

	Transmission Electron Microscopy (TEM), High Resolution Transmission Electron Microscopy (HRTEM)	
2.	Infrared Spectroscopy, Raman Spectroscopy, Electronic spectroscopy for atoms and molecules, Spin Resonance Spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR), Deep level transient spectroscopy (DLTS), Kelvin-probe measurements, Nanoscale current-voltage (I-V) investigations, Capacitance-Voltage (C-V) Relationships	08
3.	Fundamental concepts of Bottom-Up and Top-Down approaches, Self assembly and Self organization, Lithographic Process and its Limitations, Nonlithographic Techniques	04
4.	Growth Techniques of Nanomaterials: Plasma Arc discharge, Sputtering, Evaporation: Thermal, E-beam evaporation, Laser ablation, Chemical Vapor Deposition (CVD), Plasma enhanced CVD, Thermal CVD, Vapor phase growth, Laser assisted Thermal CVD, Pulsed Laser Deposition, Molecular Beam Epitaxy (MBE), Sol-Gel Technique, Electrodeposition, Other Processes: Ball Milling, Chemical Bath Deposition (CBD), Ion Beam Deposition (IBD), Ion Implantation	12
5.	Fabrication of nanoparticles, Synthesis of colloidal particles, Synthesis of nanogold particles, Synthesis of nanocomposites and nanostructures, Fabrication of quantum dots, Nanowires, Nanorods, Nanointermetallics, Controlled colloidal synthesis, Synthesis of polymer supported clusters and polymeric nanofibers, Nanolithography, Electron beam and focused ion beam lithographies, Carbon Nanotubes (CNT's): Single Walled, Multi-walled	10
Total		42

11.Suggested Books:

S. No.	Name of Books/ Authors	Year of publication/ Reprint
1.	Nanotechnology by Gregory Timp	1999/Springer
2.	Introduction to Nanoscience & Technology by K.K. Chattopadhyay, A.N. Banerjee	2012/PHI Learning Pvt. Ltd.
3.	Nanolithography: A borderland between STM, EB, IB and X-ray lithographies- M. Gentili et al	1994/Springer
4.	Nanostructures & Nano Materials by Guozhong Cao, Ying Wang	2011/World Scientific
5.	Infrared Spectroscopy: Fundamentals and applications by Barbara Stuart	2004/Wiley

1. Subject Code: EP 306 Course Title: Microwave Engineering
 2. Contact Hours: L: 3 T: 0 P: 2
 3. Examination Duration (Hrs.) Theory: 3 Practical: 0
 4. Relative Weight: CWS: 15 PRS:15 MTE: 30 ETE: 40 PRE: 0
 5. Credits: 4
 6. Semester: EVEN
 7. Subject Area: DCC
 8. Pre-requisite: NIL
 9. Objective: To familiarize the student with the concept of transmission line, microwave tubes and devices.
 10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction and review of transmission lines.	2
2.	Applications of Microwaves. Waveguide components and applications- Coupling Mechanisms – Probe, Loop, Aperture types.	2
3.	Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads	2
4.	Waveguide Attenuators –Resistive Card, Rotary Vane types; Waveguide Phase Shifters– Dielectric, Rotary Vane types.	2
5.	Waveguide Multiport Junctions – E plane and H plane Tees, Magic Tee, Hybrid Ring	2
6.	Directional Couplers – 2 Hole, Bethe Hole types	2
7.	Ferrites– Composition and Characteristics, Faraday Rotation; Ferrite Components – Gyrator, Isolator, Circulator.	2
8.	Scattering Matrix– Significance, Formulation and Properties. S Matrix Calculations for – 2 port Junction, E plane and H plane Tees, Magic Tee, Directional Coupler, Circulator and Isolator.	2
9.	MICROWAVE SOLID STATE DEVICES: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes	4
10.	Avalanche Transit Time Devices – Introduction, IMPATT and TRAPATT Diodes.	2
11.	Limitations and Losses of conventional tubes at microwave frequencies	2
12.	Microwave tubes – O type and M type classifications. O-type tubes	2
13.	2 Cavity Klystrons – Structure, Reentrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory – Expressions for o/p Power and Efficiency.	4
14.	Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Mathematical Theory of Bunching.	2
15.	Significance, Types and Characteristics of SlowWave Structures; Structure of TWT and Amplification Process (qualitative treatment), Suppression of Oscillations, Nature of the four Propagation Constants, Gain Considerations.	3
16.	M-type Tubes- Introduction, Cross-field effects, Magnetrons	2
17.	Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron	2
18.	Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation.	3
Total		42

11.Suggested Books:

S.No.	Name of Books/ Authors	Year of Publication/ Reprint
1.	Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3 rd Edition,	1994.
2.	2. Microwave Principles – Herbert J. Reich, J.G. Skalnik, P.F. Ordung and H.L. Krauss, CBS Publishers and Distributors, New Delhi,	2004.
3.	3. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley,	2nd Edition, 2002.
4.	4. Microwave Circuits and Passive Devices – M.L. Sisodia and G.S.Raghuvanshi, Wiley Eastern Ltd., New Age International Publishers Ltd.,	1995.
5.	5. Microwave Engineering Passive Circuits – Peter A. Rizzi, PHI,	1999.
6.	6. Electronic and Radio Engineering – F.E. Terman, McGraw- Hill, 4th ed.,	1955.