**Details of Course**

|  |  |  |
| --- | --- | --- |
| **Course Title** | **Course Structure** | **Pre-Requisite** |
| **Advanced Semiconductor and Microwave Devices** | |  |  |  | | --- | --- | --- | | **L** | **T** | **P** | | **3** | **0** | **2** | | **NIL** |

|  |
| --- |
| Course Objectives  This course addresses semiconductor and microwave devices at a fundamental level. It aims to enlighten the students with semiconductor materials, p/n junctions, transistors, Solid State Devices, Microwave devices/components. Understanding the physical mechanism of different Microwave Devices/High Power Microwave Devices. Understanding the Physical mechanism of Micro and Nanoelectronics Devices and their applications for Field emission properties, solar cells, supercapacitor/rechargeable batteries. |

|  |
| --- |
| Course Outcome (CO)  1. To understand major properties of semiconductor materials, and to design semiconductor devices and  calculate device characteristics and learn about Solid State Microwave Devices - their principles, mode  of operation and application.  2. To be cognizant of different waveguides, their properties and parameters associated, and to extend the  limitations of conventional tubes towards evolution of Klystron, Magnetron and TWT.  3.To analyse the physics and implementation of different High Power Microwave Devices.  4.To evaluate the growth and field emission properties of Graphene, Carbon Nanotubes (CNTs), g-CNT  Hybrid, and their applications in FETs and MOSFET.  5. To study of CNTFET and g-FET based Biosensor for the detection of various Biomolecules. |

|  |  |  |
| --- | --- | --- |
| S. No. | Content | Contact Hours |
| Unit 1 | Semiconductor Micro and Nanoelectronics Devices and their latest industrial revolution, Moore’s Law, Concept of Fermi level, charge carriers and doping. Properties of the p/n junction, Bipolar Junction Transistors (BJT): basic principles and models of operation, Need for MOSFET/MESFET devices. SOLID STATE MICROWAVE DEVICES: TEDs- Gunn Diode – Principle, Characteristics, and basic modes of operation. Avalanche Transit Time Devices: IMPATT and TRAPATT Diodes. | 12 |
| Unit 2 | Applications of Microwaves. Waveguide components (Attenuators, Phase Shifters, E plane and H plane Tees, Magic Tee, Directional Couplers, Gyrator, Isolator, Circulator).  Scattering Matrix– Significance, Formulation and Properties. Limitations of conventional tubes at microwave frequencies. Microwave tubes: two Cavity Klystrons, Reflex Klystrons and their characteristics & Applications. | 12 |
| Unit 3 | HELIX TWTs**:** Structure of TWT, Amplification Process (qualitative treatment) and Significance. Magnetrons: Hull Cut-off magnetic equation and Hull Cut-off voltage equation, and PI-Mode Operation. | 4 |
| Unit 4 | High Power Microwave Devices:Free Electron Laser (FEL): motion in a wiggler magnetic field, Gain estimate and efficiency in Compton, and Raman regime. Cerenkov free electron laser (CFEL) interaction, electron-beam excitation of a slow wave. | 6 |
| Unit 5 | Plasma production using Microwave Plasma Enhanced Chemical Vapor deposition (MPECVD) technique,Nucleation, Growth and Field Emission Properties of Carbon Nanotubes (CNTs), Graphene and g-CNT composites and their applications in FETs, MOSFET and solar cells. | 8 |
|  | Total | 42 |

**Books:**

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Name of Books/Authors/Publisher** | **Year of publication/Reprint** |
| 1. | Microwave Devices and Circuits – Samuel Y. Liao, PHI | 3rd Edition 2003 |
| 2. | Principles of Plasma Physics, N.A. Krall and A.W. Trivelpiece, McGraw-Hill LTD | 1986 |
| 3. | Foundations for Microwave Engineering – R.E. Collin | IEEE Press, John Wiley (2nd Edition, 2001). |
| 4. | Microwave Engineering Passive Circuits | Peter A. Rizzi, PHI (1999). |
| 5. | Electronic and Radio Engineering – F.E. Terman, McGraw- Hill | 4th ed. (1955). |
| 6. | Interaction of Electromagnetic Waves with Electron Beams and Plasmas, C.S. Liu and V.K. Tripathi, World Scientific Singapore | 1994 |
| 7. | Free Electron Lasers by T.C. Marshall, Macmillan Publishing Co., New York | 1985 |
| 8. | Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press | 2011 |
| 9. | Semiconductor Devices Physics and Technology by S.M. SZE, John Wiley & Sons (New York) | 2012 |
| 10. | Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press. | 2011 |

**List of Experiments -Vth Semester B.Tech. EP**

1. Study of various microwave Components.

2. To study V-I characteristics of Gunn Diode.

3. To study the characteristics of Klystron Tube and to determine its electronic

tuning range.

4. To determine the frequency & wavelength in a rectangular wave-guide working on TE10 mode.

5. To stud To measure the polar pattern and the gain of a waveguide horn Antenna.

6. To measure the gain and beam width of different Antennas.

7. To Study the function of Multi hole Directional Coupler (MHD Coupler) by

measuring the following parameters:

i) To measure main-line and auxiliary-line VSWR

ii) To measure the coupling factor, insertion-loss/Isolation and directivity of

coupler.

8. Study of Circulator/Isolator.

9. To study of Attenuators (Variable type).

10.To Measurement of phase shift of a phase shifter.

**For Fast Learners**

1. To Study of Voice Communication by using Microwave test bench.

2. Study of PC to PC communication by using Microwave test bench

3. Study of PC to PC communication using MIC components