Blow-up Syllabus

Course Code and Title

1BPHYM102/202 Physics of Materials (Mech Stream)

Module - 1 Outline

Oscillations

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

Number of Hours - 8

Module - 1 Blow-up

Subtopics	Topics to be covered	Duration
Simple Harmonic motion(SHM), differential equation for SHM	Only definition, examples, differential equation (Derivation), mention of natural frequency and time period expression	½ Hour
Springs: Stiffness Factor and its Physical Significance, series and parallel combination of springs (Derivation)	Hookes' law, Stiffness Factor and its Physical Significance, series and parallel combination of springs(Derivation)	1 ½ Hour
Types of spring and their applications	Only Compression springs and their use in shock absorber and suspensions, leaf spring and its use in railway/truck suspension.	½ Hour
Damped oscillations and types of damping	Definition, Various forces acting on the system, Set up of the Differential equation, Assuming the expression for displacement explanation for variation of amplitude, Mention of three different cases and Graphical Explanation	1 ½Hour
Engineering applications of damped oscillations	Qualitative discussion of applications such as automatic door closures, automobile suspension system,	½ Hour
Theory of forced oscillations (Derivation)	Definition of forced oscillation, Various forces acting on the system, Setting up of the Differential equation, Derivation of expression for Amplitude and Phase (Ref: A P French), Explanation of variation of amplitude with frequency (Three Cases)	1 ½ Hour
Resonance, Sharpness of resonance. Resonance in LCR circuits	Qualitative explanation of resonance and sharpness of resonance (without derivation) Qualitative explanation on LCR resonance	1 Hour
Numerical problems	Numerical problems on Stiffness Factor, Springs: series and parallel combination of springs, Forced Oscillation – Amplitude and Phase	1 Hour

Module - 2 Outline

Elasticity

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

Number of Hours - 8

Module - 2 Blow-up

Subtopics	Topics to be covered	Duration
Stress-Strain Curve Strain hardening and softening	Review of Hookes law and stress-strain curve Explanation of strain hardening and softening along with examples	1 Hour
Poisson's ratio	Define elongation and compression strain, mention the relation between them. Define Poisson's ratio	½ Hour
Elastic Moduli, relation between them, mention relation between K, Y and σ, limiting values of Poisson's ratio	Three types of Elastic Moduli, Relation between them, mention relation between K, Y and σ, limiting values of Poisson's ratio	1 ½ Hour
Static and Dynamic loading , Beams, Bending moment and derivation of expression,	Qualitative explanation on static and dynamic loading, Definition of beam, types of beams, qualitative discussion of bending and bending moment. Mention the expression for bending moment (Derivation).	2 Hour
Cantilever, Torsion and Expression for couple per unit twist, Elastic materials (qualitative). Failures of engineering materials - Ductile fracture, Brittle fracture,	Qualitative discussion on cantilever, Torsion and Expression for couple per unit twist(only Expression), Mention different elastic materials, Fundamentals of fracture, qualitative discussion of ductile and brittle fracture, stress concentration and concentration factor	1 ½Hour
Fatigue and factors affecting fatigue, S- N Curve	Definition, a brief discussion on factors affecting fatigue such as surface effect, design effect and environmental effects, Interpretation of S-N Curve (Woehler Curve - Cyclic Stress and Number of Cycles) Curve (Qualitative)	½ Hour
Numerical Problems	Numericals on Elastic moduli and relations and Poisson's ratio,	1 Hour

Thermoelectric materials and devices

Thermo emf and thermo current, Seebeck effect, Peltier effect, Seebeck 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), Numerical Problems.

Number of Hours - 8

Module - 3 Blow-up

Subtopics	Topics to be covered	Duration
Thermo emf and thermo current, Seeback effect, Peltier effect,	Introduction and definition of thermo emf and current, Qualitative explanation of both the effects along with relevant diagrams.	1 Hour
Seeback and Peltier coefficients, Figure of merits	Mention Neutral temperature, thermo electric power, Seeback and Peltier coefficients, Figure of merit along with equations	1 Hour
Laws of thermoelectricity	Statement and brief explanation of Law of homogeneous circuit, law of intermediate metals and law of intermediate thermo couple	½ Hour
Expression for thermo-emf in terms of T_1 and T_2,	Derivation of the equation Using thermodynamics and Peltier effect	1 Hour
Thermocouple and Thermopile	Construction and working, Mention of Advantages and disadvantages	½ Hour
Thermoelectric generators (TEG), Thermoelectric coolers (TEC)	Construction and working of both and mention of applications.	1 ½ Hour
Thermoelectric materials	Low, medium and high temperature TE materials with examples	½ Hour
Applications	Applications: Exhaust of Automobiles, Refrigerator, Space Program (RTG)	1 Hour
Numerical Problems	Numerical Problems on Thermo emf and Figure of Merit.	1 Hour

Module – 4 Outline

Cryogenics

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 (super fluidity), Platinum Resistance Thermometer, Applications of Cryogenics: Aerospace, Dewar Flask, Numerical Problems

Number of Hours - 8

Module - 4 Blow-up

Subtopics	Topics to be covered	Duration
Laws of Thermodynamics, Carnot's Principle, Efficiency, Production of low temperature	Qualitative explanation on laws of thermodynamics, Carnot's Principle, Efficiency- brief explanation Introduction to Production of low temperature phenomena.	1 Hour
Theory of Joule-Thomson effect,	Statement, Explanation, Derivation of expression for Joule Thomson coefficient	1 Hour
Porous plug experiment with theory, Thermodynamical analysis of Joule Thomson effect	Construction and working of Porous plug experiment, Thermodynamical analysis of Joule Thomson effect	1 Hour
Liquefaction of Oxygen by cascade process	Qualitative explanation of oxygen by cascade process with relevant diagram	1 Hour
Lindey's air liquefier	Construction and working with relevant diagram	1 Hour
Liquefaction of Helium and its properties (Superfluidity),	Construction and working and properties with relevant diagram Brief explanation on Super fluidity	1 Hour
Platinum resistance thermometer, applications of cryogenics	Construction and working with relevant diagram Qualitative explanation of applications-aerospace and Dewar flask- diagram and explanation	1 ½ Hour
Numerical Problems	Joule Thomson Effect	½ Hour

Module - 5 Outline

Material Characterization and Instrumentation Techniques

Materials Properties:

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

Instrumentation Techniques: X-Ray Diffractometer (XRD), Schrerrer equation, Atomic Force Microscope (AFM), X-ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscope (SEM), Numerical Problems.

Number of Hours: 8

Module - 5 Blow-up

Subtopics	Topics to be covered	Duration
Schrodinger equation, Interpretation of Wave Function,	Wave-Particle Dualism, Schrodinger equation (No derivation) considering Final equation, discuss significance , Physical Significance of a wave function, (Probability Density) and Born Interpretation,	1 Hour
Particle in an infinite 1D Potential Well,	Particle in an infinite 1 D potential well Explanation and Boundary conditions, Schrödinger Wave equation for a particle in 1 D infinite potential well, General Solution, Applying Boundary Conditions, Energy Eigen Values (Quantization of Energy States),Normalization and Eigen Function , Wave forms (Pictorial)	1 ½ Hour
Quantum Confinement in 0, 1, 2 and 3 Dimension (Qualitative), Graphical Representation of Density of States	Explanation of quantum confinement in 0, 1 2 and 3 dimension, Mention of expression for density of states (No derivation) with graphical approach	½ Hour
Optical properties due to Quantum Confinement, blue shift, absorption, florescence, tunneling	Discussion of size-dependent band gap and tunable emission wavelengths, observed as color shifts Qualitative explanation on blue shift, absorption, florescence, Explanation on quantum tunneling (All- Qualitative)	1 Hour
X-Ray Diffractometer (XRD), Schrerrer Equation,	Introduction of Braggs law(No Derivation), Principle, construction and working of X-ray Diffractometer with diagram, crystal size determination by Scherrer equation	1 Hour
Atomic Force Microscopy (AFM),	Principle, construction, working and mention of applications of Atomic Force Microscopy with diagram (AFM)	½ Hour
X-ray photoelectron spectroscopy(XPS), Scanning electron microscopy (SEM),	Principle, construction, working and mention of applications of X-ray photoelectron spectroscopy (XPS), Principle, construction, working and mention of applications of Scanning electron microscopy with diagram (SEM),	1 ½ Hour
Numerical Problems	Numericals on X-Ray diffraction and Scherrer equation	1 Hour