Engineering Physics for Electronics Cluster

Course Code: 26ENXXXX
Semester: 1 and 2
Programs Offered: B. Tech. (Electronics Cluster)
Course Type: Core
L – T – P – J: 3 – 0 – 2 – 0

Course Modules

Module - 1: Quantum mechanics [7 Hours]

Quantum Mechanics: Foundations of quantum theory, Wave function and its properties, de-Broglie hypothesis, Heisenberg Uncertainty principle. One dimensional time independent Schrodinger wave equation, Eigen values and Eigen functions. Applications: one dimensional motion of an electron in a potential well. Basics of Quantum computing - Concepts of Superposition, Entanglement, Interference and Qubit. **[7 hours]**

MODULE - 2: Semiconductor Physics and Devices [11 Hours]

Semiconductor Physics: Classification of Solids, Band structure, Fermi level in intrinsic and extrinsic semiconductors, Density of energy states in conduction and valence bands of a semiconductor (Mention the expression), Expression for concentration of electrons in conduction band (Derivation), Intrinsic carrier concentration, Conductivity of semiconductors, Hall effect, Derivation of Hall Coefficient, Numericals. **[7 hours]**

Semiconducting devices for optoelectronic applications: - Principle and working of Zener diode, Light Emitting Diode, Photodiode, Solar cell and BJT characteristics. [**4 hours**]

Module - 3: Novel Electronic Materials, Devices and Fabrication Techniques [10 Hours]

Novel materials: Two-Dimensional (2D) Materials-Graphene and Transition Metal Dichalcogenides (TMDs – e.g., MoS_2, WS_2, Hexagonal Boron Nitride (h-BN); Growth of 2D materials using Chemical Vapor deposition, Topological Insulators (Materials: Bi_2Se_3, Bi_2Te_3) Perovskite Materials, Applications of Electronic materials for device applications [**4 hours**]

Thin films technology: Introduction to thin films-Advantages of thin films over bulk materials, Thin film deposition processes - Physical vapor deposition (Thermal evaporation technique and sputtering technique) process, Applications of Thin films. [**3 hours**]

Nano Science & technology: Introduction to Nano materials, Size dependent properties of materials, Top-down and Bottom-up approach, Ball-milling, Photolithography, Applications of Nano technology in Engineering. [**3 hours**]

Module - 4: Optical Fibers and Optical Communication Systems [8 Hours]

Introduction to Optical Fibers: Optical Fiber and its components, Principle of Operation- Total Internal Reflection (TIR). Optical Parameters-Critical Angle: Acceptance Angle (θ_a), Numerical Aperture (NA), Types of Optical Fibers based on Modes and Based on Refractive Index Profile, Losses in Optical Fibers. [**4 hours**]

Fiber Optic Communication System-Transmitter: Optical Sources- Laser Diodes, Receiver-Photodetectors (PIN Photodiodes) Fiber Optic Communication system (Basic elements, construction and working) Applications of Optical Fibers in Telecommunications, Medical Imaging, Industrial Automation, and Défense, Numerical Problems [**4 hours**]

Module - 5: AI for Semiconductor Technology (9 Hours)

Semiconductor device process flow and fabrication (5 Hours), TCAD (Technology Computer-Aided Design) for designing, modelling, and optimizing semiconductor devices (2 Hours), Dataset preparation for lithography, Image-to-image translation in semiconductor patterns (3 Hours)

List of Experiments

No.	Experiment	Module Link
1	I-V Characteristics of Zener Diode	Module II
2	Four Probe Technique -Resistivity	Module II
3	Laser Wavelength determination using Diffraction grating	Module IV
4	Band Gap Energy of Intrinsic Semiconductor	Module II
5	Planck's Constant using LED	Module II
6	Numerical and Attenuation of Optical Fiber	Module IV
7	Transistor Characteristics (NPN-CE)	Module II
8	Hall Effect - Concentration, Mobility & Conductivity	Module II