Blow-up Syllabus

Course Code and Title

1BPHYC102/202 Physics for Sustainable Structural Systems (CV)

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 (Qualitative), Types of damping (Graphical Approach). Engineering applications of Damped oscillations, Theory of forced oscillations (Qualitative), 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, Springs: Stiffness Factor and its Physical Significance	Only definition, examples, differential equation (Derivation), mention of natural frequency and time period expression, Hookes' law, Stiffness Factor and its Physical Significance	1 Hour
Series and parallel combination of springs (Derivation)	Derivation of series and parallel combination of springs	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)	1 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 explain the variation of amplitude, Mention of three different cases and Graphical Explanation	1½ Hour
Engineering applications of damped oscillations	Qualitative discussion of applications such as automatic door closures, automobile suspension system,	½ Hour
Theory of forced oscillations	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 Hour
Resonance, Sharpness of resonance. Resonance in LCR circuits (Qualitative)	Qualitative explanation of resonance and sharpness of resonance (No derivation) Qualitative explanation on LCR resonance	1 Hour
Numerical problems	Numerical problems on Springs: Stiffness Factor, series and parallel combination of springs, Forced oscillations (Amplitude and Phase)	1½ Hour

Module - 2 Outline

Waves and their role in structural behavior :

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 withstand tsunami), Seismometer and Seismograph, Accelerometer.

Number of Hours - 8

Module - 2 Blow-up

Subtopics	Topics to be covered	Duration
Types of waves, Wave propagation in beams, rods, and slabs, Boundary effects	Types of waves : Longitudinal, Transverse, Torsional, Surface, Plate/Slab (Lamb), Flexural Waves, Wave propagation in Beams and Rods (Longitudinal, Torsional, Flexural), Slabs/Plates (Flexural),	1 Hour
Wave dispersion, Damping in structures, Energy dissipation techniques in structures	Reflection and Transmission, Dispersion, Damping in Structures: Material, structural, fluid and Radiation damping.	1 Hour
Introduction to earthquakes, General characteristics, P-waves, S-waves, Love waves, and Rayleigh waves	Introduction to Earthquakes, General Characteristics, Description of P-Waves, S Waves, Love waves and Rayleigh Wavesk Ground Motion and structural response, site effects and soil-structure interaction	1 Hour
Ground motion (Qualitative) and structural response, Site effects and soil-structure interaction. Physics of earthquakes	Qualitative discussion on Ground Motion and structural response, site effects and soil-structure interaction, Definition and causes of earthquake	1 Hour
Richter scale of measurement and earthquake-resistant measures	Sketch illustrating hypocenter, epicenter, and earthquake depth Characteristics, magnitude and energy equations, Types of earthquakes, Richter scale of measurement.	1 Hour
Tsunami (causes for tsunami, characteristics, adverse effects, risk reduction measures, engineering structures to withstand tsunami)	Definition, Cause for tsunami, characteristics, adverse effects, risk reduction measures, engineering structures to withstand earthquakes and tsunami	1 Hour
Seismometer and Seismograph, Accelerometer	Seismometer and Seismograph, Accelerometer	1 Hour
Numerical Problems	Problems on energy and magnitude of earthquakes, Richter Scale	1 Hour

Module - 3 Outline

Acoustics, Radiometry and Photometry :

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

Number of Hours - 8

Module - 3 Blow-up

Subtopics	Topics to be covered	Duration
Acoustics: Introduction to Acoustics	Acoustics: Introduction to Acoustics	½ Hour
Types of Acoustics, Reverberation and reverberation time	Types of Acoustics, Reverberation and reverberation time	½ Hour
Absorption power and Absorption coefficient, Requisites for acoustics in auditorium	Qualitative discussion on Absorption power and Absorption coefficient, Requisites for acoustics in auditorium	1 Hour
Sabine's formula (derivation)	Sabine's formula (derivation)	1 Hour
Measurement of absorption coefficient, Factors affecting the acoustics and remedial measures,	Measurement of absorption coefficient, Factors affecting the acoustics and remedial measures	½ Hour
Sound Insulation and its measurements	Explanation of Sound Insulation and its measurements	1 Hour
Noise and its Measurements, Impact of Noise in Multi-storied buildings	Noise and its Measurements, Impact of Noise in Multi-storied buildings	1 Hour
Radiometry and Photometry: Radiation Quantities, Spectral Quantities,	Introduction, qualitative discussion on Radiation Quantities, Spectral Quantities,	½ Hour
Relation between luminance and Radiant quantities, Reflectance and Transmittance, Photometry (cosine law and inverse square law)	Relation between luminance and Radiant quantities, Reflectance and Transmittance, Photometry (mention of significance of cosine law and inverse square law)	1 Hour
Numerical Problems	Numerical Problems on Sabine's formula, Absorption coefficients, Lamberts's Cosine Law	1 Hour

Module - 4 Outline

Non-Destructive Testing :

Introduction to NDT, Need for inspection, Types of inspection system, Benefits of NDT. Visual inspection, Liquid penetration test: Principles surface separation, Penetrant application and development, Eddy present testing: Inspection probes, Display methods, Ultrasonic testing: Principle, Generation of Ultrasonic, Probes, Radiography: Radiation sources, Attenuation of radiation, Shadow formation and distortion, Identification Markers, Numerical Problems.

Number of Hours - 8

Module - 4 Blow-up

Subtopics	Topics to be covered	Duration
Introduction to NDT and need for inspection, Types of inspection system, Benefits of NDT	Introduction to NDT, explanation of need for inspection, Types of inspection system, Benefits of NDT	1 Hour
Visual inspection, Liquid penetration test: Principles of Surface Preparation(Qualitative)	Fundamentals of various Visual inspection (mirrors, magnifiers, light sources and special lighting – computer enhanced system) Liquid penetration test: Principle of Surface Preparation, advantages and its limitations	1½ Hour
Penetrant application and Development, Eddy current testing	Qualitative explanation of Penetrant application and Development, Eddy current testing: Working principle, detection and advantages	1 Hour
Inspection Probes, Display Methods, Ultrasonic testing:	Qualitative discussion on Inspection Probes and Display Methods in NDT, Ultrasonic testing: working principle and key advantages	1 Hour
Generation of Ultrasonic, Probes	Generation of Ultrasonics (Piezoelectric and Magnetostriction) Qualitative , Role of Probes and mention of types of probes	1 Hour
Radiography: Radiation Sources, Attenuation of Radiation	Basic principle of radiography, Radiation Sources (X-Ray Detectors and Gamm Ray), Attenuation of Radiation (Qualitative)	1 Hour
Shadow Formation and Distortion, Identification Markers	Shadow Formation and Distortion, Identification Markers (Lead identification markers)	1 Hour
Numerical Problems	Ultrasonics : Depth of Flaw , $d=\frac{vt}{2}$ Radiography ; Attenuation of Radiation $\mu=-\frac{1}{x}\ln\left(\frac{I}{I_0}\right)$	½ Hour

Module - 5 Outline

Smart Materials for Sustainable Structures :

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.

Number of Hours - 8

Module - 5 Blow-up

Subtopics	Topics to be covered	Duration
Types of Smart Materials: Piezo, Magneto strictive, Electro strictive, Electro-rheological, Magnetorheological,	Piezoelectric, magneto strictive, electro strictive, and Electro-rheological materials, Magneto Rheological, Shape memory alloys Self healing	1½ Hour
Shape memory alloys, Phase Transformation in Shape Memory Alloys	Shape Memory Alloys: Definition, Principle (Phase Transformation), effects, types and properties	1 Hour
Overview of sensor technology, uses of sensors in intelligent structures	Overview of sensor technology: Sensors, Features of smart sensors, uses of sensors in intelligent structures	1 Hour
Classification of Sensors, Temperature sensor	Classification of Sensors: Temperature, Strain, Vibration, Pressure. Temperature sensor: Types, Working and advantages, Applications	1 Hour
Vibration Sensor, Strain Gauge sensors	Vibration Sensor, Strain Gauge sensors: Working, advantages, applications.	1 Hour
Basic concepts of Structural health monitoring	Basic concepts of smart systems/structures for Structural health monitoring, Workflow for Structural Health Monitoring system, Key techniques and applications.	1½ Hour
Numerical Problems	Strain in Electrostriction ($S = ME^2$), Strain gauge-resistance change $\Delta R = GF.\ \varepsilon.\ R$, Piezo-electric Effect – Voltage from Applied Force. $V = \frac{dFt}{\varepsilon_r \varepsilon_o A}$	1 Hour