GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

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

DiplomaProgramme inwhich this courseis offered	Semesterinwhich offered
Civil Engineering	SIXTH

1. RATIONALE:

Civil Engineering structures are normally made up of either Steel Sections or of Reinforced Cement Concrete. In Fifth Semester, we have already studied Design of Steel Structure and now, we need to study Design of reinforced Concrete Structures as per IS 456 – 2000.

Most of theresidential 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 RCC components like slab , beam , column and footing using Limit State Method is required to be studied. Also ,precise and correct detailing of reinforcement in structure drawing is also required in order to execute smooth construction of RCC structures , and , hence , study of criteria regarding reinforcement in IS 456-2000 , and in SP 34 are required to be studied.

2. COMPETENCY(Programme Outcomes (POs) According to NBA terminology)

The course content should be taught and implemented with the aim to develop with different types of skills so that students are able to acquire following competencies:

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

3. Course Outcomes :

The theory should be taught and exercise 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. Analysis & Design of Singly Reinforced Rectangular Section (SRRS) under Flexure
iii. Design Stirrups for R.C Rectangular Beam
iv. Apply Deflection & Cracking requirements of IS 456-2000
v. Design & Detail Cantilever Slab , One Way Simply Supported Slab , One Way Continuous Slab & Two Way Simply Supported Slab
vi. Analyse & Design Doubly Reinforced Rectangular Section
vii. Analyse Tee Beam for Flexure
viii. Analyse and design R C C Column
ix. Design & Detail Isolated Footing

4. TEACHINGAND EXAMINATION SCHEME

Teaching Scheme (InHours)			TotalCredits (L+T+P)	Examination Scheme				
				Theory Marks		PracticalMarks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
03	00	04	07	70	30	40	60	**200**

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

5. COURSE DETAILS:

Unit	Major LearningOutcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
UNIT – I **LIMIT STATE METHOD**	1. Understand Limit State Method and its types 2. Understand 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. 2.1 Characteristic Strength of Concrete and Steel , Partial Safety Factor for Concrete and Steel 2.2 Characteristic or Working Load , Partial Safety Factor for Load , Limit State or Factored Load
UNIT – II **LIMIT STATE OF COLLAPSE: FLEXURE**	1. Analysis & Design of Singly Reinforced Rectangular Section (SRRS) under Flexure 2. Analyse SRRS for flexure using SP-16.	1.1 Assumptions for Limit State of Collapse due to Flexure 1.2 Stress and Strain Diagram of SRRS 1.3 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 1.4 Balance Section , Under Reinforced Section , Over Reinforced Section 1.5 Minimum and Maximum steel in beam and in slab and clear cover as per IS 456-2000(Clause 26.4, 26.5, Table 16) 1.6 Numerical to find Moment of Resistance or to find External load carried by SRRS (Beam & Slab) 1.7 Numerical to find steel area in SRRS (Beam & Slab) to resist limit state Bending Moment 1.8 Numerical to find Mulim and Ptlim for SRRS (Beam & Slab) 1.9 Design problem to find size of SRRS Beam and steel area for limit state Bending Moment 2.1Numerical related to 1.6 to 1.9 using SP-16-Flexure Chart and Flexure Table

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
UNIT – III **LIMIT STATE OF COLLAPSE: SHEAR**	1. Design Stirrups for R.C Rectangular Beam 2. Apply shear requirements of IS 456-2000 to Designed Slab	1.1 Diagonal Tension Crack in Beam due to Shear 1.2 Equation related to Limit State of Collapse due to Shear as per IS 456-2000 (Clause 40). 1.3 IS 456-2000 clauses(26.5.1.5 & 1.6) related to Minimum and Maximum Spacing of Stirrups , minimum shear reinforcement 1.4 Numerical to find spacing of stirrups in Beam for the Limit State Shear Force when tension steel in beam is provided straight 1.5 Numerical to find spacing of stirrups in Beam for the Limit State Shear Force when tension steel in beam is provided with bent up bars 2.1 Clauses (40.2) related to Limit State of Collapse due to Shear for Slab in IS 456-2000 2.2 Numerical to check the slab for shear
UNIT – IV **LIMIT STATE OF SERVICEABILITY**	1. Apply Deflection clauses of IS 456-2000 to Slab & Beam 2. Apply Cracking clauses of IS 456-2000 to Slab & Beam 3. Apply Development Length clauses of Is 456-2000	1.1 Span to effective depth ratio , Modification factor for SRRS as per IS 456-2000(Clause 23.2.1, 24.1) 1.2 Numerical to check Slab & Beam for Deflection 2.1 Maximum and Minimum spacing of Main steel and distribution steel in slab , Maximum and minimum spacing of bars in beam (Clause 26.3) 2.2 Numerical to check spacing of steel in slab for cracking 3.1 Equation to find Development Length of IS 456 -2000(Clause 26.2.1,) 3.2 Numerical to find Development Length 3.3 Anchoring reinforcing bars in Tension and in Compression (Clause 26.2.2) 3.3 Clauses related to Lap Length of Is 456-2000 (Clause 26.2.5.1)

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
UNIT – V **DESIGN OF SLAB**	1. Understand Slab for Spanning under Dead Load & Live Load 2. Design & Detail Cantilever Slab , One Way Simply Supported Slab , One Way Continuous Slab & Two Way Simply Supported Slab	1.1 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 2.1 Numerical to design and detail Cantilever Slab for Bending Moment , Shear , Deflection , Cracking and for development length for the assigned Floor Finish & Live Load 2.2 Numerical to design and detail Simply Supported One Way Slab for Bending Moment , Shear , Deflection , Cracking for the assigned Floor Finish & Live Load 2.3 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) 2.4 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 (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – VI **DOUBLY REINFORCD BEAM**	**1.** Analyse & Design Doubly Reinforced Rectangular Section	1.1 Condition for Doubly Reinforced Section 1.2 Equation stated in SP-16 for D.R.S 1.3 Numerical to analyse DRS to find Moment of Resistance 1.4 Numerical to design DRS for the assigned limit state bending moment only 1.5 Numerical to design DRS for the assigned Limit state bending moment using SP-16 , Flexure Chart and/or Flexure Table
Unit – VII **FLANGED BEAM**	1. Analyse Tee Beam for Flexure	1.1 Conditions for the beam to act as Tee Beam 1.2 Width of Flange as per IS 456-2000 (Clause 23.1.2) 1.3 Equation regarding Tee Beam from IS 456-2000 (Annexure G) 1.4 Numerical to find Moment of Resistance of Tee Beam 1.5 Numerical to find main steel area in tension of Tee Beam 1.6 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 – VIII **AXIALLY LOADED SHORT COLUMN**	1. Analyse and Design axially Loaded Short Column	1.1 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) 1.2 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 1.3 Numerical to find axial load carrying capacity of Square , Rectangular & Circular Column 1.4 Numerical to design Square , Rectangular & Circular Column for the assigned limit state compression load
Unit – IX **ISOLATED FOOTING**	1. Design Isolated Slope and Pad Footing and provide reinforcement details of footing.	1.1 SBC of Soil , Types of Footing like Isolated foundation , combined footing , raft foundation , pile foundation 1.2 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 ofTheory Marks			
			R Level	U Level	A Level	Total Marks
I	LIMIT STATE METHOD	02	03	00	00	03
II	LIMIT STATE OF COLLAPSE : FLEXURE	07	01	02	07	10
III	LIMIT STATE OF COLLAPSE : SHEAR	04	00	02	05	07
IV	LIMIT STATE OF SERVICEABILITY	02	02	02	02	06
V	DESIGN OF SLAB	09	00	00	14	14
VI	DOUBLY REINFORCED SECTION	05	01	00	06	07
VII	FLANGED BEAM	05	01	00	06	07
VIII	AXIALLY LOADED SHORT COLUMN	04	02	02	05	09
IX	ISOLATED FOOTING	04	00	00	07	07
Total		42	10	08	52	**70**

Legends: R = Remember, U = Understand , A= Apply and above Level (Bloom's revised taxonomy)
Note :This specification table shall be treated as only 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

Thepractical/exercisesshouldbeproperlydesignedand implemented withan attemptto develop different types of skills(**Course outcomes in psychomotor and effective domain**)so that students are able to acquire thecompetency. Followingis thelist of experimentsforguidance.

Sr. No.	UnitNo.	Practical/Exercise	Approx. Hrs. Required
1.	**V**	**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 Drawing Sheet**	**06**

Sr. No.	UnitNo.	Practical/Exercise	Approx. Hrs. Required
2.	V	Draw One Way Continuous lab 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.	V	Draw Two Way Simply Supported Slab with Torsion Steel in Plan having longitudinal cross sections along shorter and longer span with reinforcement , bent up bars details in A2 Size Drawing Sheet	06
4.	VII , VIII , IX	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.	---	Sketch Book shall be prepared with following sketches… 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.	---	Design report file shall be prepared having design of First, Second,Third & of Fourth Sheet.	12

Sr. No.	Unit No.	Practical/Exercise	Approx. Hrs. Required
7.	**--**	**Technical Visit must be arranged to nearby residential and commercial construction and brief report shall be included in term work having photographs of site showing reinforcements , structure drawing of site , concrete work etc..**	**08**
		TOTAL HOURS	**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

1. Visit a typical building/construction site and collect details of design.
2. Collect typical photographs of building elements.
3. Collect the Photographs of reinforcement of Elevated Water Tank
4. Collect the Photographs of typical staircases having reinforcement details

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

1. Site Visit must be arranged for Residential & Commercial Buildings to show Reinforcement, cutting and laying of reinforcement, professional structure detail drawings

2. Show video of concrete work carried out in slab, beam, and column and in footing

10. SUGGESTED LEARNING RESOURCES

A. List of Books:* STUDENT IS PERMITTED TO APPEAR IN THEORY & PRACTICAL EXAMINATION WITH THESE BOOKS (highlighted and under lined)**

Sr.	Title ofBooks	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

B. List of Major Equipment/Materials

1. Drawing Hall having Drawing Facilities
2. Models of one way slab , two way slab , column and footing

C List of Software/Learning Websites

1. https://www.sefindia.org/
2. www.slideshare.net/asif108/
3. www.youtube.com/watch?v=2L1DTLV8bQk
4. *www.nptel.ac.in*
5. *www.civilengineersforum.com*

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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1. **PROF. BGRAJGOR,H.O.D, APP. MECH. , BBIT, V VNAGAR**
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