|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)
SJB Institute of Technology
BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060
Approved by AICTE, New Delhi.
Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi
Accredited by NAAC with 'A+'grade, Certified by ISO 9001 - 2015
Recognized by UGC, New Delhi with 2(f) & 12 (B)

Semester:	I/II	**Course Type:**	IASC		
Course Title: Applied Physics for Sustainable Structures					
Course Code:	**25PHI12C/22C**		**Credits:**		4
Teaching Hours/Week (L: T:P:S)			3:0:2:1	**Total Hours:**	40+12lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To Understand the types of waves and oscillations with their properties and applications.
- To study the acoustics of the building and the essentials of photometry and radiometry.
- To study the elastic properties of materials.
- To study the fundamentals of smart materials and sensor technologies.
- To understand the operations of different instruments and to analyse the experimental results.

II. Teaching-Learning Process (General Instructions):

Some of the adapted methods in teaching learning methods are

1. Chalk and Talk.
2. Blended Mode of Learning.
3. Simulations and Animations.
4. Smart Classroom.
5. Self-learning using AI tools.
6. Activity based and experiential learning.
7. Models and working model.
8. Lab Experiment videos.

III. COURSE CONTENT

III(a).Theory part

Module-1: Oscillations — 8 Hours

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.

Damped Oscillations: Theory of damped oscillations (Qualitative), Types of damping (Graphical Approach). Engineering applications of Damped oscillations.

Forced Oscillations: Theory of forced oscillations (Qualitative), Resonance, Sharpness of resonance. Resonance in LCR Circuits (Qualitative), Numerical (Hooke's law, Spring constant, Damped Oscillations).

Text Book : 1,2 & 6 Reference Book : 1, 6

Pre-requisites/Self Learning: Fundamentals of oscillations.

RBT Levels: L1 – Remembering, L2 – Understanding, L3 – Applying.

Module-2: Waves: Structural behaviour	8 Hours

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 with stand tsunami), Seismometer and Seismograph, Accelerometer. Numerical.

Text Book : 1,3 Reference Book : 4

Pre-requisites/Self Learning : Fundamentals and properties of waves.

RBT Levels: L1 – Remembering, L2 – Understanding, L3 – Applying,

Module-3: Acoustics, Radiometry and Photometry	8 Hours

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, Sound insulation and its measurements. Noise and its measurements, Impact of noise in multi-storied buildings.

Radiometry and Photometry: Radiation quantities, Spectral quantities, Relation between luminance and Radiant quantities, Reflectance and Transmittance, Photometry (cosine law and inverse square law). Numerical (reverberation time, Absorption power and Absorption coefficient).

Text Books: 1, 2 Reference Books: 5, 7

Pre-requisites/Self Learning : Fundamentals of sound wave and echo

RBT Levels:: L1 – Remembering, L2 – Understanding, L3 – Applying,

Module-4: Elastic properties of materials	8 Hours

Review Stress-Strain Curve, Strain hardening and softening. Elastic Moduli, Poisson's ratio, Relation between Y, n and σ (with derivation), Relation between K, Y and σ (with derivation), limiting values of Poisson's ratio. Static and dynamic loading, Beams, Bending moment and derivation of expression, Cantilever, Torsion, Elastic materials (qualitative). Failures of engineering materials - Ductile fracture, Brittle fracture, Stress concentration, Fatigue and factors affecting fatigue (only qualitative explanation), Numerical (Elastic Moduli, Cantilever).

Text Book: 6 Reference Book: 2, 3

Pre-requisites/Self Learning: Rigid, Plastic and elastic materials**.**

RBT Levels: L1 – Remembering, L2 – Understanding, L3 – Applying.

Module-5: Smart Materials for Sustainable Structures	8 Hours

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. Numerical.

Text Book: 4 Reference Books :8, 9

Pre-requisites/Self Learning : Fundamentals of smart materials.

RBT Levels: L1 – Remembering, L2 – Understanding, L3 – Applying.

III(b). Practical part

Sl. No.	Experiments
1	Study of the frequency response of Series & Parallel LCR circuits.
2	Determination of effective spring constant of the given springs in series and parallel combinations.
3	Study on types of damping (Pendulum and Damper / PHET).
4	Interpretation of the graphs and images of XRD and SEM.
5	Determination of Rigidity modulus of the Material of the wire using Torsional Pendulum.
6	Determination of Young's Modulus of the material of the given bar using Single Cantilever.
7	Determination of Moment of Inertia of the given irregular body by setting Torsional Oscillations.
8	Determination of Young's modulus of the material of the given bar (Uniform Bending).
9	STEP Interactive Physical Simulations. (Relevant to Theory part)
10	PHET Interactive Simulations (Relevant to Theory part)
11	Simple case study on acoustics (Auditorium, Cinema Hall, Etc)
12	Data Analysis using Spread Sheets

Instructions for conduction of practical part:

Any Ten Experiments must be completed from the list of experiments.

Each experiment to be evaluated for conduction with observation sheet and record writeup. Rubrics for the evaluation of the write-up for experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 50 marks.
- Average marks scored by the students from all the experiments are considered.
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 test for 50 marks, test shall be conducted after the completion of prescribed experiments.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 80% and the rest 20% for viva-voce.

IV. COURSE OUTCOMES

CO1	Apply fundamental principles of oscillations and elasticity to analyse the mechanical behaviour of various structural components and systems under static and dynamic loading conditions.
CO2	Evaluate the impact of wave phenomena, including seismic and tsunamis events, on structural integrity and propose appropriate mitigation strategies based on wave mechanics and energy dissipation techniques

CO3	Design and assess acoustic environments and lighting systems by applying the principles of acoustics, radiometry, and photometry for various engineering applications in buildings and structures.
CO4	Utilize knowledge of smart materials and sensor technologies to conceptualize and evaluate intelligent solutions for sustainable structures.
CO5	Conduct the experiments and analyze data to design the solutions of engineering problems through critical thinking and collaborations.

V. CO-PO-PSO MAPPING(mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	2	-	-	-	-	-	-	-	-	-	2				
CO2	3	2	-	-	-	1	2	-	-	-	-	2				
CO3	3	2	-	-	-	1	1	-	-	-	-	2				
CO4	3	2	-	-	-	1	1	-	-	-	-	2				
CO5	3	2	-	-	1	-	-	2	2	2	-	2				

VI. Assessment Details (CIE & SEE)

General Rules: Refer Appendix section 2

Continuous Internal Evaluation (CIE): Refer Appendix section 2

semester End Examination (SEE): Refer Appendix section 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Physics, Oscillations and Waves, Optics and Quantum Mechanics	H M Agarwal and R M Agarwal	2025	Pearson
2.	Engineering Physics	Satyendra Sharma and Jyotsna Sharma	2018	Pearson
3.	Dynamics of Structures - Theory and Applications to Earthquake Engineering	Anil K. Chopra	Fourth Edition,2002	University of California at Berkeley, Prentice Hall
4.	Smart Materials in Structural Health Monitoring, Control and Biomechanics	Suresh Bhalla (IIT Delhi) and C. K. Soh, Yaowen Yang	2012	Springer
5	A Textbook of Engineering Physics	M.N. Avadhanulu and P.G. Kshirsagar,	10^{th} revised Ed, 2019	S. Chand. & Company Ltd, New Delhi
6	Engineering Physics	S P Basavaraju	2018-CBCS Edition	Subhas Stores, Bengaluru
7	Modern Engineering Physics	S.L.Gaur and Sanjeev Gupta	2017.	Dhanpat Rai Publications

VII(b): Reference Books:

1	Vibrations and Waves	A P French	2003	MIT introductory Physics

2	Engineering Physics	R. K. Gaur and S. L. Gupta	2010 edition	Dhanpat Rai Publications Ltd., New Delhi-110002,
3	Engineering Physics	S L Kakani, Shubra Kakani	3rd Edition, 2020	, CBS Publishers and Distributers Pvt. Ltd.,
4	Introduction to Seismology, Earthquakes, and Earth Structure	Stein, Seth, and Michael Wysession.	2003	Blackwell Publishing,.
5	Photometry Radiometry and Measurements of Optical Losses	Micheal Bukshtab	2nd edition.	Springer
6	Engineering Physics	S Mani Naidu	2025	Pearson
7	Building Science: Lighting and Acoustics	B. P. Singh and Devaraj Singh	2013	Dhanpat Rai Publications (P) Ltc.,
8	Shape Memory Alloys: Modeling and Engineering Applications.	Lagoudas, D. C.	2008	Springer, 2008. ISBN: 978-0-387-47684-1
9	Smart Structures: Requirements and Potential Applications in Mechanical and Civil Engineering.	Holnicki-Szulc, J., & Rodellar, J. (Eds.).	1999	Springer, 1999. ISBN: 978-0-7923-5612-7.

VII(c): Web links and Video Lectures (e-Resources):

Mention the links of the online resources, video materials, etc.

1. **Simple Harmonic Motion (SHM) – NPTEL Lecture:** https://www.youtube.com/watch?v=gnD8Se92hfk
2. **Waves and Oscillations Playlist (SHM, damping, resonance, etc.)– NPTEL** https://www.youtube.com/playlist?list=PLyqSpQzTE6M9X7oRXliYM8t0aaR_N0Csd
3. **Simple Harmonic motion:** https://www.youtube.com/watch?v=k2FvSzWeVxQ
4. **Stress- strain curves:** https://web.mit.edu/course/3/3.11/www/modules/ss.pdf
5. **Stress curves:** https://www.youtube.com/watch?v=f08Y39UiC-o
6. **Acoustics:** https://www.youtube.com/watch?v=fHBPvMDFyO8
7. **INTRO – Fundamentals of Acoustics" (Lecture 1, NPTEL-NOC, IIT Madras)** https://www.youtube.com/watch?pp=0gcJCfwAo7VqN5tD&v=rT9B44Q4Rko
8. **Fundamentals of Acoustics playlist (multiple lectures on acoustic wave behavior, sound propagation, etc.)** https://www.youtube.com/playlist?list=PLgMDNELGJ1CYWnDbcbVET5zCbN4aLEbZQ
9. **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. **Smart Structures (IIT Kharagpur) – Covers smart materials, actuators, SHM:** https://onlinecourses.nptel.ac.in/noc23_ae19/preview
12. https://bop-iitk.vlabs.ac.in/basics-of-physics/List%20of%20experiments.html
13. https://virtuallabs.merlot.org/vl_physics.html
14. https://phet.colorado.edu
15. https://www.myphysicslab.com

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Seminar, assignments, quiz, case studies, self-study activities, group discussions