BPHM102C/ BPHM202C	APPLIED PHYSICS FOR MECHANICAL ENGINEERING STREAM (ME,IP and AU Branches) (Integrated)	Credits - 04
Hours/Week:(3:0:2)		CIE Marks: 50
Total Hours:60Hrs(40L+20P)		SEE Marks: 50

Course Objectives:

1. To study the properties, generation and engineering applications of types of oscillations and shock waves
2. To study the elastic properties of materials and failures of engineering materials
3. To study the fundamentals of thermoelectric materials, devices and their applications
4. To study the concepts of low temperature phenomena and generation of low temperature
5. To study the various material characterization techniques

MODULE – I	8 Hrs

Oscillations and Shock waves :

Oscillations:

Introduction, Simple Harmonic Motion (SHM), differential equation for SHM (no derivation), Springs: 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.

Pre-requisite: Basics of oscillations and waves.
Self learning: Applications of SHM and springs.

MODULE – II	8 Hrs

Elasticity:

Introduction, stress-strain curve, stress hardening and softening. Elastic moduli, Poisson's ratio, relation between Y, η 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.

Pre-requisites: Elasticity, Hooke's law
Self learning: Single cantilever

MODULE – III	8 Hrs

Thermoelectric materials and devices:

Introduction, thermo emf and thermo current, Seeback effect, Peltier effect, Seeback and Peltier coefficients, figure of merit (mention expression), laws of thermoelectricity. Derivation for thermo emf in terms of T_1 and T_2, 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.

Pre-requisites: Basics of electrical and thermal conductivity
Self-learning: Applications of thermoelectric materials and devices

MODULE – IV	8 Hrs

Cryogenics:
Introduction, 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, Linde's air liquefier, liquefaction of Helium and its properties. Platinum resistance thermometer. Applications of cryogenics in aerospace, tribology and food processing (qualitative). Numerical problems.

Pre requisites: Basics of heat and thermodynamics
Self-learning: Application of cryogenics

MODULE – V	8 Hrs

Material Characterization and Instrumentation Techniques:
Introduction to nanomaterials: Nanomaterials and nanocomposites. Principle, construction and working of X-ray diffractometer, crystallite size determination by Scherrer equation. Principle, construction, working and applications of Atomic Force Microscopy (AFM), X-Ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).
Pre-requisites:Quantum mechanics, principle and working of optical microscope
Self-learning: X-Ray diffraction, crystallites.

Reference Books :

1. A .P. French, "Vibrations and Waves" (MIT introductory Physics series),CBS,(2003 edition)
2. Timoshenko, S. and Goodier J.N.2001 "Theory of Elasticity", (2nd Edition), McGraw Hill Book Co.
3. Sadhu Singh,1997, "Theory of Elasticity", Khanna Publishers
4. Wole Soboyejo, 2002, "Mechanical Properties of Engineered Materials" (1st edition), CRC Press.
5. Singhal, Agarwal & Satyaprakash,2006 "Heat & Thermodynamics and Statistical Physics" (18thEdition), Pragati Prakashan, Meerut
6. D. S. Mathur,1991 "Heat and Thermodynamics" (1st Edition) S.Chand & Company Ltd., New Delhi
7. Brijlal & Subramanyam,1994 "Heat and Thermodynamics" S.Chand & Company Ltd., New Delhi
8. Bahman Zohuri, 2018, "Physics of Cryogenics", Elsevier
9. Sam Zhang, Lin Li, Ashok Kumar, 2008, "Materials Characterization Techniques" (1st edition), CRC Press.
10. Mitra P.K, 2014, "Characterization of Materials", Prentice Hall India Learning Private Limited
11. M. S. Ramachandra Rao & Shubra Singh,2013, "Nanoscience and Nanotechnology Fundamentals to Frontiers", Wiley India Pvt Ltd.
12. Parameswaranpillai, N.Hameed, T.Kurian, Y. Yu, 2017, "Nano Composite Materials-Synthesis, Properties and Applications", CRC Press
13. Chintoo S Kumar, K Takayama and K P J Reddy, 2014, "Shock waves made simple", Willey India Pvt. Ltd, New Delhi.
14. M.N. Avadhanulu, P. G. Kshirsagar and T. V. S. Arun Murthy, 2019, "A Textbook of Engineering Physics" (11th edition), S. Chand, New Delhi.

Weblinks and Video Lectures (e-Resources):

Simple harmonic motion :https://www.youtube.com/watch?v=k2FvSzWeVxQ

Shock waves: https://physics.info/shock/

Shock waves and its applications:https://www.youtube.com/watch?v=tz_3M3v3kxk

Stress-strain curves: https://web.mit.edu/course/3/3.11/www/modules/ss.pdf

Stress curves: https://www.youtube.com/watch?v=f08Y39UiC-o

Fracture in materials : https://www.youtube.com/watch?v=x47nky4MbK8

Thermoelectricity :https://www.youtube.com/watch?v=2w7NBuu5w9c&list=PLtkeUZItwHK5y6qy1GFxa4Z4RcmzU aaz6

Thermoelectric generator and coolers: https://www.youtube.com/watch? v=NruYdb31xk8

Cryogenics: https://cevgroup.org/cryogenics-basics-applications/

Liquefaction of gases:https://www.youtube.com/watch?v=aMelwOsGpIs

Virtual lab:https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

Materialcharacterization: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

Laboratory Component:
Any Ten experiments have to be completed from the list of experiments

LIST OF EXPERIMENTS

1. Determination of effective spring constant of the given springs in series and parallel combinations
2. The study of forced mechanical oscillations and resonance
3. The study of frequency response in series and parallel LCR circuits
4. Determination of rigidity modulus of a wire by torsional pendulum method
5. Determination of Young's modulus of metal strip by single cantilever method
6. Determination of Young's modulus of a given metal strip by uniform bending method
7. Identification of passive components and estimation of their values in a given black box
8. Determination of velocity of ultrasonic waves in a given liquid using ultrasonic interferometer
9. Determination of Fermi energy of a copper
10. Determination of energy gap of a semiconductor by four probe method
11. Determination of dielectric constant of a material in a capacitor by charging and discharging method
12. Determination of wavelength of laser using diffraction grating
13. Determination of acceptance angle and numerical aperture of a given optical fiber
14. Determination of the radius of curvature of a given planoconvex lens by Newton rings method
15. Step interactive physical simulations
16. Study of motion using spread sheets
17. Study of application of statistics using spread sheets
18. PHET interactive simulations
https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype)

Course outcomes:

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

1. Apply concepts of oscillations and shock waves for engineering applications
2. Apply concepts of elasticity for engineering applications
3. Select appropriate properties of thermoelectric materials for engineering applications
4. Apply the concepts of cryogenics to generate low temperature for engineering applications
5. Select appropriate tool for material characterization

Course Outcomes	Programme Outcomes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2			1				1			1
CO2	3	2			1				1			1
CO3	3	2			1				1			1
CO4	3	2			1				1			1
CO5	3	2			1				1			1