Course Code		:	1BPHM102C/202C	PHYSICS OF MATERIALS (ME, AU &IP)	Semester	:	I/II
L : T : P		:	3:0 :2		Course Type	:	IPCC
Hours / Sem	Teaching	:	42+26Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	44Hrs		SEE Marks	:	50
	Exam	:	08Hrs		Total Marks	:	100
	Total Hrs	:	120Hrs		Credits	:	04

Professional Competency:

Apply fundamentals of oscillations, photonics, thermo electric materials and cryogenics for engineering systems.

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 appropriate properties of laser and type of optical fiber for engineering applications.
3. Apply appropriate thermoelectric materials and cryogenics concepts for engineering applications.
4. Apply appropriate tool for material characterization.

Unit – I — 11 Hrs

Oscillations:

Introduction, 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, types of damping (graphical approach). Engineering applications of damped oscillations, theory of forced oscillations with derivation, resonance, sharpness of resonance, resonance in LCR circuits (qualitative). Numerical problems.

Shock waves:

Introduction to shock waves, Mach number, classification of waves based on Mach number, Mach regimes, definition and characteristics of shock waves and Mach angle, construction and working of Reddy shock tube, applications of shock waves. Numerical problems.

Unit – II — 10 Hrs

Photonics: Laser:

Introduction, interaction of radiation with matter (Induced absorption, spontaneous emission and stimulated emission), Einstein's coefficients (expression for energy density), conditions for laser action, requisites of a laser system, working mechanism, characteristics of a laser, classification of lasers. Construction and working of Nd:YAG and carbon dioxide lasers. Applications of lasers - Industry (drilling, cutting, welding) and laser range finder. Numerical problems.

Optical fibers:

Introduction, total internal reflection, propagation mechanism in optical fibers, angle of acceptance, numerical aperture and its derivation, fractional index change, modes of propagation (qualitative),V number and number of modes, types of optical fibers, attenuation and mention of expression for attenuation coefficient. Applications-optical fiber communication system, merits and demerits, intensity modulated temperature sensor. Numerical problems.

Unit – III — 10 Hrs

Thermoelectric materials and devices:

Introduction, thermo emf and thermo current, Seebeck effect, Peltier effect, Seebeck and Peltier coefficients, figure of merit (mention expression) and its importance in efficiency, laws of thermoelectricity. Expression for thermo emf in terms of T_1 and T_2, thermo couples, thermopile, construction and working of thermoelectric generators (TEG). Applications: RTG (radio isotope thermoelectric generator). Numerical problems.

Cryogenics:
Introduction to thermodynamics, efficiency, production of low temperature - Joule Thomson effect (derivation with 3 cases), porous plug experiment with theory, liquefaction of oxygen by cascade process, Lindey's air liquefier, liquefaction of helium and its properties (super fluidity). Applications of cryogenics- dewar container, aerospace. Numerical problems.

Unit – IV	11 Hrs

Material characterization and instrumentation techniques:
Material properties:
Introduction to quantum mechanics, matter waves and its properties, wave function and its properties. Introduction to Schrodinger wave equation, eigen function and eigen values, particle in an infinite 1D potential well (qualitative), band theory of solids, quantum 2 onfinement in 0, 1, 2 and 3 dimesions (qualitative), density of states, expressions and graphical representation, optical properties due to quantum confinement, blue shift, absorption, florescence and quantum tunneling.

Instrumentation techniques:
X-ray diffractometer (XRD), Scherrer equation, atomic force microscope (AFM), X-ray photoelectron spectroscopy (XPS), scanning electron microscope (SEM). Numerical problems.

Practical Module	26 Hrs

01	Determination of effective spring constant of the given springs in series and parallel combinations.
02	The study of forced mechanical oscillations and resonance.
03	The study of frequency response in series and parallel LCR circuits.
04	Determination of wavelength of laser using diffraction grating.
05	Identification of passive components and estimation of their values in a given black box.
06	Determination of velocity of ultrasonic waves in a given liquid using ultrasonic interferometer.
07	Determination of acceptance angle and numerical aperture of a given optical fiber.
08	Determination of rigidity modulus of a wire by torsional pendulum method.
09	Determination of Young's modulus of metal strip by single cantilever method.
10	Determination of the radius of curvature of a given plano convex lens by Newton rings method.
11	Determination of moment of inertia of the given irregular body by setting torsional oscillations.
12	Verification of Newton's law of cooling.
13	Kundt's dust tube – determination of velocity of sound.
14	Verification of inverse square law of intensity of light.
15	Determination of Planck's constant using LEDs.
16	Study the working of Peltier modules.
17	STEP interactive physical simulations. (springs, simple pendulum).
18	Study of motion using spread sheets (linear and projectile motion).

Note: i) Introduction lab
ii) Any ten experiments are to be conducted from the above list.
iii) Two Virtual/simulation labs

Text Books:

01	Avadhanulu, M N and Kshirsagar, P G, and Arun Murthy, T. V. S , A Textbook of Engineering Physics , S. Chand, New Delhi, 11th edition, 2019.
02	Sharma Satyendra and Sharma Jyotsna, Engineering Physics, Pearson, 2018.
03	Kakani S L and Kakani Shubra, Engineering Physics, CBS Publishers and Distributers Pvt. Ltd, 3rd Edition, 2020.

Reference Books:

01	French, A P, MIT Vibrations and Waves introductory Physics, 2003.
02	Chintoo S Kumar, Takayama K and Reddy K P J, Shock waves made simple, Willey India Pvt. Ltd, New Delhi, 2014.
03	Laud, B.B. "Lasers and Non-Linear Optics" , New Age International Publishers, New Delhi, 2nd edition, 2002.
04	Nambiar, K.R. LASERS Principles, Types and Applications, New Age International Publishers, New Delhi, 2006.
05	Bahman Zohuri, "Physics of Cryogenics", Elsevier, 2018.
06	Ramachandra Rao M. S. & Shubra Singh, Nanoscience and Nanotechnology Fundamentals to Frontiers, Wiley India Pvt Ltd, 2013.
07	Parameswaranpillai, N.Hameed, T.Kurian, Y. Yu, Nano Composite Materials Synthesis, Properties and Applications, CRC Press, 2017.
08	Sam Zhang, Lin Li, Ashok Kumar, Materials Characterization Techniques , CRC Press. 1st edition, 2008.
09	Mitra P.K , Characterization of Materials, Prentice Hall India Learning Private Limited, 2014.
10	Agarwal H M and Agarwal R M, Physics, Oscillations and Waves, Optics and Quantum Mechanics, Pearson, 2025.

Web Links and Video Lectures:

01	Oscillations and Waves by Prof.S.Bharadwaj, Department of Physics and Meteorology, IIT Kharagpurn: https://www.youtube.com/watch?v=gnD8Se92hfk
02	Waves and Oscillations http://www.youtub.com/watch?v=xoJWoMwTAw&list=PLyqSpQzTE6M9X7oRXliYM8t0aaR_N0Csd
03	Stress- strain curves : https://web.mit.edu/course/3/3.11/www/modules/ss.pdf
04	Stress curves: https://www.youtube.com/watch?v=f08Y39UiC-o
05	Cryogenic Engineering by Prof. M.D. Atrey , Department of Mechanical Engineering, IIT Bombay.: https://www.youtube.com/watch?v=4gGMBNEzeuc
06	Liquefaction of gases: https://www.youtube.com/watch?v=aMelwOsGpIs
07	Non-destructive testing: https://youtu.be/JGQnbwxPiFA
08	Non-destructive testing: https://youtu.be/uzogGRDSmMA
09	Materials Characterisation : https://youtu.be/SXIYzrFGmkU

Course Outcomes (Cos)	Program Outcomes and (WKs)										
	1	2	3	4	5	6	7	8	9	10	11
CO1	**3** (WK1,WK2 and WK3)	**2** (WK1,WK2 and WK3)						1			1
CO2	**3** (WK1,WK2 and WK3)	**2** (WK1,WK2 and WK3)						1			1
CO3	**3** (WK1,WK2 and WK3)	**2** (WK1,WK2 and WK3)						1			1
CO4	**3** (WK1,WK2 and WK3)	**3** (WK1,WK2 and WK3)						1			1