Course Structure &Syllabus
of
M. Tech. Programme
in

Electronics & Telecommunication Engineering
with Specialization
RF & MICROWAVE ENGINEERING
Academic Year –2019- 20

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, ODISHA
Burla, Sambalpur-768018, Indiawww.vssut.ac.in

VISION

To be recognized as a center of excellence in education and research in the field of Electronics & Telecommunication Engineering by producing innovative, creative and ethical Engineering professionals for socio-economic upliftment of society in order to meet the global challenges.

MISSION

Electronics &Telecommunication Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1. Maintaining state of the art research facilities to provide conducive environment to create, analyze, apply and disseminate knowledge.

M2. Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfill 'Make In India' policy of the Government.

M3. Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PROGRAM EDUCATIONAL OBJECTIVES

The educational objectives of Electronics &Telecommunication Engineering of VSSUT, Burla are to prepare its graduates:

1. To acquire competency in solving real-life problems and to design/develop sustainable and cost effective products according to the prevailing socio-economic context.
2. To make them enable to excel in their professional career/entrepreneurial skill/research and higher studies.
3. To provide opportunity to work and communicate effectively in a team and to engage in the process of life-long learning.

PEO-MISSION MATRIX

	M1	M2	M3
PEO1	3	1	1
PEO2	1	3	2
PEO3	2	3	3

PROGRAM OUTCOMES

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. An ability to demonstrate a degree of mastery over RF and Microwave engineering which is at a level higher than the requirements in the undergraduate program in electronics and telecommunication engineering.

4. To apply modern engineering tools for solving complex engineering problems in this field.
5. Have an effective communication with the engineering community regarding engineering activities related to the field.
6. Practice professional code of conduct, ethics of research and to contribute to the community for overall development of society.

PROGRAM SPECIFIC OUTCOMES

1. Graduates will be able to design and implement devices, systems, different high frequency transmission line, wave propagation models for communication systems.
2. Achieve technical skills necessary to enter careers in design, installation, testing in the field of RF and Microwave engineering.

COURSE STRUCTURE

SemesterI

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-I	MECRF101	RF IC	3	0	0	3
2	Core-II	MECRF102	Radio Wave Engineering	3	0	0	3
3	PE-I			3	0	0	3
4	PE-II			3	0	0	3
5	Common		Research Methodology & IPR	3	0	0	3
6	Lab-I	MECRF103	Microwave Engg. Lab I	0	0	3	2
7	Lab-II	MECRF104	Computational Electromagnetic Lab	0	0	3	2
8	Audit -I		English for Research Paper Writing				
Total Credits							19

SemesterII

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-III	MECRF201	RF & Microwave Solid State Device	3	0	0	3
2	Core-IV	MECRF202	Microstrip Components & Circuits	3	0	0	3
3	PE-III			3	0	0	3
4	PE-IV			3	0	0	3
5	Common		Term Paper	0	0	4	2
6	Lab-III	MECRF203	Antenna & Simulation Lab	0	0	3	2
7	Lab-IV	MECRF204	Microwave Engg. Lab II	0	0	3	2
8	Audit -II		Pedagogy Studies				
Total Credits							18

SemesterIII

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-V			3	0	0	3
2	OE-I			3	0	0	3
3	Minor Project		Project Progress Report	0	0	20	10
Total Credits							16

SemesterIV

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Major Project		Project & Thesis	0	0	32	16
Total Credits							16

List of Professional Elective			
Sl. No.	Category	Course Code	Subject Name
1	PE-I	MRFPE101	Computational Electromagnetics
2		MRFPE102	Advanced Signal Processing
3		MRFPE103	Advanced Electromagnetics
1	PE-II	MRFPE104	Microwave Circuits & Measurements
2		MRFPE105	MIC & MMIC
3		MRFPE106	Advanced Communication Technique
1	PE-III	MRFPE201	Advanced Antenna Technology
2		MRFPE202	Smart Antenna System
3		MRFPE203	Microwave Remote Sensing
1	PE-IV	MRFPE204	Metamaterials
2		MRFPE205	RADAR Technology & Counter Measure
3		MRFPE206	Radio Navigational Aids
1	PE-V	MRFPE301	EMI &EMC
2		MRFPE302	Cognitive Radio
3		MRFPE303	RF MEMS

List of Open Elective
Basics of RF & Microwave Engineering (MRFOE301)
Basics of Antenna &Propagation (MRFOE302)

AUDIT COURSE

Sl.No.	Course Code	Subject Name
1.	BCAC1001	English for Research Paper Writing
2.	BCAC1002	Disaster Management
3.	BCAC1003	Sanskrit for Technical Knowledge
4.	BCAC1004	Value Education
5.	BCAC2001	Constitution of India
6.	BCAC2002	Pedagogy Studies
7.	BCAC2003	Stress Management by Yoga
8.	BCAC2004	Personality Development through Life Enlightenment Skills.

FIRST SEMESTER

RF IC

Module - I (6 Hours)

Introduction: Basic Concepts in RF Design, Passive RLC Networks, Passive IC Components and Their Characteristics.

Module-II (8 Hours)

Voltage References & Biasing: Supply Independent Biasing, Bandgap Voltage Reference, Constant-g_m biasing. **Feedback Systems**: De-sensitivity, Stability, Errors, Compensation. **Noise**: Thermal noise, Shot Noise, Popcorn Noise, Flicker Noise in devices and circuits.

Module - III (10 Hours)

High Frequency Amplifier Design: Zeros as Bandwidth Enhancers, Shunt-Series Amplifiers, Tuned Amplifiers, Cascaded Amplifiers. **LNA design**: LNA Topologies (Power Match and Noise Match), Linearity and Large Signal Performance. **RF Power Amplifier**: Class A, Class B, Class C, Class AB Power Amplifiers and their Characteristics.

Module – IV (12 Hours)

Oscillators: Tuned oscillators, Negative Resistance Oscillators, Phase Noise. **PLL**: Phase Detectors, Loop Filters, Synthesizers. **Mixers:** Mixer Fundamentals, Non-Linear Systems as Linear Mixers, Mixer Types.

Module – V (4 Hours)

Transceiver Architecture, Design Example

Text Book:

1. T. H. Lee, "*The Design of CMOS RF Integrated Circuits*", Cambridge UniversityPress.
2. B. Razavi, "RF *Microelectronics*", Pearson Education.

Reference Books:

1. B. Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill,2002.
2. Sorin Voinigescu, "*High Frequency Integrated Circuits*", Cambridge University Press.
3. Reinhold Ludwig, Gene Bogdanov, "RF Circuit Design Theory and Applications", Pearson Education.

Course outcomes:

After completion of course, student should be able to

- *Conversant with RF design concepts, passive on-chip elements.*
- *Analyze biasing, feedback and noise.*
- *Design a RF amplifier, Power amplifier, LNA.*
- *Be proficient with frequency conversion and signal generation.*
- *Present the different transceiver architecture.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	2
CO2	2	---	2	3	2	2
CO3	3	2	3	2	---	1
CO4	3	2	2	2	---	1
CO5	2	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) ---: No Correlation

Programme Articulation Matrixrow for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

RADIO WAVE ENGINEERING

Module - I (8 Hours)

Introduction, Maxwell's Equation, Wave Equation: Derivation & Solution, Propagation of plane EM wave through conductors & wave guide

Module-II (8 Hours)

Dispersion, Scattering, Diffraction & Polarization of EM Waves,

Module - III (8 Hours)

Radiating System, Multi-pole Fields & Radiation

Module – IV (8 Hours)

Basics of Wave Propagation, Ground Wave propagation, Space Wave Propagation

Module – V (8 Hours)

Sky Wave Propagation, Propagation of Radar Waves

Text Book/ Reference Book:

1. Electromagnetic Waves & Radiating Systems, By Jordan & Balmain,PHI (Chapters: 4, 5, 10, 16, 17)
2. Classical Electrodynamics, By J. D. Jackson, Wiley (Chapters: 7, 9,10)
3. Antennas & Waves Propagation, By J. D. Kraus, McGraw Hill (Chapters: 4, 22, 23, 24, 25)
4. Introduction to Radar Systems, By M. L. Skolnik, McGraw Hill (Chapter:8)

Course outcomes:

After completion of course, student should be able to

- *Be familiar with Maxwell's Equation*
- *Design antennas based on various propagation such as ground wave propagation, Space Wave Propagation Sky Wave Propagation.*
- *Apply concepts and relation of maximum and lowest useable frequency for all types of propagation.*
- *Gain design ideas of propagation of Radar Waves.*
- *Analyze Sky Wave & Radar Waves Propagation*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	2	2
CO2	3	1	3	2	1	1
CO3	2	1	2	3	1	2
CO4	3	2	2	3	2	2
CO5	2	1	3	3	1	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	1	3	3	1	2

COMPUTATIONAL ELECTROMAGNETICS

Module - I (6 Hours)

Introduction to Numerical Methods: Electromagnetic Problems, Basic Numerical Methods, Solution of Algebraic Equations, Accuracy Consideration and Richardson Extrapolation, Examples

Module-II (8 Hours)

Finite-Difference Method: Finite-Difference in One Dimension, A One Dimensional Differential Equation, Finite-Difference in two Dimensions, Two Dimensional Capacitance Problem, Open Regions, Generalizations, Determination of Eigen values in One Dimension, Waveguide Mode Example, Numerical Evaluation of the Determinant, Iterative Solution Methods

Module - III (8 Hours)

Finite-Difference Time-Domain Method: Wave Equation in One Spatial Dimension, Time Quantization, Initial Conditions, Waves in Two and Three Spatial Dimensions, Maxwell's Equations.

Module – IV (10 Hours)

Finite Element Method: Basic Concept of Finite Elements, Finite Elements in One Dimension, Linear Interpolation for Isosceles Right Triangles, Square Elements, General Triangular Elements, High Order Interpolation with Triangles, Nodal Expansions and the weak Formulation, Time Dependent Variables.

Module – V (8 Hours)

Method of Moments: Linear Operators, Approximation by Expansion in Basis Functions, Determination of the parameters, Differential Operators, Integral Operators, Pulse Functions, Parallel Plate Capacitor in Two Dimensions, Analysis of Wire Dipole Antenna, Comparison of FDM, FDTD, FEM, and MoM. Hybrid Computational Methods

Text Book:

1. Analytical and Computational Methods in Electromagnetics, ByR.Garg, ArtechHousePublication
2. Computational Methods for Electromagnetics and Microwaves,By R.C Booton, Jr, , John Wiley &Sons

Reference Book:

1. Computational Methods for Electromagnetics, By A. F. Peterson, S. L. Ray, and R. Mittra, IEEE Press
2. The Finite Element Method in Electromagnetics, By J. M. Jin, John Wiley & Sons
3. The finite difference time domain method for electromagnetics,By K. S. Kunz & R.J. Luebbers, CRC Press
4. Field Computation by Moment Methods,By R. F. Harrington, Macmillan

Course outcomes:

After completion of course, student should be able to

- *Express the concept of various computational methods such as FDTD, FEM and MOM*
- *Write different numerical methods for solving the electromagnetic problems.*
- *Go for the higher studies in the field of RF and Microwave engineering.*
- *To work in the advance R&D labs such as Society for Applied Microwave Electronics Engineering and Research(SAMEER).*
- *Develop intellect to work in the leading companies of the globe such as MathWorks, Texas Instruments etc.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	2	2	3	3	1	1
CO3	3	2	2	3	1	1
CO4	3	1	2	3	2	2
CO5	2	1	3	3	2	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	2	1

ADVANCE SIGNAL PROCESSING

Module - I (8 Hours)

Multi-Rate Digital Signal Processing: Introduction, Decimation by A Factor D, Interpolation by A Factor I, Sampling Rate Conversion by Rational Factor I/D, Filter Design and Implementation for Sampling-Rate, Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion of Band-Pass Signal, Application of Multi Rate Signal Processing: Design of Phase Shifters, Implementation pf Narrowband Low Pass Filters. Implementation of Digital Filter Banks

Module-II (8 Hours)

Linear Prediction and Optimum Linear Filters: Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of The Normal Equations, Properties of The Linear Prediction Error Filters, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filter For Filtering and Prediction: FIR Wiener Filter, Orthogonality, Principle in Linear Mean-Square Estimation.

Module - III (8 Hours)

Power Spectrum Estimation: Estimation of Spectra from Finite- Duration Observation of Signals, Non-Parametric Method for Power Spectrum Estimation: Bartlett Method, Blackman And Turkey Method, Parametric Method for Power Estimation: Yuke-Walker Method, Burg Method, MA Model and ARMA Model. Filter Bank and - Filters and Its Applications

Module – IV (10 Hours)

Adaptive Signal Processing Least Mean Square Algorithm, Recursive Least Square Algorithm, Variants of LMS Algorithm: SK-LMS, N-LMS, FX-LMS. Adaptive FIR & IIR Filters, Application of Adaptive Signal Processing: System Identification, Channel Equalization, Adaptive Noise Cancellation, Adaptive Line Enhancer.

Module – V (6 Hours)

HOS- Higher Order Statistics: Definitions and Properties, Moments, Cumulants, Blind Parameters and Order Estimation of MA & ARMA Systems. Application of Higher Order Statistics: Applications to Signal Processing and Image Processing.

Text Book:

1. J.G. Proakis and D.G. Manolakis, “Digital Signal Processing”,3rd Edition, PHI.

Reference Book:

1. Oppenheim and Schafer, “Digital Signal Processing”,PHI
2. B. Widrow and Stern, “Adaptive Signal Processing”,PHI,1985

Course outcomes:

After completion of course, student should be able to

- *Implement the relationship between time and frequency domain interpretations.*
- *Analyze signal processing algorithms.*
- *Evaluate some of the most important advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques*
- *Represent power spectrum estimation techniques.*
- *Expressadaptivesignalprocessingalgorithmsbasedonsecond order statistics.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	2	2
CO2	3	1	3	3	1	1
CO3	2	2	2	3	1	1
CO4	2	1	2	2	1	2
CO5	1	1	3	3	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	1	2	3	1	1

Advanced Electromagnetics

Module - I (8 Hours)

The Dirac Delta & its representation for infinitesimal dipole, magnetic current & magnetic current density, inadequacies in Maxwell's equations, impossibility of TEM in waveguide.

Module-II (8 Hours)

Huygens's principle, Babinet's principle, holography, correlation between circuit theory & field theory, derivation of circuit relations from field theory, bridging the gap between electricity & magnetism using relativity, interaction of fields & matter.

Module - III (8 Hours)

Dielectric slab waveguide & its application to optical communication, plasma oscillations & wave propagation in plasma, dielectric resonator, Faraday rotation, Schumann resonance, tropo-scatter propagation, earth as a cavity resonator, scattering &diffraction.

Module – IV (8 Hours)

Bio-electromagnetics: Introduction, the axon, retinal optical fibers, heart dipole field, defibrillators &pacemakers, biological fields, electromagnetic hazards & environment Enhancer.

Module – V (8 Hours)

Introduction of tensors, Special theory of relativity & its applications in electromagnetics

Text Book:

1. Electromagnetic Waves & Radiating Systems, By Jordan &Balmain,PHI.
2. Maxwell's Equations & The Principles of Electromagnetism, By R.Fitzpatric Infinity Science Press LLC.

Reference Book:

1. Classical Electrodynamics, By J D Jackson,Wiley.
2. Introduction to Electromagnetic Fields, By C. R. Paul, K. W. Whites, Syed A. Nasar, McGrawHill.
3. Concepts of Modern Physics, By A. Beiser, Mc GrawHill

Course outcomes:

After completion of course, student should be able to

- *Solve inadequacies in Maxwell's equations and correlating between circuit theory and field theory.*
- *Demonstrate Huygens's, Babinet's, and holographic principles.*
- *Correlate and derive the circuits relations from field theories and vice versa.*
- *Apply the knowledge of dielectric slab waveguides, Schumann resonance, and tropo-scatter propagation.*
- *explain bio-electromagnetics, such as retinal optical fibers, defibrillators and pacemakers, electromagnetic hazards and environment.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	1	1
CO2	3	1	3	3	1	1
CO3	3	2	3	2	1	2
CO4	2	2	2	2	2	2
CO5	3	1	3	3	2	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

MICROWAVE CIRCUITS AND MEASUREMENT

Module - I (6 Hours)

Introduction to microwave circuit concepts, Relation between [s], [z], [y] parameter.

Module-II (8 Hours)

Microwave circuits & theorems, Impedance matching, Passive microwave components

Module - III (10 Hours)

Measurement of Wavelength, Frequency and Impedance-Introduction, Equivalent circuit of Cavity wave meters, Typical wave meters, resonant cavities, Methods of frequency measurements

Module – IV (8 Hours)

Standard wave reflectors, Measurement of reflection coefficient, Low, Medium, High VSWR measurements, Standing wave pattern, Slotted Line section and its limitation, Impedancemeasurement techniques, Reflectometer

Module – V (8 Hours)

Vector Network analyzer, Concept and description, Reflection and Transmission measurements, magnitude and Phase, measurement of S- Parameters, SWR and Impedances measurements, errors and corrections.

Text Book:

1. Microwave circuit, By J.L. Altmen, Van NostrandCo.
2. Foundations for microwave engineering, By R. E. Collins., John Wiley &Sons

Reference Book:

1. Microwave Circuit Theory and Analysis, By R. N. Ghosh, McGrawHill
2. RF & Microwave circuits, Measurements and modelling, M. Golio&J.Golio, CRC Press
3. An introduction to Microwave Measurements, Anan janBasu, CRCPress

Course outcomes:

- *Gain proficiency regarding microwave circuit concepts and relation between different parameters.*
- *Design impedance matching networks and familiarity with passive microwave components.*
- *Design of basic microwave laboratory set up along with measurement of parameters.*
- *Study of VNA will help in the measurement of S parameters of different microwave devices.*
- *Familiarity with VNA concept can be used for finding gain, phase, reflection and transmission coefficient etc.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	1
CO2	3	1	3	2	2	1
CO3	2	1	2	3	1	2
CO4	2	1	2	3	2	2
CO5	3	2	3	3	1	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

MIC &MMIC

Module - I (8 Hours)

Review of fundamentals of electronic conduction in compound semiconductors. Study of semiconductors like GaAs, InP. Fundamentals of band gap engineering. MIC Technology – Thick filmandThinfilmtechnology, HybridMIC's, Monolithic MIC technology.

Module-II (8 Hours)

Analysis of stripline and microstripline, Method of conformal Transformation, Characteristic parameters of strip, Microstrip lines, Microstrip circuit Design, Impedance transformers, Filters, Lumped components, Microstrip circuits.

Module - III (8 Hours)

Coupled Microstrips and Directional couplers, Even and odd mode analysis, Theory of coupled microstrip Directional couplers, Calculations for a coupled pair of Microstrips, Branch line couplers. Lumped Elements for MIC's Design and fabrication of lumped
elements, circuits using lumped elements.

Module – IV (8 Hours)

Nonreciprocal components for MIC's Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters, Design of microstrip circuits – high power and low power circuits.

Module – V (6 Hours)

Monolithic Microwave Integrated Circuits (MMICS) Technology: Fabrication process of MMIC, Hybrid MMICs, Dielectric substances, Thick film and thin film technology and materials, testing methods, Encapsulation and mounting of devices.

Text Book:

1. Microwave Devices & Circuits, By S Y Liao, Third Edition, Pearson hall, 2003.
2. Microwave Integrated circuits, By Gupta KC and Amarjit Singh- Wiley Easterrn.

Reference Book:

1. Hoffman R.K "Hand Book of Microwave Integrated Ciruits", Artech House, Boston,1987.
2. Stripline-like Transmission Lines for Microwave Integrated Circuits, By

   Bharathi, Bhat, and S.K. Koul New Age International 2007.

Course outcomes:

After completion of course student should be able:

- *To Identify about the Microwave Integrated Circuits for different types of RF applications.*
- *To design and analyze the stripline and microstripline using conformal Transformationmethod.*
- *To describe about the Design and fabrication of Directional couplers using lumped elements.*
- *To state the design and concept of circulators, Isolators and phase shifters.*
- *To Analyze the MMICS Technology with their various fabrication and testing methods.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	1
CO2	3	2	2	3	1	1
CO3	3	1	2	3	2	2
CO4	2	1	3	2	1	2
CO5	2	1	3	3	2	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

Advanced Communication Techniques

Module - I (8 Hours)

Baseband Demodulation: Signals and Noise, Detection of Binary Signals in Gaussian Noise, Intersymbol Interference, Equalization Bandpass Modulation and demodulation: Digital Bandpass Modulation Techniques, DetectionofSignalsinGaussianNoise,CoherentDetection,Noncoherent Detection, Complex Envelope, Error Performance for Binary Systems, M-ary Signaling and Performance, Symbol Error Performance for M-ary Systems.

Module-II (8 Hours)

Multiplexing and Multiple Access: Allocation of the Communications Resources, Multiple Access, Communications System and Architecture, Access Algorithms, Multiple Access Techniques Employed with INTELSAT, Multiple Access Techniques for Local Area Network.

Module - III (8 Hours)

Spread Spectrum Techniques: Spread-Spectrum Overviews, Pseudo noise Sequences, Direct Sequence, Spread-Spectrum Systems, Frequency Hopping Systems, Synchronization, Jamming Considerations, Commercial
Applications, Cellular Systems, Introduction to OFDM.

Module – IV (10 Hours)

Synchronization: Introduction, Receiver Synchronization, Network
Synchronization Communications Link Analysis: Channel and sources of signal loss, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, and System Temperature, Sample Link Analysis, Satellite Repeaters.

Module – V (6 Hours)

Fading Channels: The Challenge of Communicating over Fading Channels, Characterizing, Mobile-Radio Propagation, Signal Time-Spreading, Time Variance of the Channel Caused by Motion Mitigating the Degradation Effects of Fading, Summary of the Key Parameters Characterizing Fading Channels, Applications: Mitigating the Effects of Frequency Selective Fading.

Text Book:

1. Digital Communications - Fundamentals and applications by Bernard Sklar,2nd Edition of Pearson education Publication
2. Digital Communications - J. G. Proakis, 3rd edition, McGraw Hill Publication.

Reference Book:

1. J.G. Proakis, M. Salehi, Communication Systems Engineering, Pearson Education International, 2002.
2. Lee & Moseschmitt, Digital Communication, Springer,2004. R. Prasad, OFDM for Wireless Communications Systems, Artech House,2004.

Course outcomes:

After completion of course student should be able to

- *Analyze various modulation process in digital communication.*
- *Express the concepts communication link analysis.*
- *Apply Spread Spectrum Techniques, Fading Channels, etc.*
- *Evaluate the effects of mitigating Fading.*
- *Define the commercial applications of recent Cellular Systems.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	2
CO2	3	1	3	3	1	2
CO3	2	1	2	3	2	1
CO4	2	1	2	3	2	1
CO5	3	2	3	2	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

MICROWAVE ENGINEERING LAB-I

List of Experiment

1.	Study of microwave components
2.	Measurement of VSWR in waveguide
3.	Measurement of frequency of microwave source
4.	Study of attenuator characteristics
5.	Measurement of microwave source characteristics: Klystron, Gunn Diode
6.	Measurement of dielectric constant
7.	Measurement of Main Line and Auxiliary Line VSWR, Coupling Factor, Insertion Loss and Directivity of a Directional coupler.
8.	Study of power division in E-plane and H-plane TEE.
9.	Radiation pattern and Gain of Waveguide Horn antenna.
10.	Design and Study of H-plane TEE (using HFSS).

Sessional Outcome:

- *Familiarity with microwave components and their applications for high frequency signals.*
- *Calculate wave parameters (Frequency, VSWR, Reflection coefficients)*
- *Apply the concept and use of attenuators..*
- *Analyze the concept and characteristics of reflex klystron tube.*
- *Demonstrate the characteristics of Gunn diode.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	2	1	3	3	1	2
CO3	2	2	2	1	1	1
CO4	3	2	2	2	2	1
CO5	2	1	2	2	2	1

Programme Articulation Matrixrow for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	2	2	2	1

COMPUTATIONAL ELECTROMAGNETICS LAB

List of Experiment

1. Application of Richardson extrapolation method to find the exact value from the calculated value.
2. Application of Richardson extrapolation to evaluate potential integral
3. Evaluation of solution to Poisson's equation using finite difference method
4. Application of finite difference method to calculate the characteristic impedance of a transmission line.
5. Calculation of TM modes of a rectangular wave guide using finite difference method.
6. Determination of potential distribution of an earthed cylinder partially filled with a charge liquid using finite difference method.
7. Evaluate the solution of Laplace's equation using finite element method.
8. Evaluate the characteristic impedance of a strip transmission line using method of moments.
9. Evaluation of the self-impedance of a dipole using method of moments.
10. Evaluation of the mutual-impedance between two dipoles using method of moments.

Reference Book: Analytical and Computational Methods in Electromagnetics, By R. Garg, Artech House Publication

Sessional Outcome:

After completion of the sessional student should be able to

- *Apply finite difference method to different engineering problems.*
- *Implement finite difference time domain method to different engineering problems.*
- *Develop finite element method for different engineering problems.*
- *Apply method of moments to different engineering problems.*
- *Analyze unique numerical methods to find the exact value instead of approximated value.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	1	2
CO3	2	2	2	2	1	1
CO4	2	2	2	2	1	1
CO5	2	3	2	2	2	2

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	2	2	1	2

Second semester

RF & MICROWAVE SOLID STATE DEVICE

Module - I (6 Hours)

Energy Bands & Current Carriers in Semiconductors, Intrinsic & Extrinsic Semiconductor

Module-II (8 Hours)

Junctions Carrier Process, Drift-Diffusion, Generation-Recombination

Module - III (10 Hours)

Microwave Transistor, Tunnel Diode, Microwave Field Effect Transistor

Module – IV (8 Hours)

Transferred Electron Devices, Avalanche Transit Time Devices

Module – V (8 Hours)

Optoelectronics, LED, Laser, Photo-detector, Solar Cell

Text Book:

1. Semiconductor Devices,By Kanaan Kano, Pearson (Chapters: 2, 3, 4,14)
2. Solid State Electronic Devices, By B G Streetman & S Banerjee , Pearson (Chapters: 3, 4, 5, 8)
3. Semiconductor Physics &Devices,By D A Neamen, Tata McGraw Hill (Chapters: 4, 5, 6, 14)

Reference Book:

1. Microwave Devices &Circuits,By S Y Liao, Pearson (Chapter: 5, 6, 7,8)
2. Microwave Semiconductor Devices and their applications, Watson, McGrawHill
3. Microwave Semiconductors, H.VShurmer, WienOldenbourg

Course outcomes:

After completion of course student should be able to

- *Express working concepts of RF activecomponents.*
- *Designing of various Microwave Solid StateDevices.*
- *Analysis of various microwavedevices.*
- *Implement opto-electronicdevices.*
- *Work with transistors and diodes at highfrequency.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	2
CO2	3	1	3	3	2	2
CO3	3	2	2	2	1	1
CO4	2	1	3	2	1	1
CO5	2	2	2	3	2	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	1	1

MICROSTRIP COMPONENTS AND CIRCUITS (3-1-0)

Module - I (6 Hours)

Methods of Microstrip analysis, Losses in Microstrip

Module-II (10 Hours)

Slot line and Co-planar Waveguide, Coupled Microstrip and Directional Coupler.

Module - III (8 Hours)

Branch line coupler, Impedance transformers

Module – IV (8 Hours)

Power dividers and combiners, Circulators

Module – V (8 Hours)

Filters and Lumped components

Text Book:

1. Microwave engineering using Microstrip Circuits, Fooks and Zakarevicius, PrenticeHall

2.Microstrip lines and slotlines, Gupta,Garg,Bahl and Bhartia, ArtechHouse

Reference Book:

1. Foundations for Microstrip Circuit Design, T. C. Edwards, Wiley &Sons
2. Microstrip filters for Rf/Microwave applications, Hong & Lancaster, Wiley &Sons
3. Microstrip circuits, Fred Gardiol, Wiley &Sons

Course outcomes:

After completion of course student should be able to

- *Design and implement microstrip transmissionline*
- *Design of coplanar waveguide and its advantage compared to microstripline.*
- *Gain basic ideas about directional and branch line coupler usingmicrostrip.*
- *Gain design ideas of circulators and branch line couplers.*
- *Implement microstrip technology for various impedance matching network and couplers.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	3	1	2
CO2	3	2	3	3	1	1
CO3	2	1	3	2	2	1
CO4	3	1	2	3	1	2
CO5	2	2	3	2	2	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

ADVANCED ANTENNA TECHNOLOGY (3-1-0)

Module - I (6 Hours)

Biconical antenna, Discone and conical skirt monopole, theory behind frequency independent antenna, equiangular spiral antenna, fractal antenna concept and technology, corrugated horn antenna, multimode horn antenna.

Module-II (8 Hours)

Smart antenna systems, benefit, drawbacks of Smart antenna, array design for smart antennas, adaptive beamforming, MANET, array theory, Electrically & Physically small & big antenna

Module - III (8 Hours)

Artificial dielectric lens antenna, Luneburg & Einstein lenses, electrically and small antenna, ground plane antenna, sleeve antenna, turnstile antenna, submerged antenna, surface wave and leaky wave antenna, weather-vane antenna, flagpole antenna, chimney antenna, ILS antenna, sugar-scoop antenna, asteroid detection antenna, embedded antenna, plasma antenna

Module – IV (10 Hours)

Microstrip and other planar antennas, Various types of feeding methods for microstrip antenna (Co-axial, Inset, Aperture/Slot Coupled, Proximity coupled and Corporate feeding for Arrays); Analysis of rectangular Patch Antenna, Cavity/ Modal Expansion Technique, microstrip antennaarray

Module – V (6 Hours)

Conventional Scanning Techniques, Feed Networks for phased Arrays, Frequency Scanned Array Design, Target indicators, Search Patterns

Text Book:

1. Antennas Theory – Analysis and Design, By C. Balanis, Wiley IndiaEdition
2. Antennas, By J. D. Kraus & others, McGraw Hill-Special IndianEdition

Reference Book:

1. Phased Array Antennas, By A. A. Ollinerand G.H. Knittel,Artech House
2. Introduction to Radar Systems, By M. L. Skolnik, McGraw Hill

Course outcomes:

After completion of course student should be able to

- *Design broadband antennas including comparison ofits associatedparameters.*
- *Analyze the design and operation of Smart antennas including associatednetworks.*
- *Implement several advanced antennas for specialapplication.*
- *Demonstrate design and operation of different types of patch antennas and theirfeedings.*
- *Evaluate different scanningtechniques.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	1
CO2	3	1	3	3	2	1
CO3	2	1	2	3	2	2
CO4	2	2	3	2	1	2
CO5	3	1	2	3	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

Smart Antenna System (3-0-0)

Module - I (6 Hours)

Brief discussion on some recent antennas and its parameters: Wideband, multiband, phased array, adaptive array, highly directional, low profile, low side-lobes, low back-lobe, low beam-width, high SNR, low loss

Module-II (10 Hours)

Fundamentals on Smart antennas: Need of Smart antennas, Smart antenna configurations, Space division multiple access (SDMA), Architecture of Smart antenna system, Benefits and drawbacks, Basic principles, Mutual coupling effects System design and requirements:
Fixed beam systems, switched beam systems, adaptive antenna system, calibration

Module - III (8 Hours)

DOA algorithms and application: Conventional methods, sub-space methods, Integrated methods. Other methods, DOA estimation under coherent signal conditions, DOA estimation under other conditions

Module – IV (8 Hours)

Beamforming fundamentals: The classical beamformer, Statistically Optimum Beamforming weight vectors, Adaptive algorithms for beamforming

Module – V (10 Hours)

Integration and simulation of Smart antennas: Antenna design, mutual coupling, Adaptive signal processing algorithms, Trellis coded modulation for adaptive arrays, smart antenna systems for Mobile Ad-Hoc Networks

Text Book:

1. Smart Antennas for Wireless Communications IS-95 and Third Generation CDMA Applications, By J. C. Liberti Jr., T. S Rappaport, PTR – PHpublishers
2. Smart Antennas, By Lal Chand Godara, CRCPress

Reference Book:

1. Introduction to Smart Antennas by C. A. Balanis and P. I. Ioannides, Morgan & Claypool Publishers
2. Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location, ByT.S. Rappaport,IEEEPress, PTR – PH publishers

Course outcomes:

After completion of course student should be able to

- *Define working principle of recentantennas.*
- *Implement smartantennas.*
- *Analyze different types of Direction of Arrivalalgorithms.*
- *Express different types of beamformingtechniques.*
- *Evaluate the working principle of practical smartantenna.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	1	2
CO2	3	1	3	3	1	2
CO3	3	1	3	2	2	1
CO4	2	1	2	3	2	2
CO5	2	2	3	2	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	2

Microwave Remote Sensing

Module - I (10 Hours)

PASSIVE SURVEY SYSTEM: Introduction - History, plane waves, antenna systems, Resolution Concepts, Radiometry - Passive microwave sensing components – Emission laws - Roughness and Dielectric Constant - Radiometers – Components - Brightness temperature - Antenna temperature - Power - temperature correspondence, passive microwave interaction with atmospheric constituents - Emission characteristics of various earth features – Passive missions - Data products and Applications.

Module-II (10 Hours)

ACTIVE SURVEY SYSTEM: Basics - RADAR operation and measurements - RADAR equation - RAR - frequency bands - SLAR Imaging Geometry - Geometric Distortions, SAR – Concepts - Doppler principle & Processing System Parameters and fading concepts, Target Parameters. InteractionwithEarthsurfaceandvegetation-PhysicalScatteringModels-
Surface and Volume Backscattering.

Module - III (8 Hours)

PLATFORMS, SENSORS AND DATA PROCESSING: Airborne, Space borne and Indian missions, Data products and selection procedure, SAR Image Processing software - Measurement and discrimination - Backscatter Extraction - Preprocessing and speckle filtering - Image Interpretation, SAR Image Fusion.

Module – IV (8 Hours)

APPLICATIONS: Applications in Agriculture, Forestry, Geology, Hydrology, cryospace studies, landuse mapping and ocean related studies, military and surveillance applications, search and rescue operations, ground and air target detection and tracking - case studies.

Module – V (8 Hours)

IMAGING AND NON IMAGING METRICS: SAR interferometry - Basics - differential SAR interferometry, SAR polarimetry - Polarization Types – Polarimetricparameters-Information Extraction, Radargrammetry, Altimetry - Principle - Location systems - applications, scatterometer – Types - Calibration- applications.

Text Book:

1. Microwave remote sensing byF. T. Ulaby, K. R. Moore, and Fung, vol-1, vol-2 and vol- Addison - Wesley Publishing Company,London,1986.
2. Introduction to microwave remote sensing, By IainH.woodhouse

Reference Book:

1. Principles and applications of Imaging RADAR, Manual of Remote sensing, vol.2,By F. M.Handersonand A. J.Lewis. ASPRS, Jhumurley and sons, Inc.
2. Air and spacebornradar systems-An introduction, By P. L. JeanclandeMarchais, Jean- Philippe Hardarge and Eric Normant, Elsevierpublications
3. Radar foundations for Imaging and Advanced Concepts, By R. J Sullivan, Knovel, SciTech Pub.

Course outcomes:

After completion of course student should be able to

- *Acquire the conceptsand Basic working principle of passive microwavesystems.*
- *Define the conceptsand Basic working principle of active microwavesystems.*
- *Apply the principles of Microwave image analysis andinterpretation.*
- *Implement the various domains of microwave satellitedata.*
- *Evaluate Interferometry and Polarimetryconcepts.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	1	3	2	2	2
CO3	3	2	3	3	1	2
CO4	3	1	2	3	2	1
CO5	2	2	2	3	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

METAMATERIALS

Module - I (6 Hours)

Introduction, Fundamentals of left handed metamaterials

Module-II (8 Hours)

Transmission line theory of metamaterials

Module - III (8 Hours)

Two dimensional metamaterials

Module – IV (8 Hours)

Guided wave applications

Module – V (8 Hours)

Radiated wave applications

Text Book:

1. Electromagnetic metamaterials: Transmission line theory andmicrowave applications.
2. Metamaterials: Physics and Engineering Explorations, Nader Enghetaand R.W. Ziolkowski

Reference Book:

1. Metamaterials: Theory, Design and applications, J Cui, D. Smith and R. Liu, Springer
2. Metamaterials: Classes, properties and applications, E.J. Trembley,Nova SciencePub.

Metamaterials and plasmonics: Fundamentals, modeling andapplications, S. Zouhdi, A. Sihvola, A.P. Vinogradov, Springerscience

Course outcomes:

After completion of course student should be able to

- *Gain the fundamentals related to the left handedmaterials.*
- *implement it by transmissionline technique.*
- *Analyze the working of two dimensionalLHM.*
- *ImplementLHM for different applications.*
- *Conceptualize the principles of RHM and LHM.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	3	1	1
CO3	3	1	3	2	1	2
CO4	2	2	2	2	1	2
CO5	2	1	2	3	2	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	1	2

RADAR TECHNOLOGY & COUNTER MEASURE(3-1-0)

Module - I (8 Hours)

Radar Range Equation, Theory of target detection, Targets & Interference, MTI Radar

Module-II (8 Hours)

Pulse Compression Radar, Detection of Radar signals in noise, Waveform selection

Module - III (8 Hours)

General Introduction to Electronics Warfare, Intercept Systems. Signal Detection, Analysis andEnvironment Study

Module – IV (8 Hours)

Dumb and Smart Jammers, Confusion Reflectors, Target Masking and Decoys,

Module – V (8 Hours)

Infrared Countermeasures. ECCM system

Text Book:

1. Modern Radar System Analysis, By David Barton .K - ArtechHouse
2. Radar Design Principles Signal Processing and The Environment, ByFred Nathanson. Mcgraw Hill
3. Introduction to Radar systems, By Skolnik - McgrawHill

Course outcomes:

After completion of course student should be able to

- *Define Radartechnology.*
- *Express the concepts of Pulse Compression Radar.*
- *Design Electronics Warfare, and InterceptSystems*
- *Design and analysis of Dumb and Smart Jammers, ConfusionReflectors.*
- *Analyze Infrared Countermeasures. ECCMsystem*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	1
CO2	3	1	2	3	1	2
CO3	2	1	3	3	2	2
CO4	2	1	3	2	1	1
CO5	3	2	2	2	1	1

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

RADIO NAVIGATIONAL AIDS (3-0-0)

Module - I (6 Hours)
Navigational Systems, Inertial Navigation

Module-II (10 Hours)

Global Positioning System (GPS) for Navigation

Module - III (8 Hours)

Differential GPS and WAAS

Module – IV (8 Hours)

GPS Navigational Application

Module – V (8 Hours)

Air traffic management

Text Book:

1. Avionics Navigation Systems, By Myron Kayton and Walter Friend,Wiley
2. Global Positioning System Theory and Applications, By Parkinson. BW. Spilker, Progress in Astronautics, Vol. I and II, 1996

Reference Book:

1. Foundations for Microstrip Circuit Design, T. C. Edwards, Wiley &Sons
2. Microstrip filters for Rf/Microwave applications, Hong & Lancaster, Wiley &Sons
3. Microstrip circuits, Fred Gardiol, Wiley &Sons

Course outcomes:

After completion of course student should be able to

- *Define Radar and Radar Equations.*
- *Express the working principal of MTI and Pulse DopplerRadar.*
- *Work using Detection of Signals in Noise and Radio DirectionFinding.*
- *Work using Instrument LandingSystem.*
- *Evaluate Satellite Navigation System.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	1
CO2	2	1	2	2	2	1
CO3	2	1	3	3	1	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	1	2

Programme Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	1	2

ANTENNA AND SIMULATION LABORATORY

List of Experiments

1	Design and Analysis of monopole antenna by using MATLAB.
2	Design and analysis of Helix antenna using MATLAB.
3	Design and analysis of Pyramidal Horn Antenna using HFSS operating at 6 GHz.
4	Design and Analysis of circular loop antenna by using MATLAB.
5	Design and analysis of edge feed rectangular patch antenna at 2.4 GHz using ANSYS HFSS.
6	Design and analysis of edge feed circular patch antenna at 2.4 GHz using ANSYS HFSS.
7	Design and analysis of 5X5 planar antenna array with dipole using MATLAB.
8	Design and Analysis of 16 element circular array dipole antenna using MATLAB.
9	Design and analysis of edge feed patch antenna at 10 GHz using ANSYS HFSS.
10	Design and analysis of patch antenna array for FMCW Radar using MATLAB.

Course outcomes:

After completion of course student should be able to

- *Implement MATLAB and HFSS in antennadesigns.*
- *Implement different patch antenna designs and its associated performanceparameters.*
- *Analyze different design and types of antenna arrays and its performanceparameters.*
- *Evaluate several broadband antennas and its performance parameters.*
- *Apply different feeding techniques for antennas.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	2	2	2	2	2	1
CO3	2	2	2	2	2	2
CO4	2	2	2	1	2	2
CO5	2	2	3	2	2	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	2	2	2	2

MICROWAVE ENGINEERING LAB II

List of Experiment

1	Study of Waveguide Discontinuities-Inductive and capacitive Diaphragms
2	Determination of Slide Screw Tuner-Equivalent circuit
3	Determination of S-matrix of Directional Coupler, Circulator, Magic Tee
4	Characterization of Waveguide Slotted Array
5	Measurements with Network Analyzer
6	Design offilter
7	Design of amplifier
8	Study of different devices using mirostrip technology
9	Radiation pattern and Gain of microstrip antenna
10	Design and Study of microstrip patch antenna (using HFSS).

Course outcomes:

After completion of course student should be able to

- Express about different discontinuities and finding impedances
- Design the equivalentcircuit for different components.
- Analyzedifferent microwave components and theirS-matrix.
- Demonstrate measurement of different parameters using Networkanalyser.
- Implement the design of patchantenna.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	2	2	2	2	2	1
CO3	2	2	2	2	2	2
CO4	2	2	2	1	3	2
CO5	2	2	2	1	2	2

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	2	2	2	2	2

Third Semester

EMI & EMC (3-0-0)

Module - I (6 Hours)

Introduction, Natural and Nuclear Sources of EMI / EMC

Module-II (8 Hours)

EMI from Apparatus, Circuits and Open Area Test Sites

Module - III (8 Hours)

Radiated and Conducted Interference Measurements and ESD

Module – IV (10 Hours)

Grounding, Shielding, Bonding and EMI filters, Cables, Connectors, Components and EMC Standards

Module – V (8 Hours)

EMC requirement for electronic systems

Text Book:

1. Engineering Electromagnetic Compatibility, By Dr. V.P. Kodali, IEEEPublication, Printed in India by S.Chand&Co.Ltd.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 –9

Reference Book:

1. Introduction to Electromagnetic Compatibility, C.R. Paul, JohnWiley
2. Electromagnetic Compatibility Engineering, H.W. Ott,Wiley
3. Principles and Techniques of Electromagnetic compatability, C. Christpoulos, CRCPress

Course outcomes:

After completion of course student should be able to

- Move for real-world EMC design constraints and make appropriate trade-offs to achieve the most cost-effective design that meets allrequirements.
- Design electronic systems that function without errors or problems related to electromagnetic compatibility.
- Diagnose and solve basic electromagnetic compatibilityproblems.
- Evaluate EMC standards differentcomponents.
- Identify the Interference coming from electronic system while conducting Antenna measurement

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	2
CO2	3	1	3	3	2	2
CO3	2	2	3	2	1	2
CO4	2	2	2	3	1	1
CO5	3	2	2	2	1	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	1	2

Cognitive Radio (PE-II)

Module - I (8 Hours)

Essential functions of the SDR, SDR architecture, design principles of SDR, traditional radio implemented in hardware and SDR, transmitter architecture and its issues, A/D & D/A conversion, parameters of practical data converters, techniques to improve data converter performance, complex ADC and DAC architectures, digital radio processing, reconfigurable wireless communication systems..

Module-II (8 Hours)

Cognitive Radio (CR) features and capabilities, CR functions, CR architecture, components of CR, CR cycle, CR and dynamic spectrum access, interference temperature, CR architecture for next generation networks, CR standardization.

Module - III (8 Hours)

Spectrum sensing and identification, primary signal detection. Energy detector, cyclo stationary feature detector, matched filter, cooperative sensing, spectrum opportunity, spectrum opportunity detection, fundamental trade-offs: performance versus constraint, sensing accuracy versus sensing overhead.

Module – IV (8 Hours)

Spectrum management of cognitive radio networks, spectrum decision, spectrum sharing and spectrum mobility, mobility management of heterogeneous wireless networks, research challenges in CR.

Module – V (8 Hours)

Cognitive radio networks (CRN) architecture, terminal architecture of CRN, diversity radio access networks, routing in CRN, Control of CRN, Self-organization in mobile communication networks, security in CRN, cooperative communications, cooperative wireless networks, user cooperation and cognitive systems.

Text Book:

1. Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009

Reference Book:

1. Alexander M. Wyglinski, MaziarNekovee, and Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles and Practice”, Elsevier Inc.,2010.
2. Jeffrey H. Reed “Software Radio: A Modern Approach to radio Engg”, Pearson EducationAsia.
3. Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, “Cognitive Radio Communication and Networks,” Elsevier,2010.

Course outcomes:

After completion of course student should be able to

- Demonstrate the software defined radio architecture and design principles.
- Demonstrate the cognitive radio components, functions and capabilities.
- Evaluate different spectrum sensing mechanisms in cognitive radio.
- Analyze the spectrum management functions using cognitive radio systems and cognitive radio networks.
- Demonstrate on cooperative communications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	1	2	3	2	2
CO3	3	1	2	2	1	1
CO4	2	1	3	3	2	1
CO5	2	2	3	3	1	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

RF-MEMS (3-0-0)

Module - I (10 Hours)

Introduction: RF MEMS for microwave applications, MEMS technology and fabrication, mechanical modeling of MEMS devices, MEMS materials and fabrication techniques. MEMS Switches: Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modeling; Techniques of MEMS switch fabrication and packaging; Design of MEMS switches

Module-II (10 Hours)

MEMS inductors: Micromachined inductor, effect of inductor layout, Modeling and design issues of planar inductor. MEMS capacitors: Gap tuning and area tuning capacitors, dielectric tunable capacitors.

Module - III (8 Hours)

RF MEMS Filters: Modeling of mechanical filters,micro machined filters, surface acoustic wave filters, micro machined filters for millimeter wave frequencies. Phase shifter: MEMS phase shifters, Ferroelectric phase shifters, types , limitations.

Module – IV (8 Hours)

Micromachined Transmission lines and Antennas: Micromachined transmission lines, losses in transmission lines, coplanar transmission lines, micromachined waveguide components; Micromachined antennas: Design parameters, Micromachining
techniques to improve antenna performance, reconfigurable antennas.

Module – V (8 Hours)

Integration and Packaging: Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.

Text Book:

1. RF MEMS and their Applications, Vijay K. Varadan, Wiley-India,2011.
2. RF MEMS: Theory, Design, and Technology, Gabriel M. Rebeiz, Wiley, 2003.

Reference Book:

1. An Introduction to Microelectromechanical Systems Engineering, NadimMaluf, Artech House,2000.
2. RF MEMS Circuit Design for Wireless Communications, De LosSantosH J, Artech House, 1999.

Course outcomes:

After completion of course student should be able to

- Identify various types of RF MEMS devices, fabrication methods and packaging standards.
- Design MEMS inductors and tunable capacitors using micromachine techniques.
- Model MEMS filters and Phase shifters for various types of RF applications.
- Design and analyze Micro machined Transmission lines and Antennas forwireless applications.
- Analyze the reliability and design related issues in MEMS structures.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	2
CO2	3	1	3	3	2	2
CO3	3	2	2	3	1	1
CO4	2	1	2	2	2	1
CO5	2	1	3	2	2	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

BASICS OF RF & MICROWAVE ENGINEERING (3-0-0)

Module - I (6 Hours)

Introduction, Electromagnetic fields and waves, Maxwell's equation, skin effect, Transmission line theory

Module-II (8 Hours)

Basics of coaxial line, microstrip line, stripline, coplalnar line, Rectangular and circular waveguide

Module - III (8 Hours)

S-parameter representation of Network, calculation of S-parameter, S-parameter measurement

Module – IV (8 Hours)

RF component and circuits: Equivalent circuit of passive components, Impedance matching, Filter, Directional coupler, circulator, power divider, balanced to unbalanced circuits, RF design software

Module – V (8 Hours)

Fundamental antenna parameters, mathematical treatment of Hertzian dipole, planar antenna, antenna arrays and radio wave propagation Mechanism

Text Book:

1. RF and Microwave Engineering, Fundamentals of Wireless Communications, F. Gustrau, Wiley
2. MicrowaveEngineering:ConceptsandFundamentals,A.ShahidKhan,CRC Press

Reference Book:

1. Foundations for Microwave Engineering, R. E. Collin,Wiley
2. Essentials of RF and Microwave Grounding, E. Holzman, ArtechHouse
3. Microwave, Radar and & RF engineering, P.K. Chaturvedi,Springer

Course outcomes:

After completion of course student should be able to

- Express the basics related to RF and Microwave engineering.
- Demonstrate Scattering matrix and related measurement.
- Analyze RF components and circuits.
- Analyzethe problems related to basic antennas.
- Evaluate the mechanism of radio wave propagation.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	2
CO2	2	1	3	2	2	1
CO3	2	1	2	2	1	1
CO4	3	1	3	3	2	2
CO5	3	1	2	3	1	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	1	1

BASICS OF ANTENNA AND PROPAGATION (3-0-0)

Module - I (6 Hours)
Introduction, Basic antenna concepts

Module-II (8 Hours)

Point source and its array

Module - III (8 Hours)

Electric dipole and thin linear antenna, dipole array

Module – IV (10 Hours)

Slot, horn antenna, broadband and frequency independent antenna

Module – V (8 Hours)

Modes of radio wave propagation, Structure of Troposphere, Tropospheric Scattering, Ionosphere, Ionospheric Layers - D, E, F1, F2 regions. Sky wave propagation - propagation of radio waves through Ionosphere, Effect of earth's magnetic field, Virtual height, Skip Distance, MUF, Critical frequency, Space wave propagation.

Text Book:

1. Antenna Engineering, J. D. Krauss, Mc GrawHill
2. Electromagnetic Waves and Radiating Systems, E.C.Jordan&K.G.Balmain, PHI

Reference Book:

1. Antenna & Wave Propagation, R E. Collins, Mc GrawHill
2. Antennas Theory: Analysis and Design, C.A. Balanis, John Willey &Son
3. Antennas and Wave Propagation, G. S. N. Raju, PearsonEducation

Course outcomes:
After completion of course student should be able to
- *Explore the fundamentals related to various antennas.*
- *Gain idea about point source and its array.*
- *Design frequency independent antennas.*
- *Express different parameters related to wave propagation.*
- *Apply the concept of horn and slot antennas.*

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	2
CO2	2	2	3	3	1	2
CO3	3	2	2	2	1	1
CO4	3	2	3	2	2	1
CO5	2	1	2	3	2	1

Programme Articulation Matrix for this course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	3	2	1