

**Dr. Ambedkar Institute of Technology, Bengaluru - 56**  
**Department of Physics**  
**Scheme and Syllabus – 2026 – 27**

|                             |                                                                                                                                                                                                                                                                                                  |   |                       |    |                           |                       |         |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|----|---------------------------|-----------------------|---------|
| Course Title                | Physics for Sustainable Structural Systems                                                                                                                                                                                                                                                       |   |                       |    |                           |                       |         |
| Course Code                 | 1BPHU102A (CV Stream)                                                                                                                                                                                                                                                                            |   |                       |    |                           |                       |         |
| Category                    | Applied Science Course (ASC) (Integrated Course)                                                                                                                                                                                                                                                 |   |                       |    |                           |                       |         |
| Scheme and Credits          | No. of Hours / Week                                                                                                                                                                                                                                                                              |   |                       |    |                           | Total Teaching Hours  | Credits |
|                             | L                                                                                                                                                                                                                                                                                                | T | P                     | SS | Total                     |                       |         |
|                             | 3                                                                                                                                                                                                                                                                                                | 0 | 2                     | 4  | 5                         | 42 + 28 +50= 120      | 04      |
| CIE Marks: 50               | SEE Marks: 50                                                                                                                                                                                                                                                                                    |   | Total Max. Marks =100 |    | Duration of SEE: 03 Hours |                       |         |
| Course Learning Objectives: |                                                                                                                                                                                                                                                                                                  |   |                       |    |                           |                       |         |
| CLO1                        | To understand simple harmonic motion, free, damped and forced vibrations, and the condition for resonance in mechanical and LCR electrical systems.                                                                                                                                              |   |                       |    |                           |                       |         |
| CLO2                        | To apply the concepts of elasticity, stress-strain relationships and torsion to structural elements such as beams, cantilevers and torsional pendulums.                                                                                                                                          |   |                       |    |                           |                       |         |
| CLO3                        | To describe wave propagation in structures and analyse the physics of earthquakes, seismic waves and tsunami-resistant structural design measures.                                                                                                                                               |   |                       |    |                           |                       |         |
| CLO4                        | To explain the principles of architectural acoustics and the fundamentals of radiometry and photometry relevant to sustainable building design.                                                                                                                                                  |   |                       |    |                           |                       |         |
| CLO5                        | To introduce smart materials and sensor-based structural health monitoring techniques used in intelligent, sustainable structures.                                                                                                                                                               |   |                       |    |                           |                       |         |
| Unit No.                    | Syllabus Content                                                                                                                                                                                                                                                                                 |   |                       |    |                           | No. of Teaching Hours |         |
| 1                           | Oscillations:<br><br>Simple harmonic motion (SHM), Differential equation for SHM, Theory of free vibrations, theory of damped vibration types of damping (Graphical Approach). Engineering applications of damped oscillations, theory of forced vibrations, Resonance: condition for resonance, |   |                       |    |                           | 8                     |         |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|   | <p>sharpness of resonance. Resonance in LCR Circuits (qualitative), Numerical Problems.</p> <p><b>Self-Study:</b> Types of motion, Musical Instruments, Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |
| 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> (derivation), mention relation between <math>K</math>, <math>Y</math> and <math>\sigma</math>, limiting values of Poisson's ratio. Torsion: Expression for couple per unit twist of Cylindrical wire (derivation). Torsional Pendulum: Expression for time period of oscillation and Rigidity modulus (derivation), Beam: 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.</p> <p>Numerical problems.</p> <p><b>Self-Study:</b> Types of pendulums, various types of bridges and structures, types of beams.</p> | 8 |
| 3 | <p><b>Waves and their role in structural behavior:</b></p> <p>Types of waves, Wave propagation in beams, rods, and slabs, Boundary effects, Wave dispersion, Damping in structures, Energy dissipation techniques in structures, Introduction to earthquakes, General characteristics, P-waves, S-waves, Love waves, and Rayleigh waves, Ground motion and structural response, Site effects and soil-structure interaction, Physics of earthquakes, Richter scale of measurement and earthquake-resistant measures, Tsunami (causes for tsunami, characteristics, adverse effects, risk reduction measures, engineering structures to withstand tsunami), Seismometer and Seismograph.</p> <p><b>Self-Study:</b> Characteristics of waves, ultrasonic waves and applications, natural hazards.</p>                                                                                 | 8 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p><b>Acoustics, Radiometry and Photometry:</b></p> <p>Acoustics: Introduction to Acoustics, Types of Acoustics, Reverberation and reverberation time, Absorption power and Absorption coefficient, Requisites for acoustics in auditorium, Sabine’ s formula (qualitative), Measurement of absorption coefficient, Factors affecting the acoustics and remedial measures, Sound insulation and its measurements. Noise and its measurements, Impact of noise in multi-storied buildings.</p> <p>Radiometry and Photometry: Radiation quantities, Spectral quantities, Relation between luminance and Radiant quantities, Reflectance and Transmittance, Photometry (cosine law and inverse square law).</p> <p><b>Self-Study:</b> Significance of sound waves, design of auditorium and radiation hazards.</p> | 8 |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p><b>Smart Materials for Sustainable Structures:</b></p> <p>Types of smart materials, Piezo, Magnetostrictive, Electrostrictive, Electro-rheological, Magneto-rheological, Shape memory alloys, Phase transformation in shape memory alloys, Overview of sensor technology, uses of sensors in intelligent structures, Classification of sensors, Temperature sensor, Vibration Sensor, Strain Gauge sensors, Basic concepts of structural health monitoring.</p> <p><b>Self-Study:</b> Self-healing materials, types of sensors.</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> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |

6. Determination of Radius of curvature of Plano convex lens using Newton' s rings.
7. Determination of Young' s Modulus of the given Beam by Single Cantilever.
8. Determination of Rigidity Modulus of the wire using Torsional Pendulum.
9. Determination of Acceleration due to Gravity by Bar Pendulum.
10. Determination of Moment of Inertia of the given regular and irregular bodies Using Torsional Pendulum.
11. Energy Gap of the given Semiconductor
12. GNU Step Interactive Simulations
13. Study of Electrical quantities using spreadsheet
14. Online Circuit Simulator (<https://www.partsim.com/simulator>)
15. PHET Interactive Simulations  
(<https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototyp>)

**Suggested Learning Resources:**

1. Physics, Oscillations and Waves, Optics and Quantum Mechanics, H M Agarwal and R M Agarwal, Pearson, 2025.
2. Engineering Physics, Satyendra Sharma and Jyotsna Sharma, Pearson, 2018.
3. Dynamics of Structures - Theory and Applications to Earthquake Engineering Anil K. Chopra, University of California at Berkeley, Fourth Edition. Prentice Hall. **Year - 3,,10,5**
4. Engineering Physics by R. K. Gaur and S. L. Gupta, 2010 Edition, Dhanpat Rai Publications Ltd., New Delhi-110002.
5. Photometry Radiometry and Measurements of Optical Losses, Micheal Bukshtab, Springer, 2nd Edition.
6. Introduction to Seismology, Earthquakes, and Earth Structure, Stein, Seth, and Michael Wysession. Blackwell Publishing, 2003.
7. Disaster Management, S., R. Subramanian, Chand Publishing, 2018.

8. Engineering Physics-Gaur and Gupta Dhanpat Rai Publications -2017.
9. Concepts of Modern Physics-Arthur Beiser: 6th Ed; Tata Mc Graw Hill Edu Pvt. Ltd. New Delhi 2006.
10. Lasers and Non - Linear Optics – B.B.Laud, 3rd Ed, New Age International Publishers 2011.
11. Solid State Physics - S O Pillai, 8th Ed-New Age International Publishers-2018.
12. Quantum Physics and Applications, Dr. Geethanjali H. S., Dr. Nagaraja D., Jeevith Publications.

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

1. Laser: <https://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. NPTELSuperconductivity:<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-questions: 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 be asked for only in CIE up to 10%.**

### Course Outcomes (COs)

| CO No. | Course Outcome                                                                                                                                                                                                                                                                                                                               | Bloom's Level |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1    | Explain simple harmonic motion, free/damped/forced vibrations, and analyze resonance conditions in mechanical and LCR electrical systems.                                                                                                                                                                                                    | L2 / L4       |
| CO2    | Apply the concepts of stress-strain, Hooke's law, and elastic moduli to derive and solve problems on torsion, bending of beams, and cantilevers for structural engineering applications.                                                                                                                                                     | L3            |
| CO3    | Describe wave propagation in beams, rods, and slabs; explain earthquakes and seismic waves (P, S, Love, Rayleigh), along with tsunami-resistant structural measures. Explain architectural acoustics, including reverberation, sound absorption, and insulation, and the key radiometric and photometric quantities used in building design. | L2 / L4       |
| CO4    | Classify smart materials (piezoelectric, magnetostrictive, shape memory alloys) and sensor technologies used for structural health monitoring of intelligent structures.                                                                                                                                                                     | L2            |
| CO5    | Conduct experiments to determine physical and material properties, and analyze and interpret experimental data using appropriate instruments and simulations.                                                                                                                                                                                | L3 / L5       |

### CO-PO Mapping (NBA – 11 Program Outcomes)

Revised as per the latest NBA GAPC v4.0 guidelines (Washington Accord 2021 alignment): the earlier PO6 (The Engineer and Society) and PO7 (Environment and Sustainability) have

been merged into a single PO6 – "The Engineer and the World"; the remaining outcomes have been renumbered PO7–PO11. Correlation levels: 1 = Low, 2 = Moderate, 3 = High, – = No correlation.

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | 3   | 2   | –   | –   | –   | –   | –   | –   | –   | –    | 1    |
| CO2 | 3   | 3   | 2   | –   | –   | 1   | –   | –   | –   | –    | 1    |
| CO3 | 3   | 2   | 1   | –   | –   | 3   | –   | –   | –   | –    | 2    |
| CO4 | 2   | 1   | 2   | –   | 2   | 2   | –   | –   | –   | –    | 2    |
| CO5 | 2   | 2   | –   | 3   | 3   | –   | 1   | 2   | 2   | –    | 2    |
| Avg | 2.6 | 2.0 | 1.7 | 3.0 | 2.5 | 2.0 | 1.0 | 2.0 | 2.0 | –    | 1.6  |

| Mapping of CO's with Knowledge and Attitude Profile (WK)                                                  |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                                                                                                       | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   |  |
| CO2                                                                                                       | 2   | -   | 3   | 2   | 2   | -   | -   | -   | -   |  |
| CO3                                                                                                       | 3   | -   | -   | -   | 2   | 1   | 3   | -   | 1   |  |
| CO4                                                                                                       | -   | -   | -   | 3   | -   | 2   | -   | 2   | -   |  |
| CO5                                                                                                       | -   | 2   | -   | -   | -   | 3   | -   | 3   | -   |  |

| Mapping of CO's with Sustainable Development Goals (SDG)                                                  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                       | - | - | - | - | - | - | - | - | 2 | -  | -  | -  | -  | -  | -  | -  | -  |
| CO2                                                                                                       | - | - | - | - | - | - | - | - | 3 | -  | 2  | -  | -  | -  | -  | -  | -  |
| CO3                                                                                                       | - | - | 1 | - | - | - | - | - | 2 | -  | 3  | -  | 1  | -  | -  | -  | -  |
| CO4                                                                                                       | - | - | - | - | - | - | - | - | 3 | -  | 2  | -  | -  | -  | -  | -  | -  |
| CO5                                                                                                       | - | - | - | 1 | - | - | - | - | 2 | -  | -  | -  | -  | -  | -  | -  | -  |

### **Program Outcomes (POs) — as per NBA Graduate Attributes (11 POs)**

As per the latest NBA (Washington Accord aligned) guidelines, PO6 (“The engineer and society”) and PO7 (“Environment and sustainability”) have been merged into a single graduate attribute, reducing the total number of Program Outcomes from twelve to eleven.

| <b>PO No.</b> | <b>Program Outcome</b>                            | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PO1</b>    | <b>Engineering knowledge</b>                      | Apply knowledge of mathematics, science and engineering fundamentals to the solution of complex engineering problems.                                                                                                                                                                                                                                                                                                |
| <b>PO2</b>    | <b>Problem analysis</b>                           | Identify, formulate, review research literature and analyse complex engineering problems using first principles.                                                                                                                                                                                                                                                                                                     |
| <b>PO3</b>    | <b>Design/development of solutions</b>            | Design solutions for complex engineering problems and design system components or processes to meet specified needs.                                                                                                                                                                                                                                                                                                 |
| <b>PO4</b>    | <b>Conduct investigations of complex problems</b> | Use research-based knowledge and methods including design of experiments, analysis and interpretation of data to provide valid conclusions.                                                                                                                                                                                                                                                                          |
| <b>PO5</b>    | <b>Modern tool usage</b>                          | Create, select and apply appropriate techniques, resources and modern engineering/IT tools, including prediction and modelling.                                                                                                                                                                                                                                                                                      |
| <b>PO6</b>    | <b>The engineer, society and environment</b>      | Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues; understand the impact of engineering solutions in societal and environmental contexts; and recognise the need for sustainable development. (This is a merged attribute, combining the former PO6 ‘Engineer and Society’ and PO7 ‘Environment and Sustainability’, as per the latest NBA guidelines.) |
| <b>PO7</b>    | <b>Ethics</b>                                     | Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.                                                                                                                                                                                                                                                                                                   |
| <b>PO8</b>    | <b>Individual and team work</b>                   | Function effectively as an individual and as a member/leader in diverse and multidisciplinary teams.                                                                                                                                                                                                                                                                                                                 |

|             |                                       |                                                                                                                           |
|-------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>PO9</b>  | <b>Communication</b>                  | Communicate effectively on complex engineering activities with the engineering community and society at large.            |
| <b>PO10</b> | <b>Project management and finance</b> | Demonstrate knowledge and understanding of engineering/management principles in multidisciplinary environments.           |
| <b>PO11</b> | <b>Life-long learning</b>             | Recognise the need for, and engage in independent and life-long learning in the broadest context of technological change. |

#### 4. Justification for CO-PO Mapping

**CO1 (Oscillations & Resonance):** Explaining SHM, free/damped/forced vibrations and the condition for resonance (including LCR circuits) rests entirely on applying mathematics and core physics fundamentals — this gives a strong link to PO1 (3) and a moderate link to PO2 (2), since analysing damping types and the sharpness of resonance requires problem-analysis using first principles. A slight link to PO11 (1) reflects the self-study extension of resonance concepts to ESR/NMR, an evolving interdisciplinary area. No design, investigation or societal dimension is involved, so PO3–PO10 are not mapped.

**CO2 (Elasticity & Structural Elements):** Deriving and applying stress–strain relations, elastic moduli and torsion/bending expressions to beams, cantilevers and torsional pendulums is a strong exercise in engineering fundamentals (PO1, 3) and analytical problem-solving (PO2, 3). Because these derivations translate directly into selecting and sizing structural elements such as beams and cantilevers, a moderate link to PO3 (2, design/development of solutions) is justified. A slight link to PO6 (1) follows from the real-world relevance of beam and bridge design to society, and a slight link to PO11 (1) reflects the self-study on varied bridge and beam types.

**CO3 (Waves, Earthquakes, Acoustics & Photometry):** Describing wave propagation in beams/rods/slabs and the physics of seismic waves draws strongly on PO1 (3) and moderately on PO2 (2), since interpreting ground motion, soil–structure interaction and site effects requires analytical reasoning. A slight link to PO3 (1) arises because the unit explicitly covers tsunami- and earthquake-resistant structural design measures. This unit maps most strongly to PO6 (3, the engineer and the world), as earthquake/tsunami resilience, noise impact in multi-storied buildings and acoustic/radiation safety are direct examples of engineering judgement affecting society, safety and the environment. A moderate link to PO11 (2) reflects the continually evolving fields of seismology and architectural acoustics.

**CO4 (Smart Materials & Structural Health Monitoring):** Classifying smart materials (piezoelectric, magnetostrictive, electro-/magneto-rheological, shape memory alloys) and sensor types requires foundational knowledge (PO1, 2) and comparative analysis of material behaviour (PO2, 1). Because these materials and sensors are the building blocks used to design intelligent, self-monitoring structures, moderate links to PO3 (2, design/development of solutions) and PO5 (2, modern tool/sensor usage) are justified. A moderate link to PO6 (2) follows from the role of smart, self-healing materials in sustainable and resilient infrastructure, and a moderate link to PO11 (2) reflects the fast-evolving nature of smart-materials and sensor technology.

**CO5 (Experimental Component):** Conducting experiments and analysing/interpreting data to determine physical and material properties (e.g. Young's/rigidity modulus, moment of inertia, energy gap) maps most strongly to PO4 (3, conduct investigations of complex problems) and PO5 (3, modern tool usage), since students use instruments, circuit simulators and PhET/GNU-Step simulations. Applying fundamental concepts during experiments gives moderate links to PO1 (2) and PO2 (2). A slight link to PO7 (1, ethics) reflects the expectation of honest recording and reporting of readings; moderate links to PO8 (2, individual and team work) and PO9 (2, communication) arise from performing experiments in groups and documenting observations in lab reports. A moderate link to PO11 (2) reflects the use of continually updated simulation tools. No CO is mapped to PO10, as the syllabus content does not address project-management or financial dimensions; this is addressed by other courses in the curriculum.