



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Civil Engineering

Subject Code : DI05006011

Subject Name : Design of Reinforced Concrete Structures

w. e. f. Academic Year:	2026-27
Semester:	5 th
Category of the Course:	PCC

Prerequisite:	Mechanics of Structures-I, Concrete Technology
Rationale:	<p>Most Civil engineering structures are primarily constructed using structural steel sections or Reinforced Cement Concrete (R.C.C.). In the fourth semester, the subject Design of Steel Structures provides students with the fundamental principles of steel design.</p> <p>The subject Design of Reinforced Concrete Structures focuses on the analysis and design of R.C.C. components such as slabs, beams, columns, and footings using the Limit State Method in accordance with IS 456:2000.</p> <p>Upon completion of this course, diploma students will develop a comprehensive understanding of the structural behaviour, analysis, and design principles of R.C.C. members. They will be equipped with the necessary technical knowledge, analytical competence, and practical design skills required to undertake structural design tasks effectively in the construction and infrastructure industry.</p>

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Interpret IS Code provisions for Limit state R.C.C. Design from IS:456-2000 and SP-16	R, U
02	Analyze & Design Singly Reinforced Rectangular Section (SRRS), Doubly Reinforced Section and Analyze Flange Section under Flexure	R, U, A, N
03	Design Shear Reinforcement for R.C. Rectangular Beam	R, U, A, N
04	Design Simply Supported One-way and Two-way R.C.C. Slabs.	R, U, A, N
05	Design axially loaded short column and isolated footing	R, U, A, N

**Revised Bloom's Taxonomy (RBT)*



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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
03	00	02	04	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Fundamentals of R.C.C. Design 1.1 Reinforced Cement Concrete, necessity of steel in concrete, normal location of steel in beams, slabs, column & footing. 1.2 Limit State, Limit State of Collapse-Flexure, Shear, Compression, Torsion, Limit State of Serviceability-deflection and Cracking. 1.3 Characteristic Strength of concrete and steel, partial safety factor of concrete and steel and partial safety factors for loads. 1.4 Nominal Cover, Effective depth, Effective span.	06	12
2.	Singly Reinforced Beam 2.1. Types of beams: Singly reinforced beam, Doubly reinforced beam, T-beam, L-beam. Difference among various beams. 2.2. Stress-strain diagram for singly RC section. Under reinforced, over reinforced and balanced section. 2.3. Analysis of Singly RC beam: Determination of lever arm, total tension, total compression, percentage area of reinforcement and Moment of resistance. Numerical based on this. 2.4. Design and detailing of Singly RC beam: Determine the size of section, area and number of reinforcement bars. Combination of different diameters of reinforcement bars. Check for spacing and cover. Numerical based on this with check for serviceability	08	20
3.	Doubly Reinforced Beam 3.1 Requirements and conditions for providing doubly reinforced sections. 3.2 Stress diagram for doubly reinforced beam. Stress in compression reinforcement (f_{sc}) in doubly reinforced beams for different values of d'/d ratio. 3.3 Analysis and design of doubly reinforced section using IS:456-	06	12



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	2000 method, SP:16 table method and SP: 16 chart method. 3.4 Numerical of Moment of resistance and Area of steel (tension and compression) for doubly reinforced beam.		
4.	T-Beam 4.1 Concept of flanged beam-T-beam & L-beam. Requirement and advantage of T-beam. Effective width of flange. 4.2 Moment of Resistance for T-Beam for conditions, (i) Neutral axis lies in flange [$X_u < D_f$] (ii) Neutral axis lies in web [$X_u > D_f$] Stress strain diagram of T- beam. Numerical based on this 4.3 Numerical to find Limiting Moment of Resistance of Tee Beam using IS:456-2000 and SP-16.	06	12
5.	Shear and Development Length 5.1 Shear: Definition of shear, IS code specifications, single legged and two-legged shear reinforcement. 5.2 Vertical stirrups, Incline stirrups, benefit of bent up of main tension reinforcement. Spacing of stirrups. Numerical based on the same. 5.3 Effect of shear in slabs. IS code provision. 5.4 Development Length: Definition of development length, IS provision for determination of development length for tension and compression zone. Numerical based on the same.	05	12
6.	Slabs 6.1 Types of slabs, One way simply supported slab. Two-way slab and One-way continuous slab. 6.2 IS provision for main reinforcement, distribution reinforcement, minimum and maximum steel area, effective span, effective depth, effective cover. 6.3 Depth of Slab from deflection criteria, Dead Load, Live Load and Floor finish load on Slab. Bending moment due to loads. 6.4 Design and detailing of one way simply supported and cantilever slabs. Check limit state of serviceability. Numerical based on this. 6.5 Design and detailing of two way simply supported slab (only corners not held down condition). Check the limit state of serviceability. Numerical based on this.	08	20
7.	Axially Loaded Short Column and Isolated Footing 7.1 Column: Types of columns, Long Column, Short column, Axially loaded column, uniaxially loaded column and biaxially loaded column. 7.2 Limit state of collapse: Compression, assumptions, effective length, slenderness ratio, minimum eccentricity. IS provision for	06	12



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	reinforcement in column, lateral reinforcement as tie only (No Helical Reinforcement) 7.3 Load analysis of axially loaded short columns. 7.4 Design of axially loaded short columns. Check for minimum eccentricity. 7.5 Footing: Types of isolated footing, pad and sloped footing. IS specification for reinforcement in footing. 7.6 Design of isolated pad/slopped footing. Check for bending, one way shear and two-way shear, check for development length in footing. Numerical based on this with reinforcement details.		
	Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	55	10	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr.	Title of Books/standards	Author	Publication
1.	IS:456-2000- Plain and Reinforced concrete code of practice.	BIS, New Delhi	BIS, New Delhi
2.	SP:16-Design Aids for reinforced concrete to IS:456	BIS, New Delhi	BIS, New Delhi
3.	SP:34-Handbook on Concrete Reinforcement and Detailing	BIS, New Delhi	BIS, New Delhi
4.	Design of Reinforced Concrete Structures	N Krishna Raju	CBS Publishers & Distribution Pvt. Ltd. New Delhi ISBN: 9789385915369
5.	Design of Reinforced Concrete Structures	N Subramanian	Oxford Publisher ISBN: 0198086946
6.	Reinforced Concrete Vol.I	Dr. H. J. Shah	Charotar Publication ISBN: 9789385039478
7.	Limit State Design of Reinforced Concrete	Dr. Punamiya, A K Jain, Arun K Jain	Laxmi Publications ISBN: 9788131802410



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8.	Illustrated Reinforced Concrete Design	Dr. V L Shah & S R Karve	Structures Publication ISBN: 978819037173
9.	Limit State Design of Reinforced Concrete	Varghese P C	PHI Learning Pvt. Ltd. ISBN: 978-8120320390

NOTE: - Use of IS:456-2000 and SP:16 is permitted during Examination.

(b) Open source software and website:

List of open-source (or free-to-use) software tools that can be used for teaching or learning Design of Reinforced Concrete Structures are:

1. Video Lecture Series by Shri P. V. Rayjada
<https://www.youtube.com/channel/UCLJMmWTLK5P-Jvbi28TfeCA>
2. NPTEL Course :-Reinforced Cement Concrete by IIT, Kharagpur
<https://archive.nptel.ac.in/courses/105/105/105105105/>

Suggested Course Practical List:

Sr. No.	Practical Outcomes	Unit No.	Approx. Hrs. Required
1	Interpret IS Code provisions for Limit state R.C.C. Design from IS:456-2000 and SP-16	1	02
2	Draw sketches (not to scale) showing reinforcement details of singly, doubly reinforced beams cantilever beam, one way simply supported slab and two-way slab in longitudinal/plan and cross-sectional view.	1,2,3,6	02
3	Analyze Singly Reinforced Beams for Moment of Resistance from given data (2-Problems) and prepare a report.	2	02
4	Design of singly reinforced beams for flexure and shear and apply necessary checks from given data (1-Problem) and prepare a report.	2,5	02
5	Analyze and Design Doubly reinforced rectangular beam. (1-Problem Each) and prepare a report.	3,5	02
6	Analyze T-Beam (1-Problem) and prepare a report.	4	02
7	Draw structural details of the designed singly reinforced beam and doubly reinforced beam in A2 size drawing sheet with scale. (Sheet-1)	2,3,5	02



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Sr. No.	Practical Outcomes	Unit No.	Approx. Hrs. Required
8	Design One way simply supported slab and apply necessary checks from given data (1-Problem) and prepare a report.	6	02
9	Design of Two way simply supported slabs and apply necessary checks from given data. (Corners not held down condition only)- (1-Problem) and prepare a report.	6	02
10	Draw structural details of the designed One-way slab and simply supported two-way slab in A2 size drawing sheet with scale. (Sheet-2)	6	04
11	Draw sketches (not to scale) showing reinforcement details of axially loaded short column and isolated footing Circular Water Tank with flexible joint, Cantilever Retaining Wall, Dog Legged Stair Case	1,7	02
12	Analyze and design axially loaded short square column and design isolated footing of same column from given data and prepare a report.	7	04
13	Draw structural details of the designed axially loaded short square column with isolated footing and any other structure suggested by subject teacher in A2 size drawing sheet with scale. (Sheet-3)	7	02
Total hours			30 Hrs.

List of Laboratory/Learning Resources Required:

Sr. No	Learning Resources	Practical No.
1	IS Codes and Standards: <ul style="list-style-type: none">• IS:456-2000 – Plain and Reinforced Concrete – Code of Practice✓ https://standardsbis.bsbedge.com✓ https://www.bis.org.in/	1 to 10
2	Handbooks and Design Manuals: <ul style="list-style-type: none">• SP:16 – Design Aids for Reinforced Concrete To IS: 456 - 1978• SP:34 – Handbook on Concrete Reinforcement and Detailing✓ https://standardsbis.bsbedge.com	1 to 10



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3	<p>Software Tools: (If available)</p> <ul style="list-style-type: none">• STAAD.Pro / ETABS / SAP2000 – Structural Analysis & Design✓ URL: https://www.bentley.com/software/staad/✓ URL: https://www.csiamerica.com/products/etabs✓ URL: https://www.csiamerica.com/products/sap2000• AutoCAD – For Drafting and Detailing	1 to 10
4	<p>Drawing and Detailing Equipment</p> <ul style="list-style-type: none">• Drawing sheets (A2 size)• Pencils, set squares, compass, scale• CAD lab access with printer/plotter (if available)	7,9,11,14
5	<p>Models / Demonstration Aids</p> <ul style="list-style-type: none">• Physical models of One-way slab, Two-way slab, Different types of columns and footings	1 to 10

Suggested Project List / Activities for Students:

- Prepare a drawing in AutoCAD for Detailing of Beam (SRS / DRS / Flange), Slabs (One way / two way / One way Continuous), Staircase, Column with Footing, Ductile Detailing etc.
- Prepare Structural layout of any architectural drawing using AutoCAD.
- Carry out a Site visit for any residential project under construction and collecting its structural details, make report of that.
- Determine the Moment of Resistance of different cross sections for beams having the same cross section areas and different grades of concrete.
- Prepare spread sheet or computer program to determine M.R for S.R.S. for three grades of steel and concrete.
- Prepare spread sheet or computer program to determine development length for different grades of steel, concrete, dia. Of bar in tension and compression.
- Prepare spread sheet or computer program to calculate load carrying capacity of axially loaded short RCC column.
- Compare the design and analysis done manually with computer software or Excel worksheets for at least one of the Structural elements of our list.
- Prepare a spreadsheet computer program to design at least one of the Structural elements of the list.
- Visit a typical building/construction site and collect details of design, typical photographs of building elements under different stage of construction.
- Collect the Photographs/drawing sheets of reinforcement of Elevated



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Water Tank, typical staircases having reinforcement details

- 1) Collect the information with photographs of famous RCC structures from journals or websites and prepare a report.

Special Instructional Strategies:

- a) Site Visit must be arranged for Residential & Commercial Buildings to show reinforcement, cutting and laying of reinforcement, professional structure detail drawings.
- b) Arrange lecture of practicing structural engineers on complex issues related to design.

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