DESIGN OF STRUCTURES

ENCE 357

Lecture	**: 3**	**Year : III**
Tutorial	**: 2**	**Part : II**
Practical	**: 3/2**	

Course Objectives:

The objective of this course is to develop competency in modern structural design concepts relevant to agricultural and general civil engineering works. Upon completion, students will be able to analyze structural behavior under various loading conditions, apply limit state design principles and computational tools for steel, timber, and reinforced concrete structures, and design safe, sustainable, and code-compliant structural components and systems for practical engineering applications.

Part-A: Design of Steel and Timber Structures

1 Introduction to Structural Systems and Materials (2 hours)

- 1.1 Types of loads and load combinations
- 1.2 Steel and timber as sustainable structural materials
- 1.3 Stress-strain behavior and material properties
- 1.4 Overview of modern design codes

2 Design Philosophies and Systems (3 hours)

- 2.1 Working stress method versus limit state design
- 2.2 Introduction to load and resistance factor design (LRFD)
- 2.3 Floor systems and truss configurations
- 2.4 Sustainable and modular construction practices

3 Connections Design (4 hours)

- 3.1 Bolted and welded connections: Types, failures, and design
- 3.2 Design for axial and eccentric loading
- 3.3 Moment-resisting and simple connections
- 3.4 Use of software for connection design

4 Design of Members (7 hours)

- 4.1 Tension members: Net area, block shear, design examples
- 4.2 Compression members: Effective length, slenderness, design of columns and bases
- 4.3 Beams: Bending, shear, deflection, lateral support and bearing plates
- 4.4 Built-up sections: Design and stability checks

5 Roof Systems and Timber Design (6 hours)

5.1 Roof truss design: Loads, analysis (Graphical and software-based), purlins, bracing
5.2 Timber structures: Material grades, permissible stresses, design of beams and columns
5.3 Timber connections: Traditional and modern fasteners
5.4 Sustainability and durability considerations

Part-B: Design of Reinforced Concrete Structures

1 Fundamentals of Reinforced Concrete (RC) (3 hours)

1.1 Material behavior: concrete and reinforcement
1.2 Assumptions in RC design
1.3 Load types and combinations
1.4 Introduction to durability and fire resistance

2 Design Philosophies (4 hours)

2.1 Working stress method: Concept and limitations
2.2 Limit state method: safety, serviceability, partial safety factors
2.3 Introduction to performance-based design

3 Structural Member Design: Limit State Method (14 hours)

3.1 Beams: Singly/doubly reinforced, flanged sections
3.2 Slabs: One-way, two-way, and flat slabs
3.3 Columns: Axial, uniaxial and biaxial bending
3.4 Foundations: Isolated and combined footings
3.5 Reinforcement detailing as per IS 456/SP 34
3.6 Crack control, deflection checks and durability provisions

4 Sustainability (2 hours)

4.1 Use of alternative materials (GFRP, recycled aggregates)
4.2 Introduction to green building concepts in RC design

Tutorial (30 hours)

1. Analysis of different types of loads, load combinations, and material behavior of steel, timber, and concrete based on stress–strain characteristics
2. Design and detailing of bolted and welded connections under axial and eccentric loading, including identification of common failure modes
3. Application of software tools for modeling and visualization of structural connections and interpretation of design outputs
4. Design analysis of structural members including tension members, compression members, beams, and built-up sections considering stability and serviceability requirements

5. Design and layout of roof truss systems, purlins, bracing systems, and timber structural components considering durability and sustainability factors
6. Design of reinforced concrete structural members such as beams, slabs, columns, and foundations using limit state method
7. Detailing and evaluation of reinforcement layouts, crack control measures, durability provisions

Practical **(22.5 hours)**

1. Introduction to structural analysis and design software
2. Modeling and analysis of a 2D truss and a simple frame
3. Creation of reinforcement detailing drawings using CAD software
4. Laboratory testing of concrete cube: Mixing, preparation of samples, curing and testing
5. Tensile test of reinforcement bar
6. Test of deflection of beam: Bar bending, mixing, preparation of samples, curing and testing

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
Part A		
1-2	5	7
3	4	6
4	7	9
5	6	7
Part B		
1-2	7	9
3	13	14
4	3	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Vazirani, V. N., Ratwani, M. M. (2011). Design of reinforced concrete structures. Khanna Publishers.
2. Vazirani, V. N., Ratwani, M. M. (2012). Design of steel structures. Khanna Publishers.
3. Dayaratnam, P. (2011). Design of reinforced concrete structures. Oxford & IBH Publishing.
4. Kazimi, S. M. A., Jindal, R. S. (2010). Design of steel structures. PHI Learning Pvt. Ltd.