JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH IN MICROWAVE AND RADAR ENGINEERING.
EFFECTIVE FROM ACADEMIC YEAR 2017- 18 ADMITTED BATCH

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Advanced Electromagnetic Theory	25	75	4	0	0	4
PC-2	Radar Systems Engineering	25	75	4	0	0	4
PC-3	Microwave Components and Measurements	25	75	4	0	0	4
PE-1	Satellite Communications Radio Navigational Aids Advanced Digital Signal Processing.	25	75	**3**	0	0	3
PE-2	Microwave Networks Detection and Estimation Theory Optical Communications and Networks	25	75	**3**	0	0	3
OE-1	***Open Elective – I**	25	75	3	0	0	3
Laboratory I	Microwave Measurements Lab	25	75	0	0	3	2
Seminar I	Seminar	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Microwave Antenna Theory & Design	25	75	4	0	0	4
PC-5	Radar Signals and Processing Techniques	25	75	4	0	0	4
PC-6	Microwave Solid State Devices	25	75	4	0	0	4
PE-3	Broadband Communications Phased Array Systems EMI / EMC	25	75	**3**	0	0	3
PE4	Smart Antennas Microwave Integrated Circuits Radar Signal Processing	25	75	**3**	0	0	3
OE-2	***Open Elective – II**	25	75	3	0	0	3
Laboratory II	Microwave Antenna Design and Simulation Lab	25	75	0	0	3	2
Seminar II	Seminar	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

ADVANCED ELECTROMAGNETIC THEORY (PC-1)

UNIT -I

Fundamental Concepts: Introduction, Basic Equations, constitutive relationships, generalized current concepts, energy and power, circuit concepts, complex quantities, complex equations, complex constitutive parameters, complex power, A-C Characteristics of matter, A discussion of current, A-C behavior circuit elements, Singularities of field.

UNIT -II

Introduction of Waves: Wave Equation, Waves in perfect dielectrics, Intrinsic wave constants, waves in lossy matter, reflection of waves, transmission line concepts, waveguide concepts, resonator concepts, radiation, and antenna concepts.

UNIT -III

Some Theorems & Concepts: Source concepts, duality, uniqueness, Image theory, Equivalence principle, fields in half space, Induction theorem, reciprocity, Green's functions, Integral equations, construction of solutions, the radiation field.

UNIT -IV

Plane Wave Functions: Wave functions, Plane waves, rectangular waveguides, alternative mode sets, Rectangular cavity, partially filled wave guide, dielectric- slab guide, surface guided waves, modal Expansions of fields, currents in waveguides, Apertures in ground planes.

UNIT -V

Method of Moments: Basis functions, Testing(Weighting) functions, Galerkin method, solutions to electrostatic problems, two dimensional field problems, wire antennas and scatterers using Method of Moments.(Selected topics of Chapters 1 to 4 of Text Book 2).

TEXT BOOKS:

1. R. F Harrington., "Time Harmonic Electromagnetics", McGraw Hill, 1961
2. RF Harrington, "Field Computation by Moment Methods", New York: MacMillan, 1968
3. E.C Jordan & K.G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Edition, Prentice Hall India, Pvt. Ltd., New Delhi.

REFERENCE BOOKS:

1. William H. Hayt and John A. Buck, Engineering Electromagnetics", 8th Edition, McGraw Hill, 2010
2. C.A. Balmain, "Advanced Engineering Electromagnetics", Wiley India, Pvt. Ltd., 2005

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MICROWAVE AND RADAR ENGINEERING

RADAR SYSTEMS ENGINEERING (PC-2)

UNIT -I

Radar Range Equation: Radar fundamentals, Derivation of range equation, the search radar equation, Jamming and radar range with jamming, Radar clutter and radar range with clutter, Radar range with combined interferences sources.

UNIT -II

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

UNIT -III

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

UNIT -IV

MTI Radar: Delay lines and line cancellors, Subclutter Visibility. MTI using range gates and filters, Pulse Doppler radar, Non-coherent MTI radar, Application of Digital signal processing to radar system.

Tracking Radar: Different types of tracking techniques, Tracking in range, Tracking in Doppler, Search Acquisition radar, Comparison of Trackers.

UNIT -V

Introduction to Pulse Compression Radar: Height finding radars, Air traffic control Radars and data handling, Atmospheric effects of radar, Electromagnetic compatibility aspects, Airborne Radars, Synthetic Aperture Radar, Secondary surveillance Radars.

TEXT BOOKS:

1. David Barton .K, “Modern Radar System Analysis”, Artech House, 1988.
2. Fred Nathanson E, “Radar Design Principles Signal Processing and The Environment”, McGraw Hill, 1969.

REFERENCE BOOKS:

1. Cook CE. Bernfield. M, “Radar Signals”, Academic Press, 1967.
2. Skolnik, “Introduction to radar systems”, McGraw Hill, 2nd Edition, 2003.

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

MICROWAVE COMPONENTS AND MEASUREMENTS (PC-3)

UNIT -I

Microwave Circuits & Theorems: Equation of Voltage and Currents, Impedance description of waveguide circuits, Fosters reactance theorem, N-Port circuits, Two-port junctions, S-matrix formulation and properties, Illustrative problems.

UNIT -II

Impedance Matching: Impedance matching Concepts, Quarter wave Transformers, Theory of small reflections, single and multi sections, Binomial and Chebysheve Transformers.

UNIT -III

Passive Microwave Components: Introduction to Power dividers and couplers-T Junctions and Willkinson power dividers, Analysis and Design of Directional Couplers- Bethehole, Multi hole Couplers, Quadrature Hybrids, Faraday rotation, S-matrix of Directional Couplers and T-Junctions, Gyrator, Isolator, Circulator- Applications.

UNIT -IV

Microwave Measurements-I: Measurement of Wavelength, Frequency and Impedance-Introduction, Equivalent circuit of Cavity wave meters, Typical wave meters, resonant cavities, Methods of frequency measurements-direct method - Interpolation method, Standard wave reflectors, Measurement of reflection coefficient, Low, Medium, High VSWR measurements, Standing wave pattern, Slotted Line section and its limitation, Impedance measurement techniques, Reflectometer.

UNIT -V

Microwave Measurements-II: 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 BOOKS:

1. R.E. Collin, “Foundations for microwave Engineering”, McGraw hill Kogakusha, Ltd, International Student edition, 2nd Edition.
2. Ahmad Shahid Khan, “Microwave Engineering Concepts and Fundamental”, CRC Press

REFERENCE BOOKS:

1. David. M. Pozar, “Microwave Engineering”, 3rd Edition, John wiley& Sons Inc, 1998.
2. M.L. Sisodia, G.S. Raghuvamsi, “Microwave Circuits and Passive Devices”, New Age International Pub. Ltd, WEL-1995.
3. E.I. Ginzton, “Microwave Measurements”, McGraw Hill Book Comp, INC, 1957.
4. Ganesh Prasad Srivastava, Vijaya Lakshmi Guptha, “Microwave and Circuit design”, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., New Delhi-2006.

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

SATELLITE COMMUNICATIONS (PE-1)

UNIT -I

Communication Satellite: Orbit and Description: A Brief history of satellite Communication, Satellite Frequency Bands, Satellite Systems, Applications, Orbital Period and Velocity, effects of Orbital Inclination, Azimuth and Elevation, Coverage angle and slant Range, Eclipse, Orbital Perturbations, Placement of a Satellite in a Geo-Stationary orbit.

UNIT -II

Satellite Sub-Systems: Attitude and Orbit Control system, TT&C subsystem, Attitude Control subsystem, Power systems, Communication subsystems, Satellite Antenna Equipment.

Satellite Link: Basic Transmission Theory, System Noise Temperature and G/T ratio, Basic Link Analysis, Interference Analysis, Design of satellite Links for a specified C/N, (With and without frequency Re-use), Link Budget.

UNIT -III

Propagation Effects: Introduction, Atmospheric Absorption, Cloud Attenuation, Tropospheric and Ionospeheric Scintillation and Low angle fading, Rain induced attenuation, rain induced cross polarization interference.

Multiple Access: Frequency Division Multiple Access (FDMA) - Intermodulation, Calculation of C/N, Time Division Multiple Access (TDMA) - Frame Structure, Burst Structure, Satellite Switched TDMA, On-board Processing, Demand Assignment Multiple Access (DAMA) – Types of Demand Assignment, Characteristics, CDMA Spread Spectrum Transmission and Reception.

UNIT -IV

Earth Station Technology: Transmitters, Receivers, Antennas, Tracking Systems, Terrestrial Interface, Power Test Methods, Lower Orbit Considerations.

Satellite Navigation and Global Positioning Systems: Radio and Satellite Navigation, GPS Position, Location Principles, GPS Receivers, GPS C/A Code, Accuracy, Differential GPS.

UNIT -V

Satellite Packet Communications: Message Transmission by FDMA: M/G/1 Queue, Message Transmission by TDMA, PURE ALOHA-Satellite Packet Switching, Slotted ALOHA, Packet Reservation, Tree Algorithm.

TEXT BOOKS:

1. Timothy Pratt, Charles Bostian, Jeremy Allnutt, “Satellite Communications”, 2nd Edition, 2003, John Wiley & Sons.
2. Wilbur, L. Pritchand, Robert A. Nelson and Heuri G. Suyderhoud, “Satellite Communications Engineering”, 2nd Edition, Pearson Publications.
3. Tri.T.Ha, “Digital Satellite Communications”, 2nd Edition, 1990, Mc .Graw Hill.

REFERENCE BOOKS:

1. Dennis Roddy, “Satellite Communications”, 2nd Edition, 1996, McGraw Hill.
2. M. Richcharia, “Satellite Communications: Design Principles”, 2nd Edition, BSP, 2003.
3. Tri. T. Ha, “Digital Satellite Communications”, 2nd Edition, MGH, 1990.
4. K. N. Raja Rao, “Fundamentals of Satellite Communications”, PHI, 2004.

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MICROWAVE AND RADAR ENGINEERING

RADIO NAVIGATIONAL AIDS (PE-1)

UNIT –I

Navigational Systems: Review of Navigational Systems: Aircraft navigational system. Geometry of the earth.Navigation equation.Navigation errors.Radio navigation system types and Performance parameters.ILS System, Hyperbolic navigation systems, Loran, Omega, Decca Radio direction finding, DME.TACAN and VORTAC.

UNIT –II

Inertial Navigation: Inertial navigation system. Sensing instruments: Accelerometer. Gyro- copes, Analytic and Gimbaled platforms. Mechanization.Error analysis, Alignment.

UNIT –III

Global Positioning System (GPS) for Navigation: Overview of GPS, Reference systems. Satellite orbits, Signal structure, Geometric dilution of precision (GDOP), or Precision dilution of recision (PDOP), Satellite ephemeris, Satellite clock, Ionospheric group delay. Tropospheric group delay, Multipath errors and Receiver measurement errors.

UNIT –IV

Differential GPS and WAAS: Standard and precise positioning service local area DGPS and Wide area DGPS errors. Wide Area Augmentation System (WAAS) architecture.Link budget and Data Capacity, Ranging function, Precision approach and error estimates.

UNIT –V

GPS Navigational Application: General applications of GPS, DGPS, Marine. Air and Land Navigation, Surveying, Mapping and Geographical information systems, Military and Space.

TEXT BOOKS:

1. Myron Kavton and Walter Friend, R, “Avionics Navigation Systems”, Wiley,1997
2. Parkinson. BW. Spilker, “Global Positioning System Theory and Applications”, Progress in Astronautics, Vol. I and II, 1996.

REFERENCE BOOKS:

1. Hoffman. B., Wellenhof. H. Lichtenegger and J. Collins, “GPS Theory and Practice”, Springer Verlang Wien New York, 1992.
2. Elliot D. Kaplan, “Understanding GPS Principles and Applications”, Artech House. Inc., 1996.
3. Lieck Alfred, “GPS Satellite Surveying”, John Wiley, 1990.

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

ADVANCED DIGITAL SIGNAL PROCESSING (PE-1)

UNIT –I

Review of DFT, FFT, IIR Filters and FIR Filters: Introduction to filter structures (IIR & FIR).Implementation of Digital Filters, specifically 2nd Order Narrow Band Filter and 1st Order All Pass Filter. Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Backward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT -II

Non-Parametric Methods: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametric methods

UNIT - III

Parametric Methods: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Walker & Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

UNIT –IV

Multi Rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion. Examples of up-sampling using an All Pass Filter.

UNIT –V

Applications of Multi Rate Signal Processing: Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Subband Coding of Speech Signals, Quadrature Mirror Filters, Transmultiplexers, Over Sampling A/D and D/A Conversion.

TEXT BOOKS:

1. J.G. Proakis & D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms & Applications”, 4th Edition, PHI.
2. Alan V Oppenheim & Ronald W Schaffer, “Discrete Time signal processing”, PHI.
3. Emmanuel C. Ifeacher, Barrie. W. Jervis, “DSP – A Practical Approach”, 2nd Edition, Pearson Education.

REFERENCE BOOKS:

1. S. M .Kay, “Modern spectral Estimation: Theory & Application”, 1988, PHI.
2. P.P. Vaidyanathan, “Multi Rate Systems and Filter Banks”, Pearson Education.
3. Kaluri V. Rangarao, Ranjan K. Mallik, “Digital Signal Processing: A Practitioner's Approach”, ISBN: 978-0-470-01769-2, 210 pages, November 2006 John Weley.
4. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, “Digital Signal Processing”, 2000,TMH

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

MICROWAVE NETWORKS (PE-2)

UNIT –I

Introduction to Microwave Circuit Concept: One port junction, Terminal voltage and currents in multiport junctions, Poynting's energy theorem, Normalized waves and scattering matrix. Properties of [S]matrix

UNIT –II

Relationship between [S], [Z] and [Y] Parameters: Wave amplitude transmission matrix[A], Relation between [A] and [S], [S] matrix of magic T, E and H plane tees, Directional coupler, Applications of hybrid junction and magic tee.

UNIT –III

Passive Microwave Devices: Even and odd mode analysis of symmetrical 4 port networks, Analysis and design of branch line couplers, Hybrid ring coupler, Frequency response, Branching synthesis of hybrids, Applications of hybrids.

UNIT –IV

Microwave Propagation in Ferrites: Principles of Faraday rotation, Isolator, Gyrator, Circulator, Phase shifters, S-matrix of non reciprocal devices, Broad band matching multisection quarter wave transformers, Binomial and Chebyshev transformers design, Tapered transmission line exponential and triangular tapers, Synthesis of transmission line tapers.

UNIT –V

Wave Analysis of Periodic Structures: Image parameters method of microwave filter design, Power loss ratio, Filter design by insertion loss method, Frequency transformation, maximally flat and Chebyshev filter design and characteristics.

TEXT BOOKS:

1. Altman JL, "Microwave circuits", D van Nostrand Co., Inc.,1964.
2. Collins. RE, "Foundations for microwave engineering", John Wiley & Sons, inc 2nd Edition, 2009.

REFERENCE BOOKS:

1. Ghosh. RN, "Microwave Circuit Theory and Analysis", McGraw Hill.
2. Pozar.D M, "Microwave Engineering", 2nd Edition, John Wiley and Sons, Inc.,1999.

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MICROWAVE AND RADAR ENGINEERING

DETECTION AND ESTIMATION THEORY (PE-2)

UNIT –I

Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

UNIT –II

Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)- minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

UNIT –III

Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

UNIT –IV

Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

UNIT –V

Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

TEXT BOOKS:

1. K. Sam Shanmugan & A.M. Breipohl, “Random Signals: Detection, Estimation and Data Analysis”, Wiley India Pvt. Ltd, 2011.
2. Lonnie C. Ludeman, “Random Processes: Filtering, Estimation and Detection”, Wiley India Pvt. Ltd., 2010.

REFERENCE BOOKS:

1. Steven. M.Kay, “Fundamentals of Statistical Signal Processing: Volume I Estimation Theory”, Prentice Hall, USA, 1998.
2. Steven. M.Kay, “Fundamentals of Statistical Signal Processing: Volume I Detection Theory”, Prentice Hall, USA, 1998.
3. Srinath, Rajasekaran, Viswanathan, “Introduction to Statistical Signal Processing with Applications”, 2003, PHI.
4. Louis L. Scharf, “Statistical Signal Processing: Detection, Estimation and Time Series Analysis”, 1991, Addison Wesley.
5. Harry L. Van Trees, “Detection, Estimation and Modulation Theory: Part – I”, 2001, John Wiley & Sons, USA.
6. Mischa Schwartz, Leonard Shaw, “Signal Processing: Discrete Spectral Analysis – Detection & Estimation”, 1975, McGraw Hill.

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M. TECH. – I YEAR – I SEMESTER
MICROWAVE AND RADAR ENGINEERING

OPTICAL COMMUNICATIONS AND NETWORKS (PE-2)

UNIT - I

Optical Fibers: Structures, wave guiding and Fabrication: Nature of Light, Basic optical laws and definitions, Single mode fibers, Graded index fiber structure, Attenuation, Signal Dispersion in fibers.
Optical Sources- LEDs, Laser Diodes, Line Coding.

UNIT - II

Photo detectors: Photo detector Noise, Detector Response Time, Avalanche Multiplication Noise.
Optical Receiver Operation- Fundamental receiver operation, Digital receiver performance, Eye diagrams.
WDM Concepts and Components- Passive optical Couplers, Isolators and Circulators

UNIT - III

Digital Links: Point to point links, power penalties, error control, Coherent detection, Differential Quadrature Phase Shift Keying.
Analog Links: Carrier to noise ration, Multichannel Transmission Techniques, RF over Fiber, Radio over fiber links, Microwave Photonics.

UNIT - IV

Optical Networks: Network Concepts, Network Topologies, SONET/SDH, High speed lightwave links, Optical add/ Drop Multiplexing, Optical Switching, WDM Network, Passive Optical Networks, IP Over DWDM, Optical Ethernet, Mitigation of Transmission Impairments

UNIT - V

Performance Measurement and Monitoring: Measurement standards, Basic Test Equipment, Optical power measurement, Optical fiber characterization, Eye diagram tests, optical time domain reflectometer, optical performance monitoring, optical fiber system performance measurements.

TEXTBOOKS:

1. Gerd Keiser, “Optical Fiber Communications”, 5th Edition, McGraw Hill.
2. Rajeev Ramaswamy and Kumar N Sivarajan, “Optical Networks: A Practical Perspective”, 2nd Ed., 2004, Elsevier Morgan Kaufmann Publishers (An imprint of Elsevier).

REFERENCE BOOKS:

1. John. M. Senior, “Optical Fiber Communications: Principles and Practice”, 2nd Ed, 2000, PE.
2. Harold Kolimbris, “Fiber Optic Communication”, 2nd Ed, 2004, PEI
3. Uyless Black, “Optical Networks: Third Generation Transport Systems”, 2nd Ed, 2009, PEI
4. Govind Agarwal, “Optical Fiber Communications”, 2nd Ed, 2004, TMH.
5. S. C. Gupta, “Optical Fiber Communications and its Applications”, 2004, PHI

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MICROWAVE AND RADAR ENGINEERING

MICROWAVE MEASUREMENTS LAB (LABORATORY I)

Section -A

1. Microwave source characteristics-Reflex Klystron and Gunn oscillator
2. Waveguide Discontinuities-Inductive and capacitive Diaphragms
3. Slide Screw Tuner-Equivalent circuit
4. S-matrix of Directional Coupler, Circulator, Magic Tee
5. Gain measurement of 1) Pyramidal Horn, 2) Conical Horn antennas.
6. Pattern Measurement of 1. Pyramidal Horn, 2.Conical Horn antennas.
6. Characterization of Waveguide Slotted Array
7. Frequency Scanned Array Characteristics
8. Measurement of Input Impedance of an Antenna
9. Measurements with Network Analyzer

Section –B

The above Experiments are to be conducted preferably using X-band setup.