

**Dr. Ambedkar Institute of Technology, Bengaluru - 56**

**Department of Physics**

**Scheme and Syllabus – 2025 - 2026**

Course Title	Physics of Materials						
Course Code	1BPHU202C (ME Stream)						
Category	Applied Science Course (ASC) (Integrated Course)						
Scheme and Credits	No. of Hours / Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	02	02	02	00	06	40 + 10 – 12 labs	04
<b>CIE Marks: 50</b>	<b>SEE Marks: 50</b>	<b>Total Max. Marks =100</b>			<b>Duration of SEE: 03 Hours</b>		
<p><b>Course Objective:</b> To introduce the Engineering students to the basics of oscillations, Elasticity, Thermoelectric materials and devices, Quantum mechanics Material Characterization and Instrumentation Techniques, Materials Properties with an emphasis on inculcating strong analytical skills among them so that they can understand and analyze complex engineering problems with relative ease.</p>							
<b>Unit No.</b>	<b>Syllabus Content</b>						<b>No. of Teaching Hours</b>
<b>1</b>	<p><b>Oscillations:</b></p> <p>Simple harmonic motion (SHM), Differential equation for SHM, Springs: Stiffness factor and its physical significance, Series and Parallel combination of springs (Derivation), Types of springs and their applications. Theory of damped oscillations, and discuss the cases (Graphical Approach). Engineering applications of damped oscillations, Theory of forced oscillations with derivation, Resonance: Condition for resonance, Sharpness of resonance, Resonance in LCR circuits (Qualitative), Numerical problems.</p>						<b>8</b>

2	<p><b>Elasticity:</b></p> <p>Review of Stress-Strain Curve, Hooke's law and its limits. Elastic Moduli, Poisson's ratio, Relation between <math>Y</math>, <math>n</math> and <math>\sigma</math> (with derivation), mention relation between <math>K</math>, <math>Y</math> and <math>\sigma</math>, limiting values of Poisson's ratio.</p> <p>Torsion: Expression for couple per unit twist of Cylindrical wire (Derivation). Torsional Pendulum: Expression for time period of oscillation and Rigidity modulus (Derivation), Beams, Bending of beams: neutral surface and neutral axis. Expression for bending moment beam (derivation), Cantilever, Expression for depression in loaded cantilever (Derivation): Applications of beams in Engineering. Numerical problems.</p>	8
3	<p><b>Thermoelectric materials and devices:</b></p> <p>Thermo emf and thermo current, Seebeck effect, Peltier effect, Seebeck and Peltier coefficients, figure of merit (Mention Expression), laws of thermoelectricity. Expression for thermo emf in terms of <math>T_1</math> and <math>T_2</math>, Thermo couples, thermopile, Construction and working of thermoelectric generators (TEG) and Thermoelectric coolers (TEC), low, mid and high temperature thermoelectric materials, Applications: Exhaust of automobiles, Refrigerator, Space program (Radioisotope Thermoelectric Generator- RTG), Numerical Problems.</p>	8
4	<p><b>Quantum Mechanics:</b></p> <p>de Broglie hypothesis, Heisenberg's uncertainty principle and its application (Broadening of Spectral Lines), principle of complementarity, wave function, time independent Schrödinger wave equation (Derivation), physical significance of a wave function and Born Interpretation, expectation value and its physical significance, Eigen functions and Eigen values, Particle inside one dimensional infinite potential well, role of higher dimensions (Qualitative), Wave function and probability densities for <math>n=1, 2</math> and <math>3</math>. Quantum tunneling, Numerical Problems</p>	8

5	<p><b>Material Characterization and Instrumentation Techniques:</b></p> <p><b>Materials Properties:</b></p> <p>Nanomaterials: Introduction to nanomaterials, surface area to volume ratio, size effects, types of nanomaterials, Synthesis: Top-Down approach- high energy Ball-milling and Bottom-Up approach- sol-gel method, bragg's formula (Derivation)</p> <p><b>Instrumentation Techniques:</b> X-Ray Diffractometer (XRD), Scherrer equation (derivation), Atomic Force Microscope (AFM), Transmission electron microscope (TEM), Scanning Electron Microscope (SEM), Numerical Problems.</p>	8
<p><b>Experimental Components:</b></p> <p><b>Any Ten Experiments have to be completed from the list of experiments</b></p> <ol style="list-style-type: none"> <li>1. Series &amp; Parallel resonance LCR Circuits.</li> <li>2. Determination of Fermi energy of a copper.</li> <li>3. Determination of Wavelength of LASER using Grating.</li> <li>4. Determination of Numerical Aperture using Optical Fiber.</li> <li>5. Determination of Planck's constant using LEDs.</li> <li>6. Determination of Radius of curvature of Plano convex lens using Newton's rings.</li> <li>7. Determination of Young's Modulus of the given Beam by Single Cantilever.</li> <li>8. Determination of Rigidity Modulus of the wire using Torsional Pendulum.</li> <li>9. Determination of Acceleration due to Gravity by Bar Pendulum.</li> <li>10. Determination of Moment of Inertia of the given irregular body Using Torsional Pendulum.</li> <li>11. Energy Gap of the given Semiconductor</li> <li>12. GNU Step Interactive Simulations</li> <li>13. Study of Electrical quantities using spreadsheet</li> <li>14. Online Circuit Simulator (<a href="https://www.partsim.com/simulator">https://www.partsim.com/simulator</a>)</li> <li>15. PHET Interactive Simulations (<a href="https://phet.colorado.edu/en/simulations/filter?subjects=physics&amp;type=html,prototyp">https://phet.colorado.edu/en/simulations/filter?subjects=physics&amp;type=html,prototyp</a>)</li> </ol>		
<p><b>Teaching and Learning Process: Chalk and Talk, Power Point presentation and Lab Experiment Videos</b></p>		

**Course outcome (Course Skill Set)****At the end of the course, the student will be able to:**

1. Analyze the principles of simple harmonic, damped, and forced oscillations, and apply them to solve problems involving mechanical and electrical oscillatory systems. Apply the concepts of stress, strain, and elastic moduli to evaluate the elastic behavior of solids under various loading conditions.
2. Evaluate the principles of thermoelectric effects and assess the performance of thermoelectric materials and devices for energy conversion and thermal management.
3. Explain the core concepts of quantum mechanics such as matter waves, uncertainty principle, wave functions, and quantization of energy, with relevance to computational applications.
4. Explain the material characterization techniques and instrumentation to analyze the macroscopic and microscopic properties of engineering materials.
5. Practice working in groups to conduct basic Physics experiments, record, observations and arrive at appropriate conclusions.

**Suggested Learning Resources:**

1. A Textbook of Engineering Physics- M.N. Avadhanulu and P.G. Kshirsagar, 10th revised Ed, S. Chand. & Company Ltd, New Delhi.
2. An Introduction to Lasers theory and applications by M.N. Avadhanulu and P.S. Hemne revised Edition 2012. S. Chand and Company Ltd-New Delhi.
3. Engineering Physics-Gaur and Gupta Dhanpat Rai Publications -2017.
4. Concepts of Modern Physics-Arthur Beiser: 6th Ed; Tata Mc Graw Hill Edu Pvt. Ltd. New Delhi 2006.
5. Fundamentals of Fibre Optics in Telecommunication & Sensor Systems, B..P. Pal, New Age International Publishers.
6. Lasers and Non - Linear Optics – B.B.Laud, 3rd Ed, New Age International Publishers 2011.
7. LASERS Principles, Types and Applications by K.R.Nambiar New Age International Publishers
8. Solid State Physics - S O Pillai, 8th Ed-New Age International Publishers-2018.
9. Quantum Physics and Applications, Dr. Geethanjali H. S., Dr. Nagaraja D., Jeevith Publications. (Unit – IV)

**Web links and Video Lectures(e-Resources):**

1. Laser: <https://nptel.ac.in/courses/115/102115102124/>
2. Quantum Mechanics: <https://nptel.ac.in/courses/115/104/115104096/>
3. Physics: <http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>
4. Numerical Aperture of fiber: <https://bop-iitk.vlabs.ac.in/exp/numerical-aperture-measurement>
5. NPTEL Superconductivity: <https://archive.nptel.ac.in/courses/115/103/115103108/>

**Activity-Based Learning (Suggested Activities in Class)/ Practical-Based Learning**

1. <http://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham>

4. <https://vlab.amrita.edu/index.php?sub=1&brch=189&sim=343&cnt=1>

5. [https://virtuallabs.merlot.org/vl\\_physics.html](https://virtuallabs.merlot.org/vl_physics.html)

6. <https://phet.colorado.edu>

7. <https://www.myphysicslab.com>

### **Scheme for Examinations**

1. Two full questions to be set from each unit with internal choice

- Minimum number of sub-questions: 2.
- Maximum number of sub-question: 3.

2. Each full question shall be for a maximum of 20 marks

**Answer any five full questions choosing at least one full question from each unit**

**Note: 1. Questions from Experiments shall be included in the SEE question paper**

**2. Questions from Self-study component will not be asked for CIE and SEE**

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>CO1</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	-	-	-	-	<b>2</b>
<b>CO2</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	-	-	-	-	<b>2</b>
<b>CO3</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	-	-	-	-	<b>2</b>
<b>CO4</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	-	-	-	-	<b>2</b>
<b>CO5</b>	<b>3</b>	<b>2</b>	-	-	-	-	-	-	-	-	-	<b>2</b>

**Level-3: Highly Mapped, Level-2: Moderately Mapped, Level-1: Low Mapped**