B.N.M. Institute of Technology

An Autonomous Institution under VTU

Semester: I/II		
COURSE: Applied Physics (for CSE stream)		
Course Code: 22PHC112/122	**L:T:P:J: 2:2:2:0**	**CIE Marks:** 50
Credits:	4	**SEE Marks:** 50
Hours:	40 L &12 P	**SEE Duration:** 03 Hours

Course Learning Objectives: The students will be able to

1	Understand and apply the concepts of Quantum Mechanics and its applications in various fields of engineering by gaining practical knowledge to correlate with the theoretical concepts.
2	Demonstrate the engineering applications of Lasers and Optical Fibres by applying basic principles and their realization through experimental approach.
3	Understand and apply electrical properties of Metals and Superconductors using quantum mechanical concepts by gaining practical knowledge to correlate with the theoretical concepts.
4	Understand the basic properties of Nanomaterials and explore their applications in modern engineering fields by gaining practical knowledge to correlate with the theoretical concepts.
5	Understand the basic concepts of Quantum computing in engineering applications.

Module 1 – Quantum Mechanics	RBT	Hrs
Need for Quantum mechanics, de-Broglie's hypothesis of Matter Waves and their properties, Heisenberg Uncertainty Principle and its application (Non-existence of electrons inside nucleus). Wave function, properties and its physical significance, probability density and Normalization, Time independent one-dimensional Schrodinger equation (derivation), time dependent (qualitative), Particle in a potential well of infinite height (Eigen values and Eigen functions), Finite well potential and Quantum Tunneling (qualitative), Numerical problems.	**Apply**	**08**

Module 2 – Lasers and Optical Fibers	RBT	Hrs
2.1: LASER: Interaction of radiation with matter and characteristic properties of laser, Energy density of a photon at equilibrium in terms of Einstein's coefficients (derivation), Conditions for Laser action, Requisites of a Laser system, Construction and working of CO_2 Laser. Engineering Applications of Lasers: LIDAR (Measurement of pollutants in atmosphere), Numerical Problems. **2.2: Optical fibers:** Introduction to optical fibers, Propagation mechanism in optical fibers, Acceptance angle and Numerical Aperture (derivation), Types of Optical fibers, Attenuation in optical fibers (no derivation) and its mechanisms, Engineering Applications of optical fibers – Point to point communication, Numerical problems.	**Apply**	**08**

Module 3 – Electrical Properties of Materials	RBT	Hrs
3.1 Metals: Quantum free electron theory – Assumptions, Density of states (qualitative), Fermi energy and Fermi factor, Effect of temperature on fermi factor, Expression for Fermi energy (derivation) at absolute zero temperature and at certain higher temperature (qualitative), effective mass (qualitative). Merits of quantum free electron theory, Numerical Problems.	**Apply**	**08**

<table>
<tr><td>3.2 Superconductors: Temperature dependence of resistivity in metals (Matthiessen’s rule) and superconducting materials. Effect of magnetic field (Meissner effect). Critical magnetic field and its temperature dependence, Type-I and Type-II superconductors, BCS theory (qualitative). High temperature superconductors. Applications of superconductors – Maglev vehicles, Numerical problems.</td><td></td><td></td></tr>
<tr><td>Module 4 – Modern Engineering Materials</td><td>RBT</td><td>Hrs</td></tr>
<tr><td>4.1 Nano Materials: Introduction to Nano science and Nano materials, Surface to volume ratio, Quantum confinement – Quantum well, Quantum wire, Quantum dot. Synthesis of Nano materials – Top-down approach (Ball milling method) and bottom-up approach (Sol gel method). Carbon Nano tubes, types, properties and Applications. Scanning Electron Microscope (SEM), Application of SEM in analysis of Molecular size, Numerical problems.
4.2 Composite Materials: Introduction to composite materials, Classification of composites based on reinforcement materials and matrix. Advantages and disadvantages of composite materials, Engineering Applications</td><td>Apply</td><td>08</td></tr>
<tr><td>Module 5 – Quantum Computing</td><td>RBT</td><td>Hrs</td></tr>
<tr><td>Introduction to quantum computing- Matrix form of wave function, Identity Operator, Determination of I|0> and I|1>, classical information and quantum information, Moorle’s law, Superposition in quantum computation, concept of Qubit, properties- mathematical representation, representation of qubit by Bloch sphere, Quantum gate – Toffoli gate (qualitative) and difference between classical computing and quantum computing.</td><td>Apply</td><td>08</td></tr>
</table>

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Lab Experiments (2 Demo + 8 Lab sessions + 1 Repetition class + 1 Lab Test)	
Sl. No	**List of Experiments**
1	Determination of Planck's constant
2	Photo Diode Characteristics
3	Determination of radius of curvature of a Plano convex lens using Newton's Rings
4	Determination of wavelength of Laser using Diffraction
5	Determination of Acceptance angle and Numerical Aperture of an Optical fiber
6	Determination of Fermi energy of copper
7	Determination of Resistivity of a metal
8	Determination of size of a Nano particle using diffraction pattern

Course Outcomes: After completing the course, the students will be able to	
22PHC112/122.1	Apply the concepts of Quantum Mechanics to physical situations and determine parameter related to the concepts.
22PHC112/122.2	Apply principles of lasers and Optical Fibers to determine optical parameters in the field of engineering.
22PHC112/122.3	Apply the quantum concepts and determine parameters related to electrical properties of materials.
22PHC112/122.4	Apply the Concepts of Nano Science and determine parameters related to nano materials.
22PHC112/122.5	Apply the principles of Quantum Mechanics in Quantum Computing.

Reference Books

1. Principle of Quantum Mechanics: Concepts & Applications, Nouredine Zettili, Wiley, 2nd Edition, 2009.
2. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press, 2010 Edition.
3. Lasers and Non-linear optics, B.B. Laud, New Age International Publishers, 3rd Edition, 2011.
4. Lasers and Optical Instrumentation, S. Nagabhushana and B. Sathyanarayana, I.K. International Publishing House Pvt. Ltd, 2013.
5. Solid State Physics, S.O. Pillai, New Age International Publishers, 9th Edition, 2020.
6. Introduction to Nanoscience and Nanotechnology, Chris Binns, Wiley, 2010.
7. An Introduction to Composite Materials, T.W. Clyne and D. Hull, Cambridge University Press, 3rd Edition, 2019.
8. University Practical Physics by D.C. Tayal, Edited by ILA Agarwal, 2000, Himalaya Publishing House, Mumbai.
9. Engineering Physics Laboratory Manual (BNMIT).

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COURSE: Applied Physics (for EE & EC stream)		
Course Code: 22PHE112/122	**L:T:P:J: 2:2:2:0**	**CIE Marks:** 50
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Hours:	40 L &12 P	**SEE Duration:** 03 Hours

Course Learning Objectives: The students will be able to	
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2	Demonstrate the engineering applications of Lasers and Optical Fibres by applying basic principles and their realization through experimental approach.
3	Understand and apply electrical properties of Metals and Superconductors using quantum mechanical concepts by gaining practical knowledge to correlate with the theoretical concepts.
4	Understand the basic properties of Nanomaterials and explore their applications in modern engineering fields by gaining practical knowledge to correlate with the theoretical concepts.
5	Understand and apply the concepts of semiconductors in engineering applications and their realization through experimental approach.

Module 1 – Quantum Mechanics	**RBT**	**Hrs**
Need for Quantum mechanics, de-Broglie's hypothesis of Matter Waves and their properties, Heisenberg Uncertainty Principle and its application (Non-existence of electrons inside nucleus). Wave function, properties and its physical significance, probability density and Normalization, Time independent one-dimensional Schrodinger equation (derivation), time dependent (qualitative), Particle in a potential well of infinite height (Eigen values and Eigen functions), Finite well potential and Quantum Tunneling (qualitative), Numerical problems.	**Apply**	**08**

Module 2 – Lasers and Optical Fibers	**RBT**	**Hrs**
2.1: LASER: Interaction of radiation with matter and characteristic properties of laser, Energy density of a photon at equilibrium in terms of Einstein's coefficients (derivation), Conditions for Laser action, Requisites of a Laser system, Construction and working of CO_2 Laser. Engineering Applications of Lasers: LIDAR (Measurement of pollutants in atmosphere), Numerical Problems. **2.2: Optical fibers:** Introduction to optical fibers, Propagation mechanism in optical fibers, Acceptance angle and Numerical Aperture (derivation), Types of Optical fibers, Attenuation in optical fibers (no derivation) and its mechanisms, Engineering Applications of optical fibers – Point to point communication, Numerical problems.	**Apply**	**08**

Module 3 – Electrical properties of materials	**RBT**	**Hrs**
3.1 Metals: Quantum free electron theory – Assumptions, Density of states (qualitative), Fermi energy and Fermi factor, Effect of temperature on fermi factor, Expression for Fermi energy (derivation) at absolute zero temperature and at certain higher temperature (qualitative), effective mass (qualitative). Merits of quantum free electron theory, Numerical Problems. **3.2 Superconductors:** Temperature dependence of resistivity in metals (Matthiessen's rule) and superconducting materials. Effect of magnetic field	**Apply**	**08**

(Meissner effect). Critical magnetic field and its temperature dependence, Type-I and Type-II superconductors, BCS theory (qualitative). High temperature superconductors. Applications of superconductors – Maglev vehicles, Numerical problems.		
Module 4 – Modern Engineering Materials	**RBT**	**Hrs**
4.1 **Nano Materials:** Introduction to Nano science and Nano materials, Surface to volume ratio, Quantum confinement – Quantum well, Quantum wire, Quantum dot. Synthesis of Nano materials – Top-down approach (Ball milling method) and bottom-up approach (Sol gel method). Carbon Nano tubes, types, properties and Applications. Scanning Electron Microscope (SEM), Application of SEM in analysis of Molecular size, Numerical problems. **4.2Composite Materials:** Introduction to composite materials, Classification of composites based on reinforcement materials and matrix. Advantages and disadvantages of composite materials, Engineering Applications	**Apply**	**08**
Module 5 – Semiconductors and Semiconductor Devices	**RBT**	**Hrs**
5.1 Semiconductors: Fermi energy and Fermi level, Fermi level in intrinsic semiconductors, Expression for concentration of electrons in conduction band & holes concentration in valance band (only mention the expression), Law of mass action, Electrical conductivity of a semiconductor (derivation), Hall effect, Expression for Hall coefficient (derivation) and its application. **5.2 Semiconductor Devices:** Photodiode and Power responsivity, Construction and working of Semiconducting Laser and Numerical problems.	**Apply**	**08**

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3	Determination of wavelength of Laser using Diffraction
4	Determination of Acceptance angle and Numerical Aperture of an Optical fiber
5	Determination of Fermi energy of copper
6	Determination of size of a Nano particle using diffraction pattern
7	Series and Parallel LCR circuits
8	Photo Diode Characteristics

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22PHE112/122.1	Apply the concepts of Quantum Mechanics to physical situations and determine parameter related to the concepts.
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22PHE112/122.4	Apply the Concepts of Nano Science to determine parameters related to nano materials.
22PHE112/122.5	Apply the concepts of semiconductors to determine parameters related to engineering applications.

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4	Understand the basic properties of Nanomaterials and explore their applications in modern engineering fields by gaining practical knowledge to correlate with the theoretical concepts.
5	Understand and apply the concepts of Elastic Properties of Materials in engineering applications and their realization through experimental approach.

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I and Type-II superconductors, BCS theory (qualitative). High temperature superconductors. Applications of superconductors – Maglev vehicles, Numerical problems.		
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Module 5 – Mechanical Properties of Materials	**RBT**	**Hrs**
Teaching Component: Stress-Strain diagram, Types of stress & strain, Types of elastic moduli, Poisson's ratio, Relations between Y, η, K and σ(derivation). Types of beams, concept of Bending moment, Expression for bending moment (qualitative), Applications: Single cantilever - Young's modulus of cantilever (derivation), Concept of torsion, Rigidity modulus of a solid cylinder (derivation), Numerical problems.	**Apply**	**08**

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4	Determination of Acceptance angle and Numerical Aperture of an Optical fiber
5	Determination of Fermi energy of copper
6	Determination of size of a Nano particle using diffraction pattern
7	Young's Modulus of material of a beam using Single Cantilever
8	Rigidity modulus of material of a wire using Torsional Pendulum

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22PHM112/122.1	Apply the concepts of Quantum Mechanics to physical situations and determine parameter related to the concepts.
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22PHM112/122.3	Apply the quantum concepts and determine parameters related to electrical properties materials.
22PHM112/122.4	Apply the Concepts of Nano Science to determine parameters related to nano materials.
22PHM112/122.5	Apply the theory of elasticity to determine mechanical parameters related to engineering applications.

Reference Books
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