BVM ENGINEERING COLLEGE [AN AUTONOMOUS INSTITUTION]

104BS: SEMICONDUCTOR PHYSICS
CREDITS -4 (L_c , T_c , P_c : 3,0,1)

Course Objective:

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
L	T	P	C	Theory		Practical		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Sr. No.	Topics	Teaching Hours
1.	**Crystal Structures:** Classification of Solids, Crystalline Solids, Amorphous Solid, Crystal Structure Lattice points, Space lattice, Basis, Bravais lattice, unit cell and lattice parameters, Seven Crystal Systems with 14 Bravais lattices , Atomic Radius, Co-ordination Number and Packing Factor of SC, BCC, FCC, Miller Indices, Inter planer spacing of Cubic crystal system.	9
2.	**Principles of Quantum Mechanics:** Waves and Particles, de Broglie Hypothesis, Matter Waves, Davisson and Germer’s Experiment, Heisenberg’s Uncertainty Principle, Schrodinger’s Time Independent Wave Equation-Physical Significance of the wave Function-Particle in One Dimensional Potential Box**.**	9
3.	**Electronic materials** Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.	9
4.	**Semiconductors** Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky),	6

	Semiconductor materials of interest for optoelectronic devices	
5.	**Light-semiconductor interaction** Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model. Laser, Einstein's theory of matter radiation interaction and A and B coefficients, Amplification of light by population inversion, different types of lasers: gas laser(He-Ne, CO_2), Solid state laser (Ruby, Neodymium), Dye laser, Properties of laser beams, Mono chromaticity, Coherence, directionality and brightness, Applications of laser in science and medicines	9
6.	**Measurements** Four-point probe and van der Pauw measurements for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission.	3
	Total	**45**

References Books:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons,Inc., (2007).
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL

Course Outcomes (COs):

At the end of this course, students will be able to:

1. Analyze the fundamental principles of crystal structure and evaluate the essential concepts of quantum mechanics.
2. Understand the principles of energy band theory in semiconducting materials and differentiate between intrinsic and extrinsic semiconductors at the evaluation level.
3. Understand the concepts of light interaction with matter and its applications.
4. Analyze and apply the elementary understanding of the measurement techniques for semiconductor