Course Title: Introduction to Structural Engineering

Course Overview:

This course offers an in-depth understanding of structural engineering principles, including analysis and design of various structural systems, material behavior under loads, and the use of computational tools. Through theoretical lessons and practical projects, students will gain the knowledge and skills required to analyze, design, and evaluate the performance of structures.

Course Objectives:

- Develop an understanding of structural analysis methods.
- Learn to design structural components (beams, columns, foundations, etc.) for various materials.
- Familiarize with codes, standards, and safety protocols in structural engineering.
- Gain proficiency in using structural analysis and design software.
- Apply learned concepts in real-world case studies and projects.

Prerequisites:

- Basic courses in **Physics**, **Mechanics**, and **Mathematics**.
- Introductory knowledge of **Engineering Materials** and **Statics**.

Course Modules and Topics

Module 1: Introduction to Structural Engineering

- **Topics:**
    - Overview of Structural Engineering and its importance.
    - Types of structures and structural systems.
    - Key roles of structural engineers.
    - Design principles, codes, and standards (such as ACI, AISC, Eurocode).
- **Outcome:** Understanding the scope and purpose of structural engineering and the key concepts of structural safety, reliability, and performance.

Module 2: Engineering Mechanics and Structural Analysis

- **Topics:**
    - Statics and equilibrium of structures.
    - Internal forces (axial, shear, bending) and stress distribution.
    - Free-body diagrams and load-path analysis.
    - Types of loads (dead, live, wind, seismic, etc.).
- **Outcome:** Ability to analyze simple structural systems and identify internal forces and stresses.

Module 3: Structural Materials

- **Topics:**
    - Properties of structural materials: concrete, steel, timber, and composites.
    - Stress-strain behavior, material testing, and durability.
    - Load-deformation characteristics and failure mechanisms.
- **Outcome:** Understanding of the material behavior and selection process for different structural components.

Module 4: Structural Analysis Methods

- **Topics:**
    - Classical methods: method of joints, method of sections.
    - Matrix methods and computer-aided structural analysis.
    - Approximate methods for indeterminate structures.
- **Outcome:** Proficiency in performing structural analysis and using computational tools to solve complex problems.

Module 5: Design of Structural Components

- **Topics:**
    - **Design of beams**: bending, shear, and deflection criteria.
    - **Design of columns**: buckling, axial capacity, and slenderness effects.
    - **Design of slabs, trusses, and frames**.
    - Load combinations and safety factors.

- **Outcome:** Ability to design individual structural components according to safety and serviceability criteria.

Module 6: Foundation Engineering and Soil-Structure Interaction

- **Topics:**
    - Types of foundations: shallow, deep, and special foundations.
    - Soil properties and bearing capacity.
    - Foundation settlement and soil-structure interaction.
- **Outcome:** Knowledge of foundation systems, their design criteria, and factors influencing soil-structure interaction.

Module 7: Advanced Topics in Structural Design

- **Topics:**
    - Earthquake-resistant design principles and seismic loading.
    - Wind loading and its effects on tall buildings.
    - Retrofitting and strengthening existing structures.
    - Structural health monitoring and maintenance.
- **Outcome:** Ability to apply advanced techniques in designing structures for extreme loads and in retrofitting existing buildings.

Module 8: Structural Engineering Software Applications

- **Topics:**
    - Introduction to structural analysis software (e.g., SAP2000, ETABS, STAAD Pro).
    - Finite Element Method (FEM) basics and applications in structural analysis.
    - Modeling and analyzing real-world projects.
- **Outcome:** Proficiency in using structural engineering software for modeling and analysis.

Assessments and Assignments:

1. **Quizzes & Midterm Exam** – Assess basic concepts and understanding of core topics.

2. **Homework Assignments** – Solve structural analysis and design problems.
3. **Projects** – Design a small building or bridge structure, analyze, and present solutions using software.
4. **Final Exam** – Comprehensive exam covering all modules.

Recommended Textbooks and Resources:

- "Structural Analysis" by R.C. Hibbeler
- "Steel Design" by William T. Segui
- "Design of Concrete Structures" by Arthur H. Nilson
- "Structural Engineering Handbook" by Edwin H. Gaylord, Charles N. Gaylord, and James E. Stallmeyer
- Access to software like **SAP2000, ETABS, or STAAD Pro**.

Course Outcome:

By the end of this course, students will be equipped with fundamental skills in structural analysis and design, prepared to tackle basic structural engineering problems, and ready to use structural engineering software for design and analysis tasks.