**25MA801 Solid Mechanics and Wave Propagation 3 1 0 4**

**Course Description:**

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|---|---|
| Department | Sciences |
| Course Title | Solid Mechanics and Wave Propagation |
| Course Code | - |
| Program and Section | PhD |
| Academic Year | 2025 |
| Semester | II |
| LTP/ hours per week-Credit | L: 03, T: 01 and P: 00, 4 **Credits** |

## Learning Objectives:

- Develop a strong foundation in the principles of solid mechanics and wave propagation.
- Apply mathematical tools to analyze stress, strain, and deformation in elastic solids.
- Understand the propagation of waves in different types of media.
- Analyze the behavior of surface waves and their applications.
- Apply the principles of wave propagation to various engineering problems.

**Pedagogy:**

- **Lecture-Based Instruction:** Clear and concise explanations, Real-world examples, Problem-solving demonstrations, Interactive discussions.

- **Problem-Solving and Homework Assignments:** Regular problem sets, Exam preparation**,** Feedback and guidance.

## Syllabus:

### Unit I

Analysis of Stress and Strain: Stress vector, stress components. Cauchy equations of equilibrium. Stress tensor. Symmetry of stress tensor. Stress quadric of Cauchy. Principal stress and invariants. Maximum normal and shear stresses. Geometrical interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariants. General infinitesimal deformation. Saint-Venant's equations of Compatibility.

### Unit-II

Equations of Elasticity: Hooke's law and its generalization. Hooke's law in media with one plane of symmetry, orthotropic and transversely isotropic media, Homogeneous isotropic media. Elastic moduli for isotropic media. Equilibrium and dynamic equations for an isotropic elastic solid. Saint-Venant's Principle (statement only).

### Unit III

General form of progressive waves, Harmonic waves, Plane waves, the wave equation. Principle of superposition. Progressive types solutions of wave equation. Stationary type solutions of wave equation in Cartesian, Cylindrical and Spherical coordinates systems

**Unit IV**

Surface waves: Rayleigh waves, Love waves and Stoneley waves. Love waves in isotropic 2 layered and isotropic 3 layered structures, Rayleigh waves in elastic semi-infinite medium.

**Unit V**

Reduction of equation of motion to wave equations. P and S waves and their characteristics. Polarization of plane P and S waves. Snell's law of reflection and refraction. Reflection of plane P and SV waves at a free surface. Partition of reflected energy. Reflection at critical angles. Reflection and refraction of plane P, SV and SH waves at an interface. Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface.

**Text Books:**


1. A. E. H. Love, A Treatise on a Mathematical Theory of Elasticity, Dover Pub., New York
2. M. Bath, Mathematical Aspects of Seismology, Elsevier Publishing Company, 1968.


**Reference Books:**


1. A.K. Mal & S.J. Singh, Deformation of Elastic Solids, Prentice Hall, New Jersey, 1991
2. W.M. Ewing, W.S. Jardetzky and F. Press, Elastic Waves in Layered Media, McGraw HillBook Company, 1957.


**Course Outcome:**

| | |
|---|---|
| CO1 | Students will be able to analyze stress and strain states in a body, determine principal stresses and strains, and understand the geometric interpretation of deformation. |
| CO2 | Students will be able to apply Hooke's law to various materials and derive the equations of elasticity for isotropic solids. |
| CO3 | Students will be able to derive the wave equation for different types of waves, solve the wave equation for various boundary conditions, and understand the principles of superposition and wave propagation. |
| CO4 | Students will be able to analyze the characteristics of surface waves, understand their propagation in layered structures, and apply their knowledge to geophysical applications. |
| CO5 | Students will be able to derive the equations of motion for wave propagation in solids, analyze the characteristics of P and S waves, understand the principles of reflection and refraction at interfaces, and apply these concepts to various geophysical and engineering problems. |

**Evaluation Pattern:**

**Unit wise Evaluation Pattern:**

| Unit No | Midterm | End sem | Other IA Components | | Total |
|---|---|---|---|---|---|
| | | | Assignment 1 | Research paper/ case study/ Literature survey | |
| 1 | 25 | 16 | 02 | | |
| 2 | 25 | 15 | 02 | | |
| 3 | | 26 | 02 | 04 | |
| 4 | | 23 | 02 | 06 | |
| 5 | | 20 | 02 | | |
| Total | 50 (30) | 100 (50) | 10 | 10 | 100 |

**Internal Assessment Component:**

| Sl. No. | Component Name | | Weightage | CO Mapping | Unit Mapping |
|---|---|---|---|---|---|
| 1 | Midterm Examination | | 30 | 1, 2, 3 | 1, 2, 3 |
| 2 | Other IA components | Assignment 01 | 10 | 1,2,3,4,5 | 1,2,3,4,5 |
| | | Research paper/ case study/ Literature survey | 10 | 3,4 | 3,4 |

**External Assessment Component:**

| Sl. No. | Component Name | Weightage | CO Mapping |
|---|---|---|---|
| 1 | End sem exam | 50 | 1,2,3,4,5 |

**Employability:**

Graduates with a strong foundation in stress, strain, elasticity, and wave propagation is well-prepared for careers in various fields. They can pursue roles in:

- *Research and Development*: In industries like aerospace, automotive, civil engineering, and materials science, to develop and analyze structural components, optimize designs, and investigate material behavior under various conditions.
- *Computational Modeling and Simulation*: Using advanced software tools to simulate physical phenomena, predict material responses, and optimize designs.
- *Academic Research*: Contributing to the advancement of knowledge in areas like solid mechanics, acoustics, and geophysics.