition, by Adel S. Sedra and Kenneth C. Smith, Oxford University press, 2004.
5. Philip E. Allen Douglas and R. Holberg, "CMOS Analog Circuit Design", Second Addition Oxford University Press-2003.
6. Fundamentals of Microelectronics, 1st Edition, by Behzad Razavi, Wiley Press, January 2008.
7. M.H Rashid, SPICE for Power Electronics and Electric Power, Englewood. Cliffs, N.J. Prentice Hall, 1993.
8. PSPICE Manual, Irvine, Calif: - Micro Sim Corporation, 1992.

MEC 1035 INTRODUCTION TO SOFTWARE DEFINED RADIO

Module - 1:

Introduction to Software radio concepts :

Introduction, need, characteristics, benefits and design principles of Software Radios. Traditional radio implemented in hardware (first generations of 2G cell phones), Software controlled radio (SCR), Software defined radio (SDR), Ideal software radio (ISR), Ultimate software radio (USR)

Module -2:

Radio frequency implementation issues :

The purpose of RF Front-End, Dynamic range, RF Receiver Front-End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of Components to Overall performance, Transmitter Architecture and their issues, Noise and Distortion in RF Chain.

Module -3:

Digital generation of signals:

Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious Components due to Periodic Jitter.

Module- 4:

A/D & D/A Conversion :

Introduction, Parameters of Ideal Data Converters, Parameters of Practical data Converters, Techniques to improve Data Converter performance, Complex ADC and DAC Architectures.

Module- 5:

Multirate Signal Processing:

Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multirate Digital Filters.

Module -6:

Antennas & Antenna Arrays:

Introduction, Benefits of Smart Antennas, Structures for Beamforming Systems, Smart Antenna Algorithms.

Module -7:

Case study in Software radio design:

Introduction, SPEAKeasy, JTRS.

Text Book:

1. Software Radio: A Modern Approach to radio Engineering, Pearson Education Asia, Jeffrey H. Reed

MEC 1137 RADAR SIGNAL ANALYSIS

Module -1 :

Radar equation, MDS, detection of signal in noise, Receiver noise and signal to noise ratio, prediction of radar range.

Module -2:

Probability density functions, probabilities of detection and false alarm rate, integration of radar pulses, radar cross section of targets, radar cross section fluctuations.

Module -3:

Detection of radar signals:

matched filter, correlation receiver, detection criteria, detectors, integrators and CFAR receivers.

Module -4:

Information from radar signals:

basic radar measurements, theoretical accuracy, ambiguity diagram, pulse compression, target recognition.

Module -5:

Radar clutter :

surface clutter radar equation, land clutter, sea clutter, statistical model for surface clutter, detection of targets in clutter.

Module -6:

Estimation of signals in noise, linear mean square estimation, maximum likelihood estimation, Bays estimators of parameters of linear systems.

Module -7:

Propagation of radar waves:

Forward scattering from earth, scattering from round earth surface, atmospheric refraction, standard and non standard propagation.

Text Book :

1. M.I. Skolnik, "Introduction to Radar Systems" 3/e, TMH, New Delhi, 2001

MEC 1041 SATELLITE BASED WIRELESS COMMUNICATION

Module -1:

Introduction to Satellite Communications:

Origin, History, Current Technology State and Overview of Satellite System Engineering

Module -2:

Orbital Aspects of Earth Satellites:

Orbital Mechanics and Orbital Elements, Azimuth and Elevation, Coverage Angle and Slant Range, Placement of a Satellite in a Geostationary Orbit.

Module -3:

Satellite Link Design:

Basic Radio Transmission Theory, System Noise Temperature and G/T Ratio, Uplink and Downlink Design, Interference Analysis, Carrier-to-Noise plus Interference Ratio, Interference to and from Adjacent Satellite Systems, Terrestrial Interference, Cross-polarization Interference, Intermodulation Interference, Design of Satellite Links for Specified Carrier-to-Noise plus Interference Ratio, Digital Satellite Link.

Module -4:

Propagation on Satellite-Earth Paths and Its Influence on Link Design:

Absorbitive Attenuation Noise by Atmospheric Gases, Rain Attenuation, Noise due to Rain, Rain Depolarization, Tropospheric Multipath and Scintillation Effects.

Module -5:

Multiple Access Techniques in Satellite Communications:

Frequency Division Multiple Access, FDMA, SCPC, MCPC. Time Division Multiple Access, TDMA: random (ALOHA, S-ALOHA) and time synchronized access. Code Division Multiple Access, CDMA, Fixed and On-demand Assignment.

Module -6:

Satellite Networking:

Advantages and Disadvantages of Multibeam Satellites, Interconnection by Transponder Hopping, Interconnection by On-board Switching, Interconnection by Beam Scanning, On-Board Processing, Intersatellite Links.

Module -7:

Types of Satellite Networks:

Fixed Point Satellite Network, INTELSAT, Mobile Satellite Network, INMARSAT, Low Earth Orbit and Medium Earth Orbit Satellite Systems, Very Small Aperture Terminal (VSAT) Network, Direct Broadcast Satellite Systems, Global Positioning System.

Text Books:

1. Digital Satellite Communications, 2/e, McGraw-Hill, 1990.Tri T. Ha
2. Satellite Communications, John Willey and Sons, 2000T. Pratt, C.W. Bostian
3. Satellite Communications Systems Engineering, Pearson Education, 2/e; 2003 W.L. Prichard, H.G. Suyderhoud and R.A. Nelson

MEC 2019 MICRO-ELECTRO-MECHANICAL-SYSTEMS

Module -1:

Micro electromechanical systems:

Introduction, MEMS Overview, Microfabrication of MEMS: Surface Micromachining, Bulk Micromachining, LIGA, micromachining of polymeric MEMS devices

Module -2:

Fundamentals MEMS Device Physics:

Actuation: Electrostatic Actuation, Piezoelectric Actuation, Thermal Actuation ,Magnetic Actuation, Mechanical Vibrations ,The single degree of Freedom System ,The many Degrees of freedom system, Microsensing for MEMS: Piezoresistive sensing, Capacitive sensing, Piezoelectric sensing, Resonant sensing, Surface Acoustic Wave sensors.

Module -3:

MEMS Materials and fabrication process Modelling:

Metals, semiconductors, thin films for MEMS and their deposition techniques, materials for polymer MEMS. Solid modeling:Numerical Simulation of MEMS, Mechanical Simulation, Electrostatic Simulation .

Module -4:

MEMS Switches :

Switch parameters, basics of switching, Switches for RF and microwave applications, actuation mechanisms for MEMS devices, dynamics of switch operation, MEMS switch design considerations, Microwave Considerations, Material Consideration, Mechanical Considerations modeling and evaluation.

Module -5:

MEMS Inductors and Capacitors :

MEMS Inductors: self and mutual inductance, micromachined inductors, , modeling and design issues of planar inductors, variable inductor and polymer based inductor. MEMS Capacitors: MEMS gap tuning capacitor, MEMS area tuning capacitor, Dielectric Tunable capacitors.

Module -6:

MEMS RF applications :

Mems based RF and Microwave circuits : RF Filters, Micromachined Phase shifters, and Micromachined antenna.

Module -7:

MEMS packaging :

MEMS packaging: Role of MEMS packaging, Types of MEMS packaging,Microwave packaging Considerations, Wafer level packaging

Text Books:

1. RF MEMS & Their Applications by Vijay K. Varadan, K. J. Vinoy and K. A. Jose John Wiley & Sons, 2003
2. Introduction to Microelectromechanical Microwave Systems(2^{nd} Edition) by Hector J.De Los Santos,Artech house
3. RF MEMS: Theory, Design, and Technology, Gabriel M. Rebeiz, John Wiley & Sons, 2003.

Reference Books:

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," McGraw-Hill, 1st edition, ISBN: 0072393912.
2. Mems Mechanical Sensors Microelectromechanical system series Srephen Beeby/Artech House

MEC 2125 NUMERICAL TECHNIQUES IN ELECTROMAGNETICS

Module -1:

Introduction:

Need for Numerical Solution of Electromagnetic problems, Selection of a numerical method, Classification of Electromagnetic problems, Classification of Solution Region, Classification of Boundary Conditions.

Module -2:

Finite Difference (FD) Methods:

Introduction, FD schemes for parabolic, hyperbolic & Elliptical partial differential equations, solving the Laplace, diffusion and wave equations by FD method. Application to Guided structures: microstrip line and rectangular waveguide.

Module -3:

Finite Difference Time Domain (FDTD) Methods:

Yee's FD algorithms, Accuracy & stability, Lattice truncation condition, Initial fields, Absorbing Boundary conditions for FDTD, Scattering problems.

Module -4 :

Integral Equations:

Classification of Integral Equations, Relation between Differential and Integral Equations, Green's function: definition, Green's function for free space.

Module -5:

Method of Moments (MoM):

Solution of integral equations using MoM, Quasi-static problems (thin conducting wire, parallel plate capacitor), Dipole antenna current distribution & input impedance, mutual impedance of two short dipoles, Scattering from a dipole antenna.

Module -6:

Finite Element Method:

Finite Element Discretization, Element Governing Equations, Assembling of all Elements, Solving the resulting equations, Typical Applications.

Module -7:

Monte Carlo (MC) methods:

Introduction, Fixed and Floating Random Walks, Markov Chains, Solving typical electromagnetic Problems with random walk and Markov chain methods.

Text Books:

1. Numerical Techniques in Electromagnetics Mathew N. O. Sadiku (CRC Press)
2. Analytical and Computational Methods in Electromagnetics, Ramesh Garg, Artech House, 2008.

MEC 2029 RF CIRCUIT DESIGN

Module -1:

Introduction:

Importance of RF Design, RF Behavior of Passive Components: High Frequency Resistors, High-Frequency Capacitors, High-Frequency Inductors. Chip Components and Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface-Mounted Inductors.

Module -2:

An Overview of RF Filter Design I:

Basic Resonator and Filter Configurations: Filter Type and Parameters, Low-Pass Filter, High Pass Filter, Bandpass and Bandstop Filters, Insertion Loss, Special Filter Realizations: Butterworth –Type, Chebyshev and Denormalization of Standard Low-Pass Design.

Module -3:

An Overview of RF Filter Design II:

Filter Implementations: Unit Elements, Kuroda's Identities and Examples of Microstrip Filter Design. Coupled Filter: Odd and Even Mode Excitation, Bandpass Filter Section, Cascading Bandpass Filter Elements, Design Examples.

Module -4:

Matching and Biasing Network:

Impedance Matching using Discrete Components: Two Component Matching Networks, Forbidden regions, Frequency Response and Quality Factor, Microstrip Line Matching Networks: From Discrete Components to Microstrip Lines, Single-Stub Matching Networks, Double-Stub Matching Networks, Amplifier Classes of Operation and Biasing Network: Classes of Operation and Efficiency of Amplifiers, Bipolar Transistor Biasing Networks, Field Effect Transistor Biasing Networks.

Module -5:

RF Transistor Amplifier Design I:

Characteristics of Amplifiers, Amplifier Power Relations: RF source, Transducer Power Gain, Additional Power Relations, Stability Considerations: Satbility Circles, Unconditional Stability, Stabilization Methods.

Module -6:

RF Transistor Amplifier Design II:

Constant Gain: Unilateral Design, Unilateral Figure of Merit, Bilateral Design, Operating and Available Power Gain Circles. Noise Figure Circles, Constant VSWR Circles. Broadband, High Power and Multistage Amplifiers.

Module -7:

RF Oscillators and Mixers:

Basic Oscillator Model: Negative Resistance Oscillator, Feedback Oscillator Design, Design Steps, Quartz Oscillators. High Frequency Oscillator Configuration: Fixed Frequency Oscillators, Dielectric Resonator Oscillators, YIG-Tuned Oscillators, Voltage Controlled Oscillators, Gunn Element Oscillator. Basic Characteristics of Mixers: Basic Concepts, Frequency Domain Considerations, Single-Balanced Mixer Double-Balanced Mixer.

Text Book :

1. RF Circuit Design Theory and Application, Reinhold Ludwig and Pavel Bretchko, Ed. 2004, Pearson Education

MEC2113 REAL TIME EMBEDDED SYSTEM DESIGN

Module -1:

Introduction to Embedded Systems:

Embedded system overview, Design challenges, Common design metrics, Time-to-market design metric, NRE and unit cost design metrics, Performance design metric, Processor technology, General purpose processors – software and hardware, Application specific processors, IC technology, Semi-custom ASIC.

Module – 2:

Embedded System Processors:

Combinational logic and transistors, RT-level combinational and sequential components, Custom single purpose processor design. RT-level custom single– purpose processor design, Optimization, Optimization of FSMD, Optimization of data path.

Module-3:

Memory:

Write ability and data permanence, memory devices type of memory and basic form, EEPROM, flash memory, SRAM and DRAM, basic DRAM characteristics, memory selection for embedded systems, allocation of memory to the program segment blocks.

Module – 4:

Device and Interrupt service:

Bus models, time multiplexed bus, strobe and handshake protocols, strobe handshake compromise priority arbiter multilevel bus, and architecture.

Module -5:

Embedded System Peripherals:

Timers, Counters, Watch-dog timers, Example of reaction timer, Watchdog timer, UART, PWM, Controlling a dc motor using a PWM. General purpose processor, ASIP's and ASIC's, semiconductor IC's programmable logic devices of CGD, Processor selection for embedded systems, special purpose processor.

Module – 6:

Interfacing:

Communication basics, Basic protocol concepts, ISA bus protocol, Microprocessor interfacing, I/O addressing, Interrupts, Example of DMA I/O and ISA Bus protocol, Arbitration, Priority arbiter, Daisy-chain arbiter, Parallel, Serial and Wireless

communication, infrared-TRDA, radio frequency, error detection, CAN, USB, Blue tooth, IEEE 802-II, shared memory models

Module – 7:

Digital Camera and Systems:

Simple digital camera, User's perspective, Designer's perspective, Requirement specification, Design, Micro controller alone, Micro controller and CCDPP Digital thermometer, handhold computer, navigation system, IP phone, software defined-radio, smart card.

Text Book:

1. "Embedded System Design A Unified HW.SW Introduction", by Vahid G Frank and Givargis Tony, John Wiley & Sons, 2002.
2. "Embedded Systems Architecture, Programming and Design", by Raj Kamal, TMH-2003

Reference Book:

1. "Fundamental of Embedded System Design & Applications" by Vijay Nath, K.S. Yadav, L.K. Singh, ACM Learning, New Delhi.
2. Introduction to Embedded Systems, K. Shibu, TMH Edition.

MEC 2015 OPTICAL NETWORKING AND DWDM

Module-1:

Optical Network Elements:

Passive Components, 2x2 fiber couplers, Scattering Matrix representation, star Couplers, Mach-Zehnder multiplexers, Phase-array-based WDM devices, Fiber Grating, Tunable Sources, Tunable filters, Circulators, Isolators, Wavelength Converters, Switching Elements, Wavelength Routers.

Module-2:

Optical Amplifiers:

Types, Semiconductor Optical Amplifiers, Erbium doped fiber amplifier, amplification mechanism, Conv. efficiency, Gain, Noise, Applications, Power amplifiers, In-line amplifiers, Preamplifiers, Application to Optical Video distribution, Long Span Transmission, Repeaterless Transmission, Under Sea Transmission system.

Module -3:

Optical Networks:

Topological performance, SONET/SDH, Broadcast and select WDM networks, Single-hop networks, Multi-hop Networks, Testbeds.

Module -4:

Wavelength Routed networks, Wavelength Routing Testbeds, Nonlinear effects on network performances, SRS,SBS,SPM,XPM,FWM, Optical CDMA networks.

Module -5:

Dispersion Management:

Need for dispersion management, pre-compensation and post compensation technique, Broadband dispersion compensation, Tunable dispersion compensation, Higher order dispersion management, PMD compensation.

Module-6:

Optical Switching:

Photonic packet switching, Bit interleaving, Packet interleaving, OTDM Testbeds.

Module-7 :

Soliton communication:

Solitons, Soliton Pulses, Soliton parameters, Transmission for ultrafast (UF) OTDM signal using Soliton.

Text Book:

1. Optical Fiber Communications"G.Keiser,3/E, McGraw Hill.

Referece Books:

1. B.Mukherjee , Optical Communication Networks, McGraw Hill.
2. R. Ramaswami and K.N. Sivarajan, Optical Networks: A Practical Perspective, Morgan Kaufmann
3. G.P.Agrawal, Fiber Optic Communication Systems, John Wiley & Son (Asia) Pvt. Ltd.
4. J. H. Franz & V. K. Jain, Optical Communications, Narosa Publishing House.

MEC 2127 MICROWAVE INTEGRATED CIRCUITS

Module -1:

Introduction to Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices. Microstrips on semiconductor substrates.

Module -2:

Planar transmission lines for MICs. Method of Conformal transformation for microstrip analysis, concept of effective dielectric constant, Effective dielectric constant for microstrip, Losses in Microstrip.

Module -3:

Slot Line Approximate analysis and field distribution, Transverse resonance method and evaluation of slot line impedance, comparison with microstrip line.

Module -4:

Fin lines & Coplanar Lines. Introduction, Analysis of Fin lines by Transverse Resonance Method, Conductor loss in Fin lines . Introduction to coplanar wave guide and coplanar strips.

Module -5:

Lumped Elements for MICs:

Use of Lumped Elements, Capacitive elements, Inductive elements and Resistive elements,

Module -6:

Microwave Solid – State Active Devices for MICs:

Schottky Barrier diode, Pin diode, Varactor diode – structure , characteristics , operation, equivalent circuit , gain expression and output power efficiency and applications. Bipolars, MESFETs and HEMTs

Module -7:

MIC Measurement,Testing and Applications:

MIC measurement system, measurement techniques – S parameter measurement, noise measurement, MIC applications.

Text Book:

1. Microwave Integrated circuit, K. C. Gupta.
2. Microwave Devices & Circuits 3/e, Samuel Y. Liao.
3. Microstrip lines and Slot lines, K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, Boston, 1996.

Reference Books:

1. Stripline-like Transmission lines for Microwave Integrated circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd., New Delhi.
2. Microwave Integrated Circuits, By Ivan Kneppo, J. Fabian, P. Bezousek

MEC 2137 WIRELESS NETWORKS

Module -1

Wireless Personal Area Networks:
Bluetooth-IEEE 802.15.1: Bluetooth Protocol Stack, Bluetooth Link Type, Bluetooth Security. Network Connection establishment in Bluetooth
ZigBee Technology: ZigBee Components & Network Topologies
Ultra Wideband-IEEE 802.15.3a

Module -2:

Wireless Local Area Networks:
WLAN Technologies, Protocol architecture, Physical layer, Data link layer, Medium access control layer, Interference between Bluetooth and IEEE 802.11, Security of 802.11 systems

Module -3:

Wireless Wide Area Networks:
GSM Evolution for data, 3G Wireless Systems, cdmaOne Evolution, Evolution of cdmaOne to cdma2000 & Differences between cdma2000 & WCDMA.

Module -4:

TCP over wireless network:
Overview of traditional TCP, Impact on the performance of TCP over wireless environment, Link Layer Scheme (Snoop Protocol), The I-TCP protocol, The mobile TCP protocol .

Module -5

IPv6:
IPv4 vs. IPv6, IPv6 addressing, IPv6 header format, IPv6 extension, IPv6 routing architecture, QoS capabilities, IPv6 transition mechanism

Module -6 :

Mobile IP:
Mobile IP: New architecture entities, Operation of Mobile IP, Message Format, Agent Discovery, Agent advertisement, Registration, Authentication, Route optimisation, Mobility support for IPV6

Module -7:

Wireless ATM:
WATM services, Reference model, Functions, Radio access layer, Handover, Location management, Access Point Control Protocol.

Text Book:
1. Wireless Communication & Networking by Vijay K. Garg, Elsevier
Reference Books:
1. Mobile communication by J.Schiller, Pearson Education
2. FOROUZAN----------
3. www.ietf.org
   (i) rfc 3513.txt : IPv6 addressing architecture
   (ii) rfc 2460.txt : IPv6 specification

MEC2141 Wireless Signal Propagation and Fading

Module-1

Radio Propagation and Path Loss Models

Free space attenuation, attenuation over reflecting surface, effects of earth curvature, radio wave propagation, propagation path loss models (Okumura model, Hata model, COST 231 model), indoor propagation models.

Module-2

Statistical Multipath Channel Models

Time varying channel impulse response, characteristics of wireless channels, signal fading statistics (Rician distribution, Rayleigh distribution, Lognormal distribution) level crossing rate and average duration of fades, wideband fading models (power delay profile, coherence bandwidth, Doppler spread).

Module-3

Capacity of Wireless Channels

Capacity in AWGN, Capacity of flat fading channels, capacity of frequency selective channels, time invariant channels, time varying channels.

Module-4

Adaptive Modulation and Coding

Adaptive transmission systems, adaptive techniques (variable rate technique, variable power, variable error probability, variable coding technique, hybrid techniques.

Module-5

Diversity and Equalization Techniques

Realization of independent fading paths, receiver diversity, transmitter diversity, equalizer noise enhancements, equalizer types, folded spectrum and ISI free transmission, linear equalizers, adaptive equalizers.

Module-6

Multicarrier Modulation

Data transmission using multiple carriers, mitigation of subcarrier fading, discrete implementation of multicarrier modulation, OFDM, challenges in multicarrier modulation.

Module-7

Multiple Antennas and Space Time Communications

MIMO channel capacity, MIMO diversity gain, Beam forming, diversity-multiplexing trade-off, space time modulation and coding, frequency selective MIMO channel, smart antennas.

Text Book

1. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

Reference Books

1. Vijay K Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).
2. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Pearson Education, Delhi, 2005.

MEC 2171 Microwave Measurement and Materials Characterization

Module -1:

Electromagnetic Properties of Materials:

Materials Research and Engineering at Microwave Frequencies, Physics for Electromagnetic Materials ,General Properties of Electromagnetic Materials, Intrinsic Properties and Extrinsic Performances of Materials

Module -2:

Reflection Methods:

Introduction, Coaxial-Line Reflection Method, Free-Space Reflection Method, Measurement of Both Permittivity and Permeability Using Reflection Methods, Surface Impedance Measurement.

Module -3:

Transmission/Reflection Methods:

Theory for Transmission/Reflection Methods , Coaxial Air-Line Method ,Hollow Metallic Waveguide Method, Surface Waveguide Method , Free-Space Method, Transmission/Reflection Methods for Complex Conductivity Measurement

Module -4:

Resonator Methods:

Introduction, Dielectric Resonator Methods, Coaxial Surface-Wave Resonator Methods, Split-Resonator Method, Dielectric Resonator Methods Measurement for Surface-Impedance

Module -5:

Resonant Perturbation Methods:

Basic Theory, Cavity-Perturbation Method, Dielectric Resonator Perturbation Method, Measurement of Surface Impedance.

Module -6:

Planar-Circuit Methods:

Introduction, Stripline Methods, Microstrip Methods, Coplanar-Line Methods

Module -7:

Measurement of Permittivity and Permeability Tensors:

Introduction, Measurement of Permittivity Tensors, Measurement of Permeability Tensors, Measurement of Ferromagnetic Resonance, Measurement of Ferromagnetic Materials.

Text Book :

1. Microwave Electronics: Measurement and Materials Characterization, L. F. Chen, C. K. Ong, C. P. Neo, V. V. Varadan, Vijay K. Varadan, John Wiley , ISBN: 978-0-470-84492-2