GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3143902

Semester – IV
Subject Name: Physics of Nanomaterials

Type of course: Physical Science and Technology

Prerequisite: Solid state physic, crystal physics, mathematics (differentiation and integration), material chemistry (inorganic chemistry) and some physical properties of materials from 12th science level syllabus.

Rationale: The objective of this course is to develop basic concepts of quantum mechanics and their relation to properties of materials, and how the properties are modified with nano scale materials

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	4	5	70	30	30	20	150

	PHYSICS OF NANOMATERIALS	
Sr. No.	**Topics**	**Teaching Hrs.**
1	**Introduction to Quantum Mechanics: -** 1.1 Inadequacies of classical mechanics to explain nano-scale phenomena 1.2 The wave-particle duality and de Broglie Waves 1.3 Uncertainty principle 1.4 The Schrodinger equation 1.5 Application of Schrodinger equation 1.5.1 Wave function of a free electron 1.5.2 Particle in a box – quantum well 1.5.3 Interacting quantum wells 1.6 Basic Postulates of Quantum Mechanics	16
2	**Nearly Free electron approximation** 2.1 Origin of the energy gap 2.2 Periodic boundary conditions and Bloch functions 2.3 Density of electronic states for 1d, 2d, and 3d electron gas 2.4 Energy bands 2.5 Direct- and Indirect- gap semiconductors 2.6 Effective mass 2.7 Variation of energy bands with alloy composition and its exploitation for devices.	16
3	**Quantum confined systems** 3.1 Heterojunctions 3.1.1 Type I and Type II heterostructures 3.2 Classification of Quantum confined systems 3.3 Electrons and holes in Quantum wells 3.4 Surface to volume ratio in quantum confined systems 3.5 Spherical cluster approximation - Exterior surface area, and Interior surface area. 3.6 Electronic wave functions, energy sub bands and density of electronic	10

	states in Quantum wires, and Quantum dots 3.7 lattice mismatch in hetero structures	
4	**Vibrational and Thermal Properties of Nano materials.** 4.1 Introduction 4.2 Quantized Vibration Mode 4.3 Transverse Vibration 4.4 Heat Capacity 4.5 Thermal Property 4.6 Low Energy Excitation in Amorphous. 4.7 Heat Capacity Calculation 4.8 Thermal conductivity.	10

Reference Book:

1. Quantum Mechanics Concepts and Application, Willey Publication By Nouredine Zettili.
2. Introduction to Solid State Physics C. Kittle
3. V.V. Mitin, V.A. Kochelap, and M.A. Stroscio, "QuantumHeterostructures: Microelectronics andOptoelectronics", Cambridge University Press, 1999.
4. C.P. Poole, Jr. and F.J. Owens, "Introduction toNanotechnology", Wiley India. 2006.
5. T. Pradeep, "Nano: The essentials", Tata McGraw-Hill,2007.
6. P. Harrison, "Quantum Wells, Wires, and Dots:Theoretical and Computational Physics", John Wiley,2000.
7. B.G. Streetman and S. Banerjee, "Solid State ElectronicDevices", Prentice Hall of India, 2001.
8. A. Shik, "Quantum Wells: Physics and Electronics oftwo-dimensional systems", World Scientific, 1999.7. G.L. Hornyak, J. Dutta, H.F. Tibbals and A.K. Rao,"Introduction to Nanoscience", CRC Press, 2008.

Course Outcome

Sr. No.	CO statement	Marks % weightage
CO-1	Students will get familiarized with essential quantum mechanical principles that are required for understanding various phenomena occurring at nanoscale	**30**
CO-2	Students will gain understanding of essential concepts explaining relation between nanoscale structures and macroscopic properties of materials	**30**
CO-3	Student will get familiarized with real life nanostructures and explanation of their properties with quantum mechanical concepts	**20**
CO-4	Student will gain understanding of vibrational and thermal properties of nanomaterials	**20**

Bloom's Taxonomy for Cognitive Domain	Marks % weightage
Recall	35
Comprehension	45
Application	20
Analysis	0
Evaluate	0
Create	0