GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: DESIGN OF REINFORCED CONCRETE STRUCTURES
(COURSE CODE: 3360601)

Diploma Programme in which this course is offered	Semester in which offered
Civil Engineering	6th Semester

1. RATIONALE:

Most of the civil Engineering structures are normally made up of either Steel Sections or of Reinforced Cement Concrete. In Fifth Semester, Design of Steel Structure has been covered and in this course Design of reinforced Concrete Structures will be taught as per IS 456 – 2000.
Most of the residential buildings, Commercial and Public Buildings are designed using R. C. C. due to their long durability and flexibility in size and shape of structures and its members. So, Design of R.C.C. components like slab, beam, column and footing using Limit State Method is required to be understood. Also precise and correct detailing of reinforcement in structure drawing is also required in order to execute smooth construction of RCC structures. Hence this course will provide a detailed knowledge of reinforcement as per IS 456-2000, SP 34 and SP 16.

2. COMPETENCY:

The course content should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competencies:

- **Analyse RCC building structure/element for various application.**
- **Provide a design and detailed drawing of analysed structure/element using Limit State Method as per code of practice IS 456 -2000, SP 34 and SP 16.**

3. COURSE OUTCOMES (COs) :

The theory should be taught and exercises should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Develop methods of RCC design using concrete and steel properties
ii. Analyse & Design Singly Reinforced Rectangular Section (SRRS) under Flexure
iii. Design Stirrups for R.C Rectangular Beam
iv. Apply design conditions of IS 456-2000 for various elements of structures
v. Perform analysis for Tee Beam for Flexure, R. C. C. Column and Isolated Footing

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
03	00	04	07	70	30	40	60	***200***

Legends: L- Lecture; **T-** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -**Credit; **ESE**-End Semester Examination; **PA**-Progressive Assessment

5. COURSE CONTENT DETAILS:

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
UNIT – I Limit State Method	1a Explain Limit State Method and its types 2a Explain concrete and steel for its Design compressive and tensile strength and Limit State Load	1.1 Reinforced Cement concrete, necessity of steel in concrete, normal location of Tension steel in beams, slabs &in footing 1.2 Limit State, Limit State of Collapse – Flexure, Shear, Compression, Torsion, Limit State of Serviceability- Deflection, Cracking. 1.1 Characteristic Strength of Concrete and Steel, Partial Safety Factor for Concrete and Steel 1.2 Characteristic or Working Load, Partial Safety Factor for Load, Limit State or Factored Load

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
UNIT – II **Limit State of Collapse: Flexure**	2a Analyse & Design of Singly Reinforced Rectangular Section (SRRS) under Flexure 2b Analyse SRRS for flexure using SP-16. 2c Analyse & Design Doubly Reinforced Rectangular Section 2d Analyse flanged beam for Flexure	2.1 Assumptions for Limit State of Collapse due to Flexure 2.2 Stress and Strain Diagram of SRRS 2.3 Equation (No Derivation) related to maximum depth of N.A- Xumax, Actual Depth of N.A- Xu , Limiting Moment of Resistance- Mulim , Actual Moment of Resistance- Mu , maximum % limiting steel – Ptlim as per IS 456-2000 & Design Aid SP-16 2.4 Balance Section, Under Reinforced Section, Over Reinforced Section 2.5 Minimum and Maximum steel in beam and in slab and clear cover as per IS 456-2000(Clause 26.4, 26.5, Table 16) 2.6 Design problem to find size of SRRS Beam and steel area for limit state Bending Moment 2.7 Numerical related to 1.6 to 1.9 using SP-16-Flexure Chart and Flexure Table. 2.8 Condition for Doubly Reinforced Section 2.9 Equation stated in SP-16 for D.R.S. 2.10 Conditions for the beam to act as Tee 2.11 Beam. 2.12 Width of Flange as per IS 456-2000 (Clause 23.1.2) 2.13 Equation regarding Tee Beam from IS 456-2000 (Annexure G). 2.14 Numerical to find Limiting Moment of Resistance of Tee Beam using equation of IS 456-2000 and using Flexure Table of SP-16 regarding Tee beam.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
UNIT – III Design of Slab	3.a Design Slab for Spanning under Dead Load & Live Load 3.b Design & Detail Cantilever Slab , One Way Simply Supported Slab , One Way Continuous Slab & Two Way Simply Supported Slab	3.1 Slab –Spanning in Shorter Span, Steel for Bending Moment, Distribution Steel, Depth of Slab as per Deflection, Effective span as per IS 456-2000 (Clause 22.2), Dead Load, Live Load on Slab, Shear and Cracking in Slab. 3.2 Numerical to design and detail Simply Supported One Way Slab for Bending Moment , Shear , Deflection , Cracking for the assigned Floor Finish & Live Load. 3.3 Numerical to design and detail One Way Continuous Slab for Bending Moment, Shear, Deflection, Cracking for the assigned Floor Finish & Live Load using IS 456 -2000 B.M and S.F coefficients(Table 12 & 13) 3.4 Numerical to design and detail Two Way Simply Supported Slab with and without Torsion Steel for Bending Moment, Shear, Deflection, Cracking for the assigned Floor Finish & Live Load using IS 456 -2000 B.M coefficients (Annexure D)*** Numerical in 2.1 to 2.4 , use of SP-16 is permitted

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
UNIT – IV **Limit State of Collapse: Shear**	4a Design Stirrups for R.C Rectangular Beam 4b Apply shear requirements of IS 456-2000 to Designed Slab	4.1 Diagonal Tension Crack in Beam due to Shear 4.2 Equation related to Limit State of Collapse due to Shear as per IS 456-2000 (Clause 40). 4.3 IS 456-2000 clauses(26.5.1.5 & 1.6) related to Minimum and Maximum Spacing of Stirrups , minimum shear reinforcement 4.4 Clauses (40.2) related to Limit State of Collapse due to Shear for Slab in IS 456-2000 4.5 Numerical to check the slab for shear
UNIT – V **Limit State of Serviceability**	5a Apply Deflection clauses of IS 456-2000 to Slab & Beam 5b Apply Cracking clauses of IS 456-2000 to Slab & Beam Apply Development Length clauses of Is 456-2000	5.1 Span to effective depth ratio, Modification factor for SRRS as per IS 456-2000(Clause 23.2.1, 24.1) 5.2 Numerical to check Slab & Beam for Deflection 5.3 Maximum and Minimum spacing of Main steel and distribution steel in slab, Maximum and minimum spacing of bars in beam (Clause 26.3) 5.4 Numerical to check spacing of steel in slab for cracking 5.5 Equation to find Development Length of IS 456 -2000(Clause 26.2.1,) 5.6 Anchoring reinforcing bars in Tension and in Compression (Clause 26.2.2) Clauses related to Lap Length of Is 456-2000 (Clause 26.2.5.1)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
UNIT – VI **Axially Loaded Short Column and Isolated Footing**	6a Analyse and Design axially Loaded Short Column 6b Design Isolated Slope and Pad Footing and provide reinforcement details of footing	6.1 Column , slenderness Limit for Short & Long Column , Minimum Eccentricity in column , condition for axially loaded column , equation for axially loaded short column of IS 456-2000(Clause 25 & 39.3). 6.2 Clauses(26.5.3.1, 26.5.3.2(C ,1-2)) of IS 456-2000 related to % compression steel , numbers of compression bars and its spacing, lateral ties – diameter and pitch. 6.3 SBC of Soil, Types of Footing like Isolated foundation, combined footing, raft Foundation, pile foundation. 6.4 Numerical to design & to detail Isolated Pad and Slope Foundation for assigned limit state compression load of column and SBC of soil for Bending Moment, One Way Shear, Punching or Double Shear, Load Transfer from Column to Footings (Clause 34).

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Limit State Method	03	02	02	00	**04**
II	Limit State of Collapse : Flexure	16	04	06	12	**22**
III	Design of Slab	08	02	04	08	**14**
IV	Limit State of Collapse: Shear	04	02	02	04	**08**
V	Limit State of Serviceability	03	02	02	02	**06**
VI	Axially Loaded Short Column and Isolated Footing	08	02	06	08	**16**
Total		**42**	**14**	**22**	**34**	**70**

Legends: R = Remember, **U** = Understand, **A**= Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical/Exercise (outcomes in psychomotor domain)	Approx. Hours Required
1.	III	Draw One Way Simply Supported Slab in Plan and in Longitudinal cross section along shorter spanwith reinforcement and its bent up details in A2 Size	06

		Drawing Sheet	
2.	III	Draw One Way Continuous Slab in Plan and in Longitudinal cross section having five equal spans with reinforcement and its curtailment and its bent up details in A2 Size Drawing Sheet	06
3.	III	Draw Two Way Simply Supported Slab with Torsion Steelin Plan having longitudinal cross sections along shorter and longer span with reinforcement , bent up bars details in A2 Size Drawing Sheet	06
4.	II,IV,VI	1. Draw Plan and Cross Section Elevation of RCC Column having Isolated Slope Foundation with reinforcement details. 2. Draw Longitudinal Cross Section Elevation and a Section along Length of Doubly Reinforced Beam with shear reinforcement (Above two in A2 Size Drawing Sheet)	06
5.	---	Prepare following sketches in sketch book: 1. Longitudinal and cross section elevation along Length of Singly Reinforced Simply Supported Beam 2. Longitudinal and cross section elevation along Length of Cantilever Beam 3. Longitudinal and cross section elevation along Length of Simply Supported Tee Beam 4. Plan & c/s elevation along shorter span of One Way Simply Supported Slab 5. Plan & c/s elevation along shorter span& Longer span of Two Way Simply Supported Slab without torsion steel 6. Plan of Circular Slab with reinforcement 7. Column and Beam ductile connection 8. Column to Column Connection when size of Upper column is reduced 9. Circular Water Tank with flexible joint 10. Cantilever Retaining Wall 11. Reinforcement details of Shear Wall 12. Reinforcement details of R C C Dome 13. Dog Legged Stair Case	12
6.	---	Prepare design report having designs of First, Second, Third & of Fourth Sheet.	12
7.	--	Visit nearby residential and commercial construction and prepare brief having sketches/photographs of site including reinforcements, structure drawing of site, concrete work etc.	08
Total Hours			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Visit a typical building/construction site and collect details of design.
ii. Collect typical photographs of building elements under different stage of construction.
iii. Collect the Photographs/drawing sheets of reinforcement of Elevated Water Tank
iv. Collect the Photographs /drawing sheets of typical staircases under construction having reinforcement details

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i. Site Visit must be arranged for Residential & Commercial Buildings to show reinforcement, cutting and laying of reinforcement, professional structure detail drawings
ii. Show video of concrete work being carried out in slab, beam, column and in footings of different type and size.
iii. Arrange lecture of practicing structural engineers on complex issues related to design.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr.	Title of Books/standards	Author	Publication
1.	***IS-456 – 2000	-----	Bureau of Indian Standard
2.	***Design Aid – SP - 16	-----	Bureau of Indian Standard
3.	R C C Detailing – SP - 34	-----	Bureau of Indian Standard
4.	Ductile Detailing 13920	-----	Bureau of Indian Standard
5.	Reinforced Concrete	Dr. H J shah	Charotar Publication
6.	Limit State Design of Reinforce Concrete	Dr. Punamiya, A K Jain, Arun K Jain	Laxmi Publications
7.	R C C design and drawing	Neelam Sharma	S K Kataria and Sons
8.	Illustrated Reinforced Concrete Design	Dr. V L Shah &S R Karve	Structures Publication
9.	Limit State Design of Reinforced Concrete	Vaghrese P C	PHI Learning Pvt. Ltd.
10.	R C C Design & Drawing	M I Ohri	Tech India Publication Series

*** students are permitted to appear in theory & practical examination with these standards (highlighted and under lined)

B. List of Major Equipment/Materials

i. Drawing Hall having Drawing Facilities
ii. Models of one way slab , two way slab, different types of columns and footings

C List of Software/Learning Websites

i. https://www.sefindia.org/
ii. www.slideshare.net/asif108/
iii. www.youtube.com/watch?v=2L1DTLV8bQk
iv. www.nptel.ac.in
v. www.civilengineersforum.com

11. COURSE CURRICULUM DEVELOPMENT

COMMITTEE Faculty Members from Polytechnics

- **Prof. B G Rajgor**, H.O.D, App. Mech., BBIT, Vallabh Vidya Nagar
- **Prof. B G Bhankhar**, H.O.D, App. Mech., Government Polytechnic, Ahmedabad
- **Prof. K K Patel**, H.O.D, App. Mech., Government Polytechnic, Rajkot
- **Prof. C H Bhatt**, Lecturer, App. Mech., Dr. S &S S Gandhi Engg. College, Surat
- **Prof(Ms.) Bhruguli Gandhi**, Lecturer, Government Polytechnic for Girls, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. M. C. Paliwal**, Associate Professor, Department of Civil and Environmental Engineering
- **Dr. K. K. Pathak**, Professor, Department of Civil and Environmental Engineering