Course Title:	**Applied Physics for Mechanical Engineering Stream**	Semester	I/II
Course Code:	**BPHYM102/ BPHYM202**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	2:2:2:0	Exam Hours	03
Total Hours of Pedagogy	40 hours Theory + 10 to12 Lab slots	Credits	04

Course Learning Objectives

- **CLO 1.** To understand the types of oscillation, shock waves & its generation, and applications. To study the principles of quantum mechanics
- **CLO 2**. To Study the elastic properties of materials and failures of engineering materials
- **CLO 3.** To understand the fundamentals of thermoelectric materials and devices and their application.
- **CLO 4.**To understand the Concepts in Low temperature phenomena and generation of low temperature.
- **CLO 5.** To study the various relevant material characterization techniques.
- **CLO6.** To conduct experiments in Physics and measure precise quantities.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. Flipped Class

2. Chalk and Talk

3. Blended Mode of Teaching and Learning

4. Simulations, Interactive Simulations and Animations

5. NPTEL and Other Videos for theory topics

6. Smart Class Room

7. Lab Experiment Videos

8. Self-study motivation

9. Group Discussion

10. Quiz

Module-1: OSCILLATIONS AND SHOCK WAVES (8 hours)

Self-study: Basics of Oscillations, SHM

Simple Harmonic motion (SHM), Differential equation for SHM (derivation), Sprigs: Stiffness Factor and its Physical Significance, Series and Parallel combination of springs (Derivation), Types of Springs and their applications. Theory of Damped oscillations (Qualitative), Types of Damping (Graphical Approach). Engineering applications of Damped oscillations, Theory of Forced oscillations (Qualitative), Resonance, Sharpness of resonance. Numerical Problems.
Shock waves: Mach number and Mach Angle, Mach Regimes, Definition and Characteristics of Shock waves, Construction and working of Reddy Shock tube, Applications of Shock Waves, Numerical problems.

Applications: Design of springs for automatic door closure, car seats, Design of effective energy transfer systems
(RBT Levels: L1, L2 and L3)

Module-2: ELASTICITY (8 hours)

Self-study: Elasticity, Stress & Strain

Stress-Strain Curve, Stress hardening and softening. Elastic Moduli, Poisson's ratio, Relation between Y, n and σ (with derivation), mention relation between K, Y and σ, limiting values of Poisson's ratio. Beams, bending moment and derivation of expression, Cantilever and I section girder and their Engineering Applications, Elastic materials (qualitative). Failures of engineering materials - Ductile fracture, Brittle fracture, Stress concentration, Fatigue and factors affecting fatigue (only qualitative explanation), Numerical problems.

Applications: To design Beams and Strength of materials
(RBT Levels: L1, L2 and L3)

Module-3: THERMOELECTRIC MATERIALS AND DEVICES (8 hours)

Self-study: Basics of Electrical conductivity, Thermo emf, Thermo current

Thermo emf and thermo current, Seeback effect, Peltier effect, Seeback and Peltier coefficients, figure of merit (Mention Expression), laws of thermoelectricity. Expression for thermo emf in terms of T1 and T2, 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 (RTG), Numerical Problems

Applications: Thermoelectric Generators Refrigerator
(RBT Levels: L1, L2 and L3)

Module-4: CRYOGENICS (8 hours)

Self-study: Laws of Thermodynamics, Joule Thomson effect

Cryogenics: Production of low temperature - Joule Thomson effect (Derivation with 3 cases), Porous plug experiment with theory, Thermodynamical analysis of Joule Thomson effect, Liquefaction of Oxygen by cascade process, Lindey's air liquefier, Liquefaction of Helium and its properties, Platinum Resistance Thermometer, Applications of Cryogenics, in Aerospace, Tribology and Food processing(qualitative), Numerical Problems

Applications: Application of Cryogenics in Food Processing
(RBT Levels: L1, L2 and L3)

Module-5: MATERIAL CHARACTERIZATION AND INSTRUMENTATION TECHNIQUES (8hours)

Self-study: Density of states of 0D 1D 2D 3D

Introduction to nano materials: Nanomaterial and nanocomposites. Density of States of 0D 1D 2D and 3D Principle, construction and working of X-ray Diffractometer, Crystallite size determination by Scherrer equation, Atomic Force Microscopy (AFM): Principle, construction, working and applications, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Numerical Problems.

Applications: structure and image of nanomaterials
(RBT Levels: L1, L2 and L3)

List of Laboratory experiments (2 hours/week per batch/ batch strength 15)
10 lab sessions + 1 repetition class + 1 Lab Assessment

1. Determination of Young's modulus of the material of the given bar Single Cantilever..
2. Determination of Rigidity modulus of the Material of the wire and Moment of Inertia of the given body using Torsional Pendulum
3. Study of Forced Mechanical Oscillations and Resonance.
4. Study of the frequency response of Series & Parallel LCR circuits.
5. Determination of Fermi Energy of the given Conductor.
6. Determination of Resistivity by Four Probe Method.
7. Determination of effective spring constant of the given springs in series and parallel combinations.
8. Determination of Wavelength of Laser using Diffraction Grating.
9. Determination of Acceptance angle and Numerical Aperture of the given Optical Fiber.
10. Study of motion using spread Sheets

Suggested software: Virtual Lab, Pspice

Course outcome

At the end of the course the student will be able to:

1. **Set** equation of motion, **solve** and **analyze** solution for free, damped and forced oscillations, **classify** Mach regime and determine Mach number.

2. **Determine** elastic moduli, Poisson's ratio, its limiting value and **discuss** beams, failures of engineering materials.
3. **Determine** inversion temperature, neutral temperature, Peltier coefficient, thermo emf and **discuss** thermopile**,** thermoelectric generator, thermoelectric cooler.
4. **Determine** degree of cooling, Joule Thomson coefficient, discuss liquification of air by Linde's air liquefier, Cascade process, liquification of helium
5. **Determine** Bragg's angle and grain size of a crystal and discuss instrumentation techniques- Bragg's Spectrometer, atomic force microscopy, electron microscopy**.**
6. **Practice** working in groups to conduct experiments in physics and perform precise and honest measurements

Course Assessment and Evaluation Details (both CIE and SEE)

Continuous Internal Evaluation: 50 marks		
Theory Assessment Tool	**Marks**	**Reduced marks**
IAT-1	25	15
IAT-2	25	
Assessment -1(activity based)	25	10
Assessment -2(activity based)	25	
Lab Assessment Tool	**Marks**	**Reduced marks**
Conducting Experiment and Laboratory Record (10 labs)	15(each lab)	15
Lab Test	10	10
Semester End Examination (SEE) : 50 marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	100	50

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

1. Circuit design of LCR circuits using Pspice and study frequency response curve
2. Understand Instrumentation techniques using virtual lab
3. Conduct Study of Forced Mechanical Oscillations and Resonance using virtual lab
4. Seminars on instrumentation techniques, thermoelectric devices and cryogenics.
5. Problem solving exercises
6. Quiz
7. Reports on Guest lectures/ industry visit
8. Solving Crystal structure from XRD data

http://nptel.ac.in
https://swayam.gov.in
https://virtuallabs.merlot.org/vl_physics.html
https://phet.colorado.edu
https://www.myphysicslab.com
https://www.electronics-lab.com/

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)

Text Books

1. Vibrations and Waves (MIT introductory Physics Series), A P French, CBS, 2012 Edition
2. Timoshenko, S. and Goodier J.N. "Theory of Elasticity", 2nd Edition, McGraw Hill Book Co, 2001.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, 1997
4. Heat & Thermodynamics and Statistical Physics(XVIII-Edition) – Singhal, Agarwal &Satyaprakash – Pragati Prakashan, Meerut, 2006. 4
5. Heat and Thermodynamics (V-Edition) – D.S.Mathur - S. Chand & Company Ltd., New-Delhi, 2004
6. Heat and Thermodynamics, Brijlal & Subramanyam,S. Chand & Company Ltd., New-Delhi. 8. Physics of Cryogenics by Bahman Zohuri, Elsevier, 2018
7. Characterization of Materials- Mitra P.K . Prentice Hall India Learning Private Limited.2013
8. Nanoscience and Nanotechnology: Fundamentals to Frontiers – M.S.Ramachandra Rao & Shubra Singh, Wiley India Pvt Ltd. 2013

Reference Books

1. Mechanical Properties of Engineered Materials by Wole Soboyejo, CRC Press; 1st edition, 2002
2. Physics of Cryogenics by Bahman Zohuri, Elsevier, 2018
3. Materials Characterization Techniques-Sam Zhang, Lin Li, Ashok Kumar, CRC Press, First Edition, 2008.
4. Nano Composite Materials-Synthesis, Properties and Applications, J. Parameswaranpillai, N.Hameed, T.Kurian, Y. Yu, CRC Press. 2016
5. Shock waves made simple by Chintoo S Kumar, K Takayama and K P J Reddy: Willey India. Ltd, Delhi,2014

Web links and Video Lectures (e-Resources):

- https://physics.info/shock/ Shock waves and its applications:
- https://www.youtube.com/watch?v=tz_3M3v3kxk
- https://web.mit.edu/course/3/3.11/www/modules/ss.pdf
- https://www.youtube.com/watch?v=f08Y39UiC-o
- https://www.youtube.com/watch?v=x47nky4MbK8
- https://www.youtube.com/watch?v=2w7NBuu5w9c&list=PLtkeUZItwHK5y6qy1GFxa4Z4RcmzUaaz6
- https://www.youtube.com/watch?v=NruYdb31xk8
- https://cevgroup.org/cryogenics-basics-applications/ Liquefaction of gases:
- https://www.youtube.com/watch?v=aMelwOsGpIs
- https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham Material characterization
- https://onlinecourses.nptel.ac.in/noc20_mm14/preview
- https://www.encyclopedia.com/science-and-technology/physics/physics/cryogenics
- https://www.usna.edu/NAOE/_files/documents/Courses/EN380/Course_Notes/Ch10_Deformation.pdf

Cos and POs mapping (CO-PO mappings are only indicative

COs	POs											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3		3					2		2
CO2	3	3	3		3					2		2
CO3	3	3	3		3					2		2
CO4	3	3	3		3					2		2
CO5	3	3	3		3					2		2
CO6	3	3	3		3			2	2	2		2

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped