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 - I	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 - II	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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. – I YEAR – II SEMESTER MICROWAVE AND RADAR ENGINEERING

MICROWAVE ANTENNA THEORY & DESIGN (PC- 4)

UNIT - I

Antenna Theory: Antennas, Radiation concept, Types of Antennas, Antenna parameters, Friis Transmission equation.

UNIT - II

Aperture Antenna: Introduction, Pyramidal Horns- Design Procedure, Conical and Corrugated Horns, Aperture Corrugated Horns, Reflected Antennas- Parameters, Analysis of front-fed parabolic reflector, Feed methods and feed types, Cassegrain Reflector Horns.

UNIT - III

Microstrip Radiators: Introduction, Rectangular Microstrip Antenna analysis and Design, Circular Microstrip Antenna Analysis and Design,

UNIT - IV

Microstrip Slot Antennas: Wave guide fed slots, Radiation mechanism, Micro strip slot antennas, Introduction to rectangular slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas.

UNIT - V

Micro Strip Antenna Arrays: Introduction, Micro strip array antennas, Characteristics of fixed beam linear antenna arrays, Linear micro strip arrays, Characteristics of planar arrays, Microstrip planar arrays, Microstrip scanned array antennas, Phase scanned microstrip arrays, Time delay scanning, Electronic feed switching, Frequency scanned microstrip arrays, Advantage and disadvantages of phased array antennas.

TEXT BOOKS:

1. Constantine Balanis. A, “Antenna Theory-Analysis and Design”, 3rd Edition, John Wiley, 2005.
2. Bahl IJ, and P. Bhartia, “Microstrip Antennas”, Artech House, 1980.

REFERENCE BOOKS:

1. Ramesh Garg, Prakash Bhatia, Inder Bahl, Apisak Ittipiboon, “Microstrip Antenna Design Hand Book”, Artech House Inc., 2001.
2. Samuel Silver, “Microwave Antenna - Theory and design”, IEE Press, 1984.
3. James. J R. Hall, P S. Wood. C, “Micro strip Antenna-Theory and Design”, Peter Peregrinus Ltd., 1981.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. – I YEAR – II SEMESTER MICROWAVE AND RADAR ENGINEERING

RADAR SIGNALS AND PROCESSING TECHNIQUES (PC - 5)

UNIT- I

Introduction: Radar Block Diagram, Radar Equation, Information Available from Radar Echo, Review of Radar Range Performance– General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bistatic Radar. Matched Filter Receiver – Impulse Response, Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver, Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

UNIT – II

Detection of Radar Signals in Noise: Detection Criteria – Neyman-Pearson Observer, Likelihood-Ratio Receiver, Inverse Probability Receiver, Sequential Observer, Detectors – Envelope Detector, Logarithmic Detector, I/Q Detector. Automatic Detection - CFAR Receiver, Cell Averaging CFAR Receiver, CFAR Loss, CFAR Uses in Radar, Radar Signal Management – Schematics, Component Parts, Resources and Constraints.

UNIT – III

Waveform Selection: Radar Ambiguity Function and Ambiguity Diagram – Principles and Properties; Specific Cases – Ideal Case, Single Pulse of Sine Wave, Periodic Pulse Train, Single Linear FM Pulse, Noiselike Waveforms, Waveform Design Requirements, Optimum Waveforms for Detection in Clutter, Family of Radar Waveforms.

UNIT – IV

Pulse Compression in Radar Signals: Introduction, Significance, Types. Linear FM Pulse Compression – Block Diagram, Characteristics, Reduction of Time Sidelobes, Stretch Techniques, Generation and Decoding of FM Waveforms – Block Schematic and Characteristics of Passive System, Digital Compression, SAW Pulse Compression.

UNIT – V

Phase Coding Techniques: Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar.
Poly Phase Codes: Frank Codes, Costas Codes, Non-Linear FM Pulse Compression, Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM). Sidelobe Reduction for Phase Coded PC Signals.

TEXT BOOKS:

1. M.I. Skolnik, “Radar Handbook”, 2nd Edition, 1991, McGraw Hill.
2. Fred E. Nathanson, “Radar Design Principles: Signal Processing and The Environment”, 2nd Edition, 1999, PHI.
3. M.I. Skolnik, “Introduction to Radar Systems”, 3rd Edition, 2001, TMH.

REFERENCE BOOKS:

1. Peyton Z. Peebles, Jr., “Radar Principles”, 2004, John Wiley.
2. R. Nitzberg, “Radar Signal Processing and Adaptive Systems”, 1999, Artech House.
3. F.E. Nathanson, “Radar Design Principles”, 1st Edition, 1969, McGraw Hill.

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

MICROWAVE SOLID STATE DEVICES (PC - 6)

UNIT – I
Varactor Diode: Equivalent circuit, static and dynamic figures of merit Manley Rowe power relation, parametric amplifiers, up converter, Degeneration amplifiers, Varactor multipliers, Charge storage capacitance.

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

UNIT – III
PIN Diodes: Description, the I-layer, Equivalent circuit behavior under reverse bias and forward bias, Diode impedance, Materials, Applications.

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

UNIT – V
Microwave Transistor: Wafer design. Equivalent circuit, Design compromises, Package design.

TEXT BOOKS:
1. Watson, “Microwave Semiconductor Devices and their applications”, McGraw Hill, 1969.
2. Sze. S.M, and Kwok K. Ng, “Physics of Semiconductor Devices”, John Wiley, 3rd Edition 2007.

REFERENCE:
1. Shurmer, H.V, “Microwave Semiconductors”, Wien Oldenbourg, 1971.

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

BROADBAND COMMUNICATIONS (PE - 3)

UNIT – I

ISDN: Switching Techniques, Principles of ISDN, Architecture, ISDN standards, I-series, Recommendations, Transmission structure, User network interface, ISDN protocol, architecture, ISDN connections, Addressing, Interworking

UNIT – II

B-ISDN: Architecture and standards, B-ISDN Services, Conversational, Messaging, Retrieval, Distribution, Business and Residential requirements, B-ISDN protocols User plane, Control plane, Physical layer, Line coding, Transmission structure, SONET- Requirement, Signal Hierarchy, System Hierarchy.

UNIT – III

ATM: Overview, Virtual channels, Virtual paths, VP and VC switching, ATM cells, Header format, Generic flow control, Header error control, Transmission of ATM cells, Adaptation layer, AAL services and protocols.

UNIT – IV

ATM switching: ATM switching building blocks, ATM cell processing in a switch, Matrix type switch, Input, Output buffering, Central buffering, Performance aspects of buffering switching networks.

UNIT – V

ATM Traffic and congestion Control: Requirements for ATM Traffic and Congestion Control, Cell-Delay Variation, ATM Service Categories, Traffic and Congestion Control Framework, Traffic Control, Congestion Control

TEXT BOOKS:

1. William Stallings, “ISDN and Broadband ISDN with Frame Relay and ATM”, Prentice-Hall, 4th edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. – I YEAR – II SEMESTER MICROWAVE AND RADAR ENGINEERING

PHASED ARRAY SYSTEMS (PE - 3)

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

Frequency Scanned Array Design: Snake feed, Frequency-phase scanning, Phase scanning, Digital phase shifter PIN diode and Ferrite phase shifters for phased arrays, Beam pointing errors due to digitization, Beam pointing accuracy.

UNIT – V

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

TEXT BOOKS:

1. Olliner, A.A, and G.H. Knittel, “Phased Array Antennas”, Artech House, 1972.
2. Kahrilas. PJ, “Electronic Scanning Radar Systems Design Handbook”, Artech House, 1976.

REFERENCE BOOKS:

1. Skolnik. MI, “Radar Handbook”, Mc Graw Hill, NY, Mc Graw Hills-2007
2. Galati,G-(editor), “Advanced Radar Technique and Systems”, Peter Peregrinus Ltd, London, 1993.

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

ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY (EMI / EMC) (PE - 3)

UNIT - I

Introduction, Natural and Nuclear Sources of EMI / EMC: Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations, An overview of EMI / EMC, Natural and Nuclear sources of EMI.

UNIT - II

EMI from Apparatus, Circuits and Open Area Test Sites: Electromagnetic emissions, Noise from relays and switches, Non-linearity in circuits, passive intermodulation, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic interference (EMI), Open area test sites and measurements.

UNIT - III

Radiated and Conducted Interference Measurements and ESD: Anechoic chamber, TEM cell, GH TEM Cell, Characterization of conduction currents / voltages, Conducted EM noise on power lines, Conducted EMI from equipment, Immunity to conducted EMI detectors and measurements, ESD, Electrical fast transients / bursts, Electrical surges.

UNIT - IV

Grounding, Shielding, Bonding, and EMI filters: Principles and types of grounding, Shielding, and bonding, Characterization of filters, Power lines filter design.

UNIT - V

Cables, Connectors, Components and EMC Standards: EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, optoisolators, National / International EMC standards.

TEXT BOOKS:

1. Dr. V.P. Kodali, IEEE Publication, “Engineering Electromagnetic Compatibility”, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. IIT – Delhi, “Electromagnetic Interference and Compatibility IMPACT series”, ,Modules 1 – 9.

REFERENCE BOOKS:

1. C.R. Pal., “Introduction to Electromagnetic Compatibility”, Ny John Wiley, 1992.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. – I YEAR – II SEMESTER MICROWAVE AND RADAR ENGINEERING

SMART ANTENNAS (PE - 4)

UNIT - I

Smart Antennas: Introduction, Need for Smart Antennas, Overview, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.

UNIT - II

DOA Estimation Fundamentals: Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Autocovariance, Conventional DOA Estimation Methods, Conventional Beamforming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates .

UNIT - III

Beam Forming Fundamentals: Classical Beam former, Statistically Optimum Beamforming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beamforming

UNIT - IV

Integration and Simulation of Smart Antennas: Overview, Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Adhoc Networks (MANETs), Protocol, Simulations, Discussion.

UNIT - V

Space–Time Processing: Introduction, Discrete Space–Time Channel and Signal Models, Space–Time Beamforming, Intersymbol and Co-Channel Suppression, Space–Time Processing for DS-CDMA, Capacity, and Data Rates in MIMO Systems, Discussion.

TEXT BOOKS:

1. Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2. Joseph C. Liberti Jr., Theodore S Rappaport, "Smart Antennas for Wireless Communications IS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

REFERENCE BOOKS:

1. T.S Rappaport, "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2. Lal Chand Godara, "Smart Antennas", CRC Press, LLC-20

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MICROWAVE INTEGRATED CIRCUITS (PE - 4)

UNIT- I
MIC Technology – Thick film and Thin film technology, Hybrid MICs, Monolithic MIC technology.

UNIT - II
Analysis of stripline and microstripline, Method of conformal Transformation, Characteristic parameters of strip, Microstrip lines, Microstrip Circuit Design, Impedance transformers, Filters, Lumped constant Microstrip circuits.

UNIT - III
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.

UNIT - IV
Lumped Elements for MICs, Design and fabrication of lumped elements, circuits using lumped elements.

UNIT - V
Nonreciprocal components for MICs, Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters, Design of microstrip circuits – high power and low power circuits.

TEXT BOOKS:
1. Gupta KC and Amarjit Singh, “Microwave Integrated circuits”, Wiley Eastern, 1974.
2. Leo Young, “Advances in Microwaves”, Academic Press.

REFERENCE BOOKS:
1. Bharathi Bhat,and S.K. Koul, “Strip line-like Transmission Lines for Microwave Integrated Circuits”, New Age International, 2007.

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RADAR SIGNAL PROCESSING (PE - 4)

UNIT - I

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

UNIT - II

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

UNIT - III

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

UNIT - IV

Introduction to Synthetic Aperture Imaging, Introduction to SAR Fundamentals, Stripmap SAR Data Characteristics, Stripmap SAR Image Formation Algorithms, Spotlight SAR Data Characteristics, the Polar Format Image Formation Algorithm for Spotlight SAR, Interferometric SAR

UNIT - V

Introduction to Beamforming and Space-Time Adaptive Processing- Spatial Filtering, Space-Time Signal Environment , Space Time Signal Modeling, Processing the Space Time Signal, Computational Issues in STAP, Reduce – Dimension STAP, Advanced STAP Algorithms and Analysis, Limitations to STAP

TEXT BOOKS:

1. Mark A. Richards, “Fundamentals of Radar Signal Processing”, McGraw Hill
2. Fred E. Nathanson, “Radar Design Principles: Signal Processing and The Environment”, 2nd Edition, 1999, PHI.
3. M.I. Skolnik, “Introduction to Radar Systems”, 3rd Edition, 2001, TMH.

REFERENCE BOOKS:

1. Peyton Z. Peebles, Jr., “Radar Principles”, 2004, John Wiley.
2. R. Nitzberg, “Radar Signal Processing and Adaptive Systems”, 1999, Artech House.
3. F.E. Nathanson, “Radar Design Principles”, 1st Edition, 1969, McGraw Hill.

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MICROWAVE ANTENNA DESIGN AND SIMULATION LAB

SECTION –A

Design and testing of microwave Antennas operations:

1. Pyramidal Horn- Antenna
2. Conical Horn –Antenna
3. Rectangular Microstrip patch Antenna
4. Circular Microstrip patch Antenna
5. Microstrip Monopole Antenna.

SECTION –B

Software Simulation (using HFSS/IE3D/FEKO or Equivalent) and Testing of:

1. Rectangular Microstrip Antenna, Circular Microstrip antenna.
2. Micro strip Monopole
3. Microstrip Tee
4. Cylindrical Horn antenna, Pyramidal Horn antenna
5. Microstrip Filters
6. Microstrip power Dividers, Passive Components
7. Radar Signals