NIRMA UNIVERSITY

Institute of Technology

School of Engineering

Master of Technology - Civil Engineering

(Computer Aided Structural Analysis and Design)

Semester- II

L	T	P	C
3	0	0	3

Course Code	6CL166
Course Name	Design of Plates and Shells

Course Outcomes:

At the end of the course, students will be able to –

1. evaluate response of thin plate under lateral loading
2. analyze different types of shell subjected to various loading
3. design concrete shell roofs.

Syllabus — Teaching hours: 45

Unit-1: Plate Analysis — **Hours: 15**

Introduction to plate theory, Small deflection of laterally loaded thin rectangular plates for pure bending, Navier's and Levy's solution for various lateral loading and boundary conditions Energy methods.

Unit-2: Shell Analysis and Design — **Hours: 30**

Shell behaviour, Shell surfaces and characteristics, Classification of shells, Equilibrium equations, Force displacement relations, Membrane analysis of shells of revolution and cylindrical shells under different types of loads, Membrane solution of elliptic paraboloids, Hyperboloids and conoids, Finite element analysis, Design of concrete cylindrical shell roofs.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Timoshenko, S. P. & Woinowsky, K. W. *Theory of Plates and Shells*, McGraw-Hill.
2. Ugural, A. C. *Stresses in Plates and Shells*, McGraw-Hill.
3. Bairagi, N. K. *A Text Book of Plate Analysis*, Khanna Publishers.

4. Bairagi, N. K. *Shell Analysis*, Khanna Publishers.
5. Szilard, R. *Theory and Analysis of Plates - Classical and Numerical Methods*, Prentice Hall.
6. Ramaswamy, G. S. *Design and Constructions of Concrete Shell Roofs*, CBS Publishers.

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Semester- II

L	T	P	C
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Course Code	6CL167
Course Name	Prestressed Concrete Structures

Course Outcomes:

At the end of the course, students will be able to –

1. assess losses and deflection in prestressed concrete structural elements
2. design prestressed concrete structural elements
3. analyze and design composite prestressed concrete structures.

Syllabus: Teaching hours: 45

Unit-1: Introduction Hours: 08

Types, Systems and devices, Materials, Losses in prestress, Deflection, Analysis of flexural members: stresses at transfer and service loads.

Unit-2: Design of Beam Hours: 12

Design for ultimate and serviceability limit state for flexure, shear and torsion.

Unit-3: Transmission of Prestress Hours: 05

Transmission of prestress in pretensioned members, Anchorage zone stresses for post tensioned members.

Unit-4: Analysis and Design of Structural elements Hours: 10

Analysis and design of structural elements like slab, continuous beams, frames, columns with moments and concrete pipes.

Unit-5: Composite Structures Hours: 10

Composite construction with precast prestressed concrete beam and cast in-situ reinforced concrete slab: analysis and design, creep and shrinkage effects, Partial prestressing: principles, analysis and design concepts.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Krishnaraju, N. *Prestressed Concrete*, Tata McGraw Hill.
2. Rajagopalan, N. *Prestressed Concrete*, Narosa Publication.
3. Lin, T. Y. & Burns, N. H. *Design of Prestressed Concrete Structures*, Wiley India.
4. Bhatt, P. *Prestressed Concrete Design for Eurocodes*, Taylor & Francis.
5. Codes: IS:1343, IRC:112.

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Semester- II

L	T	P	C
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Course Code	6CL168
Course Name	Marine Structures

Course Outcomes:

At the end of the course, students will be able to –

1. analyze and design marine structures
2. plan and design protection work for marine structures
3. assess performance of structures under marine environment.

Syllabus — Teaching hours: 45

Unit-1: Introduction — Hours: 05

Types, Structural systems for shallow, medium and deep water, Structural actions of onshore structures, Types of offshore structures.

Unit-2: Analysis and Design of Structures — Hours: 20

Types, Materials of construction, Estimation of load and load combination, Design principles, Analysis and design of wharf, jetty, dolphin, dry dock, slipway and lock.

Unit-3: Marine Protection Work — Hours: 10

Break waters, Effects on the beach, Types, Selection of site and type, Design of rubble mound, Vertical wall and composite breakwaters.

Unit-4: Performance Assessment — Hours: 10

Materials for marine applications, Properties and selection of materials for marine environment, Corrosion and corrosion protection methods, Codes of practice for materials in marine environment.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Narasimhan, S. & Kathiroli, S. *Harbour and Coastal Engineering (Indian Scenario) -Vol. I & II*, National Institute of Ocean Technology.
2. *Shore Protection Manual*, U. S. Army Coastal Engineering Research.
3. Quinn, A. D. F. *Design and Constructional of Ports and Marine Structures*, McGraw-Hill.
4. Bruun, P. *Port Engineering*, Gulf Publishing.
5. Codes: IS:4651, IS:9527, IS:10020, IS:2911, IS:456.

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Semester- II

L	T	P	C
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Course Code	6CL169
Course Name	Earthquake Engineering

Course Outcomes:

At the end of the course, students will be able to –

1. interpret earthquake ground motion and develop response & design spectrum
2. estimate lateral load and its distribution for reinforced concrete and masonry buildings
3. appraise concept of ductility and related codal specification for earthquake resistant design.

Syllabus: Teaching hours: 45

Unit-1: Introduction to Seismology Hours: 05

Causes of earthquake and their characteristics, Earthquake parameters, Characterization of ground motion, Earthquake intensity & magnitude, Recording instruments.

Unit-2: Response and Design Spectrum Hours: 10

Equation of motion for earthquake excitation, Response spectra & design spectra for elastic and inelastic systems.

Unit-3: Lateral Load Analysis of the Building Hours: 10

Lateral load analysis of building systems, Modal superposition method and modal analysis of buildings, Classical damping, Lateral load distribution for torsionally coupled and uncoupled systems.

Unit-4: Earthquake Design of Reinforced Concrete Structural Elements Hours: 10

Earthquake resistant design philosophy, Analysis and design of lateral load resisting systems - moment resisting frames and shear walls, Ductility based design of beams and columns using codal provisions.

Unit-5: Earthquake Design of Masonry Structures Hours: 06

Lateral load analysis of masonry structures, Earthquake resistant features for masonry structures and related codal provisions.

Unit-6: Advances in Earthquake Engineering **Hours: 04**

Earthquake geotechnical aspects, Structural response control using base isolation system & supplemental damping devices.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Chopra, A. K. *Dynamics of Structures: Application to Earthquake Engineering*, Pearson.
2. Paulay, T. & Priestley, M. J. N. *Seismic Design of Reinforced Concrete and Masonry Buildings*, Wiley.
3. Wakabayashi, M. *Design of Earthquake Resistant Buildings,* McGraw-Hill.
4. Kramer, S. L. *Geotechnical Earthquake Engineering*, Pearson.
5. Wiegel, R. L. *Earthquake Engineering*, Prentice-Hall.
6. Codes : IS:1893, IS:4326, IS:13920, IS:13828, IS:456, IS:1905.

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Course Code	6CL170
Course Name	Chimney, Silo and Transmission Line Tower

Course Outcomes:

At the end of the course, students will be able to –

1. design chimney structures
2. design storage structures
3. design transmission line tower.

Syllabus: Teaching hours: 45

Unit-1: Chimney Structures **Hours: 15**

Dimensioning of chimney, Design factors, Stresses due to temperature, Components, Platform and safety ladders, Steel stacks, Refractory linings, Stability consideration, Openings, Access ladder, Caps and foundation, Design and detailing of chimney structures.

Unit-2: Storage Structures **Hours: 20**

Silo and Bunker: Introduction, Requirements, Shape, Dimension and layout, Circular and square bunkers, Jansen's and Airy's theories, Design philosophies; Design and detailing of walls, hopper, staging and foundation, Battery of silos.

Unit-3: Transmission Line Tower **Hours: 10**

Classification, Economical spacing, Tower configuration, Assessment of loads, Permissible stresses; Analysis, design and detailing of towers including foundation.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Krishna, J. & Jain, O. P. *Plain & Reinforced Concrete Volume – II*, Nemchand & Bros.

2. Krishna, R. N. *Advanced Reinforced Concrete Design*, CBS Publishers.
3. Manohar, S. N. *Tall Chimneys: Design & Construction*, Tata McGraw-Hill.
4. Murthy, S. S. & Santhakumar, A. R. *Transmission Line Structures*, McGraw-Hill.
5. Rajagopalan, K. R. *Storage Structures*, Routledge.
6. Codes: IS:802, IS:4091, IS:4998, IS:4995, IS:6533.

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Course Code	6CL171
Course Name	Industrial Structures

Course Outcomes:

At the end of the course, students will be able to –

1. estimate loads and load combinations for industrial structures
2. design elements and systems for industrial structures
3. analyze and design pre-engineered, movable and oscillating structures.

Syllabus: Teaching hours: 45

Unit-1: Planning and Functional Requirement Hours: 05

Classification of industries and industrial structures, Process planning, Requirements regarding lighting, ventilation and fire safety, Protection against noise and vibration - guidelines from factories act.

Unit-2: Analysis and Design of Industrial Structures Hours: 20

Loads and load combinations, Design of braced and unbraced single and multi-bay industrial structures in steel and/or concrete, Roofs for industrial buildings, Self-supporting roofs, Lifting devices: EOT cranes of different types, monorails, General fabrication construction drawings, Structural platforms: chequered plate, structural decking, Lug/leg supported vessels and M. S. stairs.

Unit-3: Equipment and Machine Foundation Hours: 10

Equipment and its effect in industrial structures, Analysis and design of machine foundations.

Unit-4: Pre-engineered Structures Hours: 10

Pre-engineered/Pre-fabricated, Movable and oscillating structures.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Srinivasulu, P. & Vaidyanathan, C. V. *Handbook of Machine Foundations*, Tata McGraw-Hill.
2. Subramanian, N. *Steel Structures: Design and Practice*, Oxford University Press.
3. Krishna, J. & Jain, O. P. *Plain and Reinforced Concrete Vol. I & II*, Nemchand Bros.
4. Ghosh, K. M. *Analysis and Design Practice of Steel Structures*, PHI Learning.
5. Codes: IS:800, IS:875, IS:456, IS:11384, IS:2974.

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Course Code	6CL172
Course Name	Bridge Structures

Course Outcomes:

At the end of the course, students will be able to –

1. assess different type of loads on substructures and superstructure of the bridge
2. analyze and design superstructure of bridge
3. analyze and design substructure and foundation of bridge.

Syllabus Teaching hours: 45

Unit-1: Introduction Hours: 06

Bridge components and its function, Classification of bridges, reconnaissance study, planning and layout of bridges, IRC specifications for bridges, Standard live loads and other forces acting on bridges, General considerations.

Unit-2: Design of Superstructure Hours: 22

Analysis, design and detailing of reinforced concrete slab culverts, tee beam & slab bridges, continuous bridges and box girder bridges; Analysis, design and detailing of prestressed concrete bridges.

Unit-3: Design of Substructure Hours: 10

Forces acting on substructure; Design of abutment, wing wall and expansion joints, Design of pier & pier cap, Types & functions of bearings, Design of bearings.

Unit-4: Design of Foundation Hours: 05

Types and classification of foundation, Design and detailing of bridge foundation.

Unit-5: Maintenance of Existing Bridge Hours: 02

Evaluation of existing bridges, Maintenance and retrofitting of bridges

Self-Study:
The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Raina, V. K. *Concrete Bridge Practice: Analysis, Design and Economics*, Shroff Publishers.
2. Krishnaraju, N. *Design of Bridges*, Oxford & IBH.
3. Bakht, B. & Jaegar, L. G. *Bridge Analysis Simplified*, McGraw-Hill.
4. Victor, D. J. *Essentials of Bridge Engineering*, Oxford & IBH.
5. Saran, S. *Analysis and Design of Substructures*, Oxford and IBH Publishing.
6. Codes: IRC:6, IRC:112, IRC:78, IS:456.

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Semester- II

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Course Code	6CL173
Course Name	Nonlinear Analysis of Structures

Course Outcomes:

At the end of the course, students will be able to –

1. classify nonlinearities and select appropriate nonlinear models for different materials
2. evaluate structural response using nonlinear analysis
3. choose appropriate computational techniques for nonlinear systems.

Syllabus: Teaching hours: 45

Unit-1: Introduction Hours: 08

Types and sources of nonlinearities, Nonlinear structural analysis, Principles of plasticity: overview, yield criterion, flow rule, hardening rule, loading/unloading criterion.

Unit-2: Material Modelling Hours: 12

Elastic-perfectly plastic material, Material models for concrete, steel and masonry materials.

Unit-3: Member Section Analysis Hours: 15

Member section analysis, Fiber section discretization, Moment-curvature response, Force-deformation response, Material nonlinear beam-column element formulation, Lumped plasticity models, Distributed nonlinearity models, Displacement-based nonlinear beam-column element, Force-based nonlinear beam-column element, Geometrically nonlinear analysis, Simplified second order P-Δ analysis.

Unit-4: Application of Computational Techniques Hours: 10

Solution strategies for nonlinear system: incremental single-step methods, Euler method, second-order Runge-Kutta methods, incremental-iterative methods, load control, displacement control, work control, arc-length control, Nonlinear structural dynamic analysis: semi-discrete equations of motion, explicit time integration, Implicit time integration, dissipative integration algorithms, stability and accuracy.

Self-Study:
The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Sathyamoorthy, M. *Nonlinear Analysis of Structures*, CRC Press.
2. Reddy, J. N. *Non-linear Finite Element Analysis*, Oxford University Press.
3. Owen, D. R. J. & Hinton, E. *Finite Elements in Plasticity-Theory and Practice*, Pineridge Press.
4. *ATC 40, Seismic Evaluation and Retrofit of Concrete Building – Vol. I & II*, Applied Technology Council.
5. Priestley, M. J. N., Calvi, G. M. & Kowalsky, M. J. *Displacement-Based Seismic Design of Structures*, IUSS Press.
6. Chapra, S. C. & Canale, R. P. *Numerical Methods for Engineers*, McGraw Hill Education.

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Course Code	6CL174
Course Name	Tall Buildings

Course Outcomes:

At the end of the course, students will be able to –

1. identify various structural systems, materials and assess loading for tall buildings
2. illustrate behaviour of tall buildings subjected to gravity and lateral loading
3. analyze and design tall buildings.

Syllabus: Teaching hours: 45

Unit-1: Introduction Hours: 02

History, Definition, Need, Factors affecting design of tall buildings.

Unit-2: Materials Hours: 03

Steel, Concrete, Prestressed concrete, Fibre reinforced concrete, Self-compacting concrete, High performance concrete, Ductility of materials.

Unit-3: Loading Hours: 04

Gravity, Lateral loading due to wind, earthquake, blast, impact, Load combination.

Unit-4: Structural Systems: Behaviour and Modelling Hours: 10

Regular and irregular structural systems, Structural systems for gravity and lateral loading: frame, wall, wall-frame, framed tube, core, braced frames, tubular structures, space structures, hybrid structures.

Unit-5: Analysis Methods Hours: 06

Static, Dynamic and nonlinear analysis, Approximate analysis for gravity and lateral loading, Application of stiffness method and finite element method for tall buildings.

Unit-6: Design Methods Hours: 10

Concrete buildings: design of beam, column, shear wall, joints, ductile detailing, Steel-concrete composite buildings: type of composite beam, columns, design of composite beam, column, shear connectors, joints, Detailing of composite structures, Foundation systems for tall buildings.

Unit-7: Use of Software **Hours: 04**

Modeling, Analysis and design of tall buildings using commercial software.

Unit-8: Advance Topics **Hours: 06**

Axial deformation of column, Unit quantities, Floor vibration, Cladding, Response control techniques.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Taranath, B. S. *Steel Concrete and Composite Design of Tall Buildings*, McGraw-Hill.
2. Smith, B. S. & Coull, A. *Tall Building Structures: Analysis and Design*, John Wiley & Sons.
3. Fintel, M. *Handbook of Concrete Engineering*, CBS Publishers.
4. Aoyama, H. *Design of Modern High Rise Reinforced Concrete Structures*, Imperial College Press.
5. *Structural System for Tall Buildings*, Council for Tall Building and Urban Habitat.
6. Codes: IS:16700, IS:875, IS:1893, IS:13920, IS:456, IS:800, IS:4326, IS:11394.

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Semester- II

L	T	P	C
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Course Code	6CL175
Course Name	Blast Resistant Structures

Course Outcomes:

At the end of the course, students will be able to –

1. estimate blast load on structures
2. design structural elements against blast loading
3. evaluate progressive collapse potential of structures

Syllabus: Teaching hours: 45

Unit-1: Introduction Hours: 07

Introduction to blast and identification of threats, Sources of explosion and explosives, History and overview of blast resistant structural design, Blast effects on buildings, Study of protection methodology and risk assessment.

Unit-2: Blast Loading Hours: 10

Characteristics of blast waves and its propagation, Factors affecting blast load, Analytical and computational methods for blast load prediction, Response of structures to blast load.

Unit-3: Blast Resistant Design and Detailing Hours: 20

Important parameters affecting design of blast resistant structures, Design procedure for structural elements subjected to blast load, Structural detailing, Retrofitting technologies.

Unit-4: Progressive Collapse Analysis of Structure Hours: 08

Introduction and causes of progressive collapse, Concept of controlled demolition, Overview of guidelines for progressive collapse analysis and design, Alternate load path method, Tie force method, Local resistant method, Mitigation strategies.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Dusenberry, D. O. *Handbook for Blast Resistant Design of Buildings*, Wiley.
2. Bangash, M. Y. H. & Bangash, T. *Explosion-Resistant Buildings: Design, Analysis, and Case Studies*, Springer.
3. Cormie, D., Mays, G. & Smith, P. *Blast Effects on Buildings*, Thomas Telford Publishing.
4. Krauthammer, T. *Modern Protective Structures*, CRC Press.
5. Bulson, P. S. *Explosive Loading of Engineering Structures*, CRC Press.

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