Course Code		:	1BPHC102C/202C	**PHYSICS FOR SUSTAINABLE STRUCTURAL SYSTEMS (Integrated)**	Semester	:	I/II
L : T : P		:	3:0 :2		Course Type	:	IPCC
Hours / Sem	Teaching	:	42+28Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42Hrs		SEE Marks	:	50
	Exam	:	08Hrs		Total Marks	:	100
	Total Hrs	:	120Hrs		Credits	:	04

Professional Competency:

Apply fundamentals of oscillations, elasticity, acoustics and smart materials for sustainable structural systems.

Course Outcomes:

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

1. Apply concepts of oscillations and elasticity for engineering applications.
2. Apply the concepts of acoustics and select appropriate properties of ultrasonic waves for engineering applications.
3. Analyze appropriate properties of waves and shockwaves for engineering applications.
4. Apply appropriate properties of lasers and smart materials for engineering applications.

Unit – I — 11 Hrs

Oscillations:

Simple harmonic motion (SHM), the 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 (derivation), resonance and sharpness of resonance, resonance in LCR circuits (qualitative). Numerical problems.

Elasticity:

Stress-strain curve, stress hardening and softening. Elastic moduli, Poisson's ratio, relation between Y, n and σ (derivation), limiting values of Poisson's ratio. Beams, types of beams, bending moment (qualitative), applications of beams, Numerical problems

Unit – II — 10 Hrs

Acoustics:

Introduction to acoustics, types of acoustics, reverberation and reverberation time, absorption power and absorption coefficient, requisites for acoustics in auditorium, Sabine's formula (derivation), measurement of absorption coefficient, factors affecting the acoustics and remedial measures. Numerical problems.

Nondestructive testing (NDT):

Introduction to NDT, need for inspection, types of inspection system, benefits of NDT. Visual inspection. Liquid penetration test: Principles, surface separation, penetrate application and development. Eddy presents testing: Inspection probes, display methods. Ultrasonic testing: Principle, generation of ultrasonic waves, probes. Numerical problems.

Unit – III — 10 Hrs

Waves and their role in structural behavior:

Types of waves, wave propagation in beams, rods, 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.

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 – IV	11 Hrs

Laser:
Introduction, 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, semiconductor diode laser. Applications of laser: Laser range finder, LIDAR (air pollution), road profiling, bridge deflection, speed checker. Numerical problems.

Smart materials for sustainable structures:
Types of smart materials, piezo, magnetostrictive, electrostrictive, electro-rheological, magneto-rheological, overview of sensor technology, uses of sensors in intelligent structures, pressure (strain guage) and vibration sensors.

Practical Module	28 Hrs

01	Study of forced mechanical oscillations and resonance.
02	Study of the frequency response of series and parallel LCR circuits.
03	Determination of effective spring constant of the given springs in series and parallel combinations.
04	Kundt's dust tube – determination of velocity of sound.
05	Verification of inverse square law of intensity of light.
06	Determination of velocity of ultrasonic waves using ultrasonic interferometer.
07	Determination of Young's modulus of the material of the given bar using single cantilever.
08	Determination of rigidity modulus of the material of the wire using torsional pendulum.
09	Determination of moment of inertia of the given irregular body by setting torsional oscillations.
10	Determination of wavelength of LASER using diffraction grating.
11	Identification of passive components and estimation of their values in a given black box.
12	Determination of Young's modulus of the material by uniform bending method.
13	STEP Interactive physical simulations. (relevant to theory part).
14	PHET Interactive simulations (relevant to theory part).
15	Simple case study on acoustics (auditorium, cinema hall, etc,).
16	Study of motion using spread sheets.

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

Text Books:

01	Avadhanalu M. N. Kshirsagar P. G. and Arun Murthy T. V. S, "A Textbook of Engineering Physics", S. Chand, New Delhi 11th edition, 2019.
02	Agarwal H. M. and Agarwal R. M, "Physics Oscillations and Waves, Optics and Quantum Mechanics", Pearson,2025.
03	Sharma Satyendra and Sharma Jyotsna, "Engineering Physics", Pearson, 2018.

Reference Books:

01	Chopra Anil K, "Dynamics of Structures - Theory and Applications to Earthquake Engineering", University of California at Berkeley Prentice Hall, Fourth Edition.
02	Hull J. B. & John V, "Non-Destructive Testing - Macmillan International Higher Education", 2015.
03	Bhalla Suresh (IIT Delhi), C. K. Soh, Yaowen Yan, "Smart Materials in Structural Health Monitoring, Control and Biomechanics", Springer.
04	French A P, "Vibrations and Waves introductory Physics", MIT, 2003.
05	Kakani, S L Kakani Shubra, "Engineering Physics", CBS Publishers and Distributers Pvt. Ltd, 3rd Edition, 2020.
06	Stein, Seth, and Michael Wysession, " Introduction to Seismology, Earthquakes, and Earth Structure", Blackwell Publishing, 2003.
07	S Mani Naidu, " Engineering Physics", Pearson, 2025.
08	B. P. Singh and Devaraj Singh, "Building Science: Lighting and Acoustics", Dhanpat Rai Publications (P) Ltd.
09	Lagoudas, D. C, "Shape Memory Alloys: Modeling and Engineering Applications", Springer ISBN: 978-0-387-47684-1, 2008.
10	Holnicki-Szulc J. & Rodellar J, "Smart Structures: Requirements and Potential Applications in Mechanical and Civil Engineering", Springer ISBN: 978-0-7923-5612-7, 1999.

Web Links and Video Lectures:

01	Simple Harmonic Motion (SHM) – NPTEL Lecture: https://www.youtube.com/watch?v=gnD8Se92hfk
02	Waves and Oscillations Playlist (SHM, damping, resonance, etc.)– NPTEL https://www.youtube.com/playlist?list=PLyqSpQzTE6M9X7oRXliYM8t0aaR_N0Csd
03	Simple Harmonic motion: https://www.youtube.com/watch?v=k2FvSzWeVxQ
04	Stress- strain curves :https://web.mit.edu/course/3/3.11/www/modules/ss.pdf
05	Stress curves: https://www.youtube.com/watch?v=f08Y39UiC-o
06	Acoustics: https://www.youtube.com/watch?v=fHBPvMDFyO8
07	INTRO – Fundamentals of Acoustics" (Lecture 1, NPTEL□NOC, IIT Madras) https://www.youtube.com/watch?pp=0gcJCfwAo7VqN5tD&v=rT9B44Q4Rko
08	Fundamentals of Acoustics playlist (multiple lectures on acoustic wave behavior, sound propagation, etc.) https://www.youtube.com/playlist?list=PLgMDNELGJ1CYWnDbcbVET5zCbN4aLEbZQ
09	Structural Health Monitoring of Composites (IIT Kanpur) – Full NPTEL Course: https://nptel.ac.in/courses/112104160
10	Course Introduction – Structural Health Monitoring (IITM – NPTEL): https://www.youtube.com/watch?v=It4aogUfQis 11.
11	Smart Structures (IIT Kharagpur) – Covers smart materials, actuators, SHM: https://onlinecourses.nptel.ac.in/noc23_ae19/preview

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