|| 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 of Materials					
Course Code:	**25PHI12D/22D**			**Credits:**	4
Teaching Hours/Week (L: T: P: S)			3:0:2:1	**Total Hours:**	40+12 lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To Understand the types of oscillations with their properties and applications.
- To study the elastic properties of materials.
- To study the fundamental concepts of thermoelectricity, cryogenics and their applications in devices.
- To study the working principles of material characterization instruments.
- 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 (Quantitative and different cases), Resonance, and Sharpness of resonance. Resonance in LCR Circuits (Qualitative), Numerical (Hooke's law, Spring constant, Damped Oscillations).

Text Book: 1,2 Reference Book: 1

Pre-requisites/Self Learning: Fundamentals of oscillations.

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

Module-2: 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: 2 Reference Book: 2

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

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

Module-3: Thermoelectric materials and devices	8 Hours

Thermo emf and thermo current, Seebeck effect, Peltier effect, Seeback and Peltier coefficients, figure of merit (Mention Expression), 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) and Thermoelectric coolers (TEC), low, mid and high temperature thermoelectric materials, Applications: Exhaust of automobiles, Refrigerator, Space program (Radioisotope Thermoelectric Generator- RTG), Numerical Problems.

Text Book: 3 Reference Book: 3

Pre-requisites/Self Learning: Basics of thermo dynamics

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

Module-4: Cryogenics	8 Hours

Introduction to Thermodynamics, Carnot's principle, Efficiency, 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 (superfluidity), Platinum Resistance Thermometer, Applications of Cryogenics: Aerospace, Dewar Flask, Numerical Problems (Joule Thomson effect, Carnot's principle)

Text Book: 4 Reference Book: 4,5

Pre-requisites/Self Learning: Basics of low temperature physics

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

Module-5: Material Properties and Characterization Techniques	8 Hours

Qualitative explanation of Schrodinger equation, Interpretation of wave function and Particle in an infinite 1D potential well. Quantum confinement in 0, 1, 2 and 3 Dimension (Qualitative), Density of states expressions and graphical representation, Optical properties due to quantum confinement, blue shift, absorption, florescence, Quantum tunnelling

Characterization Techniques: X-Ray Diffractometer (XRD), Scherrer equation, Atomic Force Microscope (AFM), Scanning Electron Microscope (SEM), Numerical (Scherrer equation and Particle in an infinite 1D potential well)

Text Book: 5 Reference Book: 6

Pre-requisites/Self Learning: Fundamentals of wave mechanics

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

III (b). Practical part

Sl. No.	Experiments
1	Determination of Young's modulus of the material of the given bar Uniform Bending.
2	Determination of Rigidity modulus of the Material of the wire using Torsional Pendulum.
3	Study of the frequency response of Series & Parallel LCR circuits.
4	Determination of effective spring constant of the given springs in series and parallel combinations.
5	Determination of Young's modulus of the material of the given bar using Single Cantilever.
6	Determination of Moment of Inertia of the given irregular body by setting Torsional Oscillations.
7	Data Analysis using Spread Sheets.
8	STEP Interactive Physical Simulations. (Springs, Simple Pendulum).
9	PHET Interactive Simulation (Relevant to Theory).
10	Interpretation of graphs and images using XRD and SEM.
11	Study of forced Mechanical oscillations and Resonance.
12	Study of motion 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	Analyze and apply the principles of oscillations and elasticity to understand the mechanical properties and behaviour of materials in various engineering contexts.
CO2	Explain the fundamental concepts of thermoelectricity and cryogenics to discuss their applications in materials and devices.
CO3	Apply the principles of material characterization instruments to analyze the properties of materials.
CO4	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
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	2	-	-	-	-	-	-	2

CO4	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	2019	Pearson
2	Engineering Physics	Satyendra Sharma and Jyotsna Sharma,	2018.	Pearson
3	A Text book of Engineering Physics	M.N. Avadhanulu, P G. Kshirsagar	2014, Revised Edition.	S Chand
4	Fundamentals of Cryogenic Engineering	Mamata Mukhopadhyay	1st edition 2010	PHI Learning (India)
5	Characterization of Materials	Mitra P.K.	2013	Prentice Hall India Learning Private Limited.
6	Modern Engineering Physics	S.L.Gaur and Sanjeev Gupta	2017.	Dhanpat Rai Publications
7	Solid State Physics	S O Pillai	8th Ed; 2018	New Age International Publishers
VII(b): Reference Books:				
1	Vibrations and Waves (MIT introductory Physics Series)	A P French	2003 Edition	CBS
2	Elements of Properties of Matter	D S Mathus	Reprint 2016	S Chand
3	Engineering Physics	S L Kakani, Shubra Kakani	3rd Edition, 2020	CBS Publishers and Distributers Pvt. Ltd.
4	Cryogenics: A Textbook	S.S. Thipse	2013	Alpha Science International , Limited
5	Treatise on Heat	M N Saha and B N Srivastava	2nd Edition	Indian Press, 1935 ; Original from, the University of California
6	Materials Characterization Techniques	Sam Zhang, Lin Li, Ashok Kumar	First Edition, 2008	CRC Press
7	Applied Physics Lab Manual	Anoop Sing Yadav	1st Ed	Vayu Education of India
8	Engineering Physics	R K Guptha and R K Gaur	8th Revised-2001	Dhanpat Rai Publications
9	Applied Physics for engineers	P K Diwan	2014	Wiley Publications

10	Engineering Physics	S P Basvaraju	CBCS edition	Subhas Publications
11	Fundamentals of Fibre Optics in Telecommunication & Sensor Systems	B.P. Pal	2nd Ed; 2015	New Age International Publishers
12	LASERS Principles, Types and Applications	K.R. Nambiar	1st Ed.; 2004	New Age International Publishers
13	Lasers and Non-Linear Optics	B.B. Laud	3rd Ed; 2011	New Age International Publishers
14	Engineering physics	G. Aruldhas	1st Ed.; 2010	Eastern Economy Edition
15	Concepts of Modern Physics	Arthur Beiser	6th Ed; 2006	Tata McGraw Hill Edu Pvt Ltd- New Delhi

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

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

1. Lecture Series on Physics - I: Oscillations and Waves by Prof.S.Bharadwaj, Department of Physics and Meteorology, IIT Kharagpurn: https://www.youtube.com/watch?v=gnD8Se92hfk

2. **Waves and Oscillations**: https://www.youtube.com/watch?v=xoJWoMQwTAw&list=PLyqSpQzTE6M9X7oRXliYM8t0aaR_N0Csd

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

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

5. Cryogenic Engineering by Prof. M.D. Atrey , Department of Mechanical Engineering, IIT Bombay.: https://www.youtube.com/watch?v=4gGMBNEzeuc

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

7. Materials Characterisation: https://youtu.be/SXIYzrFGmkU

8. https://bop-iitk.vlabs.ac.in/basics-of-physics/List%20of%20experiments.html

9. https://virtuallabs.merlot.org/vl_physics.html

10. https://phet.colorado.edu

11. **https://www.myphysicslab.com**

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

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