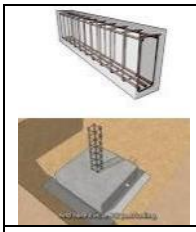
Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru



Course Title: **DESIGN OF REINFORCED CEMENT CONCRETE**		
Credits (L:T:P) : **4:0:0**	Total Contact Hours: **52**	Course Code: **15CE51T**
Type of Course: **Lectures, Case Study, Mini-Project**	Credit **: 04**	Core/ Elective: **Core**
CIE-25 MARKS		SEE-100MARKS

Prerequisite: Student should have knowledge of fundamentals of Materials of constructions, Strength of Materials and Concrete Technology.

COURSE OBJECTIVE

1. To realize the basic concept of reinforcement in Reinforced Cement Concrete and Pre-stressed concrete and methods of pre-stressing.
2. To analyse stress and load carrying capacity in different structural elements.
3. To design and detail the structural elements as per IS codes.
4. To identify the application of available software with respect to failures of structures and present it.

COUSE OUTCOMES

At the end of the course students should be able to:

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Illustrate the concepts of Reinforced Cement Concrete, compare various design methodologies, identify grades of concrete and steel, types of loads acting on structures, and analyse beams.	***R/U/Ay***	1,2,3,4,5,6,7, 10	12
CO2	Design singly and doubly reinforced beams.	***R/U/Ap/E***	1,2,4,5,6,7, 9,10	08
CO3	Differentiate between one way and two way slabs, Design one way, one way continuous and two way slabs.	***R/U/Ap/E***	1,2,4,5,6,7, 10	12
CO4	Design column and column footings economically and suitably recommend the appropriate type according to site conditions.	***R/U/Ap/E***	1,2,4,5,6,7, 10	10
CO5	Economically design Staircase and Lintel.	***R/U/Ap/E***	1,2,4,5,6,7, 10	06
CO6	Explain the concept of Pre-stressed concrete, methods of pre-stressing and losses in pre-stress.	***R/U***	1,2,4,5,6, 10	04
C07	Identify problems on structural elements in the building in order to improve future problem solving ability and able to present it.	**R/U/Ap/E/ Ay/C**	1,2,3,4,5,6, 7,8,9,10	*
			Total sessions	**52**

Legend- R; Remember, U: Understand, Ap: Application, Ay: Analysis C:Creation
****- Related to Student activity beyond classroom hours.***

Programme outcome Attainment Matrix

Course	Programme Outcome									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	Basic knowledge	Discipline knowledge	Experiments and practice	Engineering Tools	Engineer and society	Environment & Sustainability	Ethics	Individual and Team work	Communication	Life long learning
RCC	3	3	1	3	3	3	3	1	1	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

DETAILED COURSE CONTENT

UNIT	COURSE CONTENTS	HOURS
1.0	**Introduction:** Concept of reinforced concrete structures, Different grades of concrete and steel used in RCC Load and loading standards as per IS:875. Differentiate between ultimate load method, working stress method and limit state method of design. **Design Based on Limit State Method:-**Fundamentals of Limit State Method, types of limit state, Introduction to stress block parameters**,** Assumptions in the theory of simple bending for RCC beams, Neutral Axis, Moment of resistance, critical neutral axis, actual neutral axis, concept of balanced, under reinforced and over-reinforced sections. Partial safety factors, characteristic strength of materials and loads, Flexural strength, Shear Strength, Development Length of bars, Concept of Deflection and cracking , Design requirements, Side face reinforcement, Nominal Cover to reinforcement. **Analysis of Beams:** Analysis of the following beam as per IS:456-2000(Simply supported and cantilever beams) (i) Singly reinforced Beams (ii) Doubly reinforced Beams and its necessity. (iii) T-beams: Structural behaviour of a beam and slab floor laid monolithically, Rules for the design of T-Beams, Economical depth of T-Beams, Strength of T-Beams, concept of L-beam.	12
2.0	**Design of singly reinforced concrete beams** as per IS: 456 from the given data such as span load and properties of materials used. (Design for shear Two legged vertical stirrups only and check for deflection) **Design of doubly reinforced concrete beams** as per IS: 456 from the given data such as span, load and properties of materials used. (Design only for shear), **Problems** on simply supported and cantilever beams.	08

3.0	**Design of RCC Slabs:** Structural behaviour of one way and two way slabs under uniformly distributed load (UDL), Types of end supports, Check for DEFLECTION is not necessary. (i) Design and reinforcement detailing of one way slab (simply supported) and Concept of design of balcony slab. (ii) One way continuous slab (Two span only) using moment co-efficient as per IS: 456 Table 12. (iii) Design and reinforcement detailing of Two-way slab : a) Corners are not held down b) Corners are held down : All the Four edges discontinuous case only.	12
4.0	**Design of Columns:** Concept of long and short columns, Specifications for main and lateral reinforcement, interaction diagram in column design, Behaviour of RCC column under axial load. (i) Design and detailing of Axially loaded short columns (circular, square and rectangular as per IS specifications), (ii) Design of column subjected to uniaxial bending for reinforcement distributed equally on TWO sides only using SP-16 chart (Square and Rectangular). **Design of Column Footings:** Concept of column footing, Design criteria, Design of square, rectangular isolated column footings, Detailing of reinforcement.	10
5.0	**Design of Staircase:** Introduction to stair cases, design and detailing of dog-legged stair, Single flight stairs. **Lintel :** Design and Detailing of a Lintel	06
6.0	**Pre-Stressed Concrete :** Concept of prestressing, Difference between RCC & PSC, Situations where prestressed concrete is used, and Materials used in prestressed concrete and their specifications as per IS. Pre-tensioning and Post-tensioning, Mention the systems of prestresses, Mention the Losses in Prestresses. (Excluding numerical problems)	04

Note:
(i) Students have to be taken to construction sites to give the demonstrative examples of structural elements such as columns, beams, slab, staircase, etc.
(ii) IS 456-2000 & SP16 is permitted in the examination only original copy or hard bound xerox copy attested by head of the institution.

COURSE DELIVERY: Lectures, Power point presentations, demonstrations etc.

SUGGESTED ACTIVITIES

The topic should be related to the course in order to enhance his knowledge, practical skill & and lifelong learning, communication, modern tool usage.

1. Prepare a case study of failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.
2. Design the structural elements-Beams, slabs and columns for residential building (One and Two story building).
3. Visit to nearby multi-storeyed building/Apartment etc and collect the structural details.

4. Preparing a model of pre stressed concrete using locally available materials.
5. Understand the concept of formwork for different types of buildings and collect information about stripping times for forms for different conditions.
6. Visit to PSC manufacture site and prepare a report on methodology of different components.
7. Practical difference between RCC and PSC bridges and present it.
8. Use structural analysis software to analyse the various elements of structures
9. Prepare spreadsheet for design of RCC elements
10. Analyse the elements of structures using analysis software
11. Collect the information about Floating column and shear wall and present a seminar on it.
12. Collect the IS codes related to Design of RCC and PSC structures, make a report and present it

NOTE:

1. Students should select any one of the above or other topics relevant to the subject approved by the concerned faculty, individually or in a group of 3 to 5. Students should mandatorily submit a written report and make a presentation on the topic. The task should not be repeated among students. Report will be evaluated by the faculty as per rubrics. Weightage for 5 marks Internal Assessment shall be as follows: (Unsatisfactory **1**, Developing **2**, Satisfactory **3**, Good **4**, Exemplary **5**)

2. Reports should be made available along with bluebooks to IA verification officer.

Example of model of rubrics / criteria for assessing student activity

Dimension	Students score (Group of five students)				
	STUDENT 1	STUDENT 2	STUDENT 3	STUDENT 4	STUDENT 5
Rubric Scale	Unsatisfactory **1**, Developing **2**, Satisfactory **3**, Good **4**,Exemplary5				
1.Literature	1				
2.Fulfill team's roles & duties	4				
3.Conclusion	3				
4.Convensions	5				
Total	13				
Average=(Total /4)	3.25=4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks One activity to attain last CO (course outcome) may be given to a group of FIVE students					

Note: Dimension should be chosen related to activity and evaluated by the course faculty

Dimension	Rubric Scale				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary
1.Literature	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed
2.Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles
3.Communication	Poor	Less Effective	Partially effective	Effective	Most Effective
4.Convensions	Frequent Error	More Error	Some Error	Occasional Error	No Error

COURSE ASSESSMENT AND EVALUATION SCHEME:

	What		To whom	When/Where (Frequency in the course)		Max Marks	Evidence collected	Course outcomes
Direct Assessment method	CIE (Continuous Internal Evaluation)	IA	Students	Three tests (Average of three tests)	Test 1	20	Blue books	CO1, CO2
					Test 2			CO3, CO4
					Test 3			CO5, CO6
				Student activities		05	Report/ Handouts	All CO's
	SEE(Student End Examination)	End Exam		End of the course		100	Answer scripts at BTE	CO1 to CO6
Indirect Assessment	Student Feedback on course		Students	Middle of the course			Feedback forms	1 & 2 Delivery of course
	End of Course Survey			End of the course			Questionnaires	1,2,3,4,5,6&7 Effectiveness of Delivery of instructions & Assessment Methods

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier*: *The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks evaluated through appropriate rubrics.
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods

WEIGHTAGE OF MARKS AND BLUE PRINT OF MARKS FOR SEE

Unit	Major Topics	Hours Allotted	Questions to be set for SEE						Marks weightage	weightage (%)
			Cognitive Levels							
			R	U	Ap	Ay	C	E		
1	Introduction to RCC, Analysis of singly reinforced, doubly reinforced beams, T-beam	12	11.10% 5	22.22 % 10	0.00% 0	66.67 % 30	0.00 % 0	0.00% 0	45	23
2	Design of singly reinforced, doubly reinforced beams, Lintels	8	0.00% 0	13.33 % 2	66.67% 10	0.00% 0	0.00 % 0	20.00 % 3	15	15
3	Design of Slabs	12	0.00% 0	13.33 % 4	66.67% 20	0.00% 0	0.00 % 0	20.00 % 6	30	23
4	Design of Column and Footings	10	0.00% 0	13.33 % 4	66.67% 20	0.00% 0	0.00 % 0	20.00 % 6	30	19
5	Design of Dog-legged Staircase	6	0.00% 0	13.33 % 2	66.67% 10	0.00% 0	0.00 % 0	20.00 % 3	15	12
6	Pre-stressed Concrete	4	66.67% 10	33.33 % 5	0.00% 0	0.00% 0	0.00 % 0	0.00% 0	15	8
	Total	52	**13.0%** **15**	**18.0 %** **27**	**40.0%** **60**	**20.0 %** **30**	**0.0 %** **0**	**12.0 %** **18**	150	100

Legend- R: Remember U: Understand Ap: Application Ay: Analysis C: Creation E: Evaluation

Questions for CIE and SEE will be designed to evaluate the various educational components such as:

Sl. No	Bloom's taxonomy	% in Weightage
1	Remembering and Understanding	**31**
2	Applying the knowledge acquired from the course	**35**
3	Analysis	**20**
4	Synthesis (Creating new knowledge)	**05**
5	Evaluation	**12**

Format of Model Question Paper for CIE(Tests)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I Test/6 th week of sem 10-11 Am	Sem : V SEM	Course : RCC and PSC	20
	Year : 2016-17	Course code:15CE51T	

Name of Course coordinator :
Course outcome :CO1, CO2 **Note: Answer all questions**

Q No	Question	M	CL	CO	PO
1	List the basic assumption of design for limit state of collapse in flexure.	3	R	1	1, 2
2	Differentiate between under reinforced section and balanced section(Limiting section)	4	U	1	1, 2
3	An RCC rectangular beam of size 230X600mm overall is to carry a super imposed load of 40KN/m over an effective span of 6m. Find the area of tension and compression reinforcement. Use M20 & Fe500 steel. Take effective cover 40mm on both sides. OR Find the ultimate moment of a T-beam from the following sectional properties. Use M15 & Fe415 steel. • Width of flange = 1500mm • Thickness of flange = 100mm • Overall depth of beam = 600mm • Width of rib or web = 300mm • Ast = 2455mm^2 • Effective cover = 40mm	6	U/ A y	1	1, 2, 4, 5, 7
4	Design a singly reinforced beam of clear span 6m to support a working live load of 15KN/m. Use M20 & Fe500 steel. Sketch the reinforcement details. OR Design a cantilever beam of clear span 3.5m to support a working live load of 15KN/m. Use M20 & Fe500 steel. Sketch the reinforcement details.	7	U/ A p	2	1, 2, 6, 7

TEXT BOOKS

1. Ashok K. Jain,*Reinforced Concrete* by Limit State Design by Nem Chand & Bros, Roorkee.
2. UNNIKRISHNAN PILLAI AND DEVADAS MENON, Design Of Reinforced Concrete Structures –Tata McGraw Hill Publications.
3. Design of reinforced concrete structures by Krishna raju
4. Limit state design of concrete structural elements –TTTI (NITTTR), Chennai
5. Minocha&Diwedi, *Design of R.C.C. Structures*, B. Bharat Prakshain, Merrut.
6. S.K. Mallick, *Reinforced Concrete*, Oxford & IBH Publshing Co., Delhi.
7. Design of reinforced concrete structures by P.C. Varghees
8. Design of Reinforced Concrete Structures by S Ramamrutham& R Narayan

9. Theory & design of RCC Structures by Gurucharan Singh
10. Reinforced Concrete Structures by B C Punmia
11. Treasure of RCC Designs by Sushil Kumar S
12. SP-16 Design aid for IS 456-2000, SP-23 Hand book on concrete mixes
13. IS 875-1987 Loading standards, SP-34 Detailing of RC Structures

REFERENCES

1. Punmia B.C., *Limit State Design of Reinforced Concrete*, Laxmi Publication (P), Delhi.
2. Raju N.K., *Reinforced Concrete Design IS 456 – 2000 Principles & Practice*, New Age International Publishers, New Delhi.
3. BIS, *IS 456 – 2000 Code of Practice for Plain & Reinforced Concrete*.
4. SINHA S N, *Reinforced Concrete Design*, Tata McGraw Hill Publications
5. KARVE S R AND SHAH V L, *Limit State Theory And Design Of Reinforced Concrete* – Vidyarthi Prakashan, Pune
6. PARK AND PAULAY, *Reinforced Concrete*, John Wiley and Sons

E-Learning

https://books.google.co.in/books?id=o_mKzwhbeHkC&pg=PR9&lpg=PR9&dq=introduction+to+limit+state+design+IS+456-2000
https://www.youtube.com/watch?v=Grv09rIAPQM
https://youtu.be/Grv09rIAPQM
http://freevideolectures.com/Course/2686/Design-of-Reinforced-Concrete-Structures#
https://youtu.be/hxakW1miEcM
https://www.google.co.in/url?-to-design-rcc-column-in-limit-state.
https://www.google.co.in/url? concrete&usg=AFQjCNFmUZeUdmDxV3VSLCsQsKFf5f5V-w

Guidelines to the paper setter

Part-A : Answer any 5 questions. Each question carries 5 marks.
Part-B : Answer any 5 questions, two questions from each section. Each question carries 15 marks.

Part-A :

Q1, Q2, Q3, Q4, Q5 are based on RCC theory.
Q6, Q7, Q8 are based on PSC.

Part-B :

Section-I :
Q9, Q10, Q11 based on analysis of SR, DR and T-beams.

Section-II :
Q12 based on design of SR beam or DR beam
Q13 based on design of Lintel or One way slab or Staircase.
Q14 based on design of One way continuous slab or Two way unrestrained or Two way restrained.
Q15 based on design of Columns or design of column by using SP 16 charts or design of column Footing.

Note :

- **In analysis problems, A_{st} is calculated by using codal formula by solving quadratic equation.**
- **In design problems A_{st} is calculated by using tables.**
- **IS 456-2000 & SP16 is permitted in the examination only original copy or hard bound xerox copy attested by head of the institution.**

MODEL QUESTION PAPER

Diploma in Civil Engineering

5TH Semester

REINFORCED CEMENT CONCRETE

Time: 3Hrs. **Max Marks: 100**

Note: IS 456-2000 & SP16 is permitted in the examination only original copy or hard bound xerox copy attested by head of the institution.

Part –A

Answer any 5 questions **5X5=25 Marks**

1) Explain interaction diagram in the design of column.
2) Explain characteristic strength of material, characteristic load and partial safety factor.
3) Define Neutral axis, Limiting neutral axis, moment of resistance, Lever arm, Effective depth.
4) Distinguish between singly reinforced and doubly reinforced sections.
5) Differentiate between short column and long column.
6) Explain the principle of prestressing.
7) Difference between pre-tensioned and post-tensioned members.
8) Mention the systems of pre-stress and its losses.

Part –B

Answer any 5 questions, atleast TWO questions from each section **5X15=75 Marks**

Section –I

1) An RCC rectangular beam of 200X500mm overall is used as a SS beam of an effective span of 6m. It is reinforced with a tensile steel of 4000mm^2. What maximum UDL can be allowed on the beam. Take effective cover 35mm. Use M20 & Fe415 steel.

2) An RCC rectangular beam of size 230X600mm overall is to carry a super imposed load of 40KN/m over an effective span of 6m. Find the area of tension and compression reinforcement. Use M20 & Fe500 steel. Take effective cover 40mm on both sides.

3) A T-beam of depth 450mm has a flange width of 1000mm and depth of 120mm. It is reinforced with 6 of 20mmϕ as tension steel with a clear cover of 30mm. Use M20 & Fe415 steel. Find M_u and super imposed UDL. Take b_w= 300mm.

Section –II

1) Design a singly reinforced beam of clear span 6m to support a working live load of 15KN/m. Use M20 & Fe500 steel. Sketch the reinforcement details.

2) The main stair of an office building has to be located in a hall measuring 3.3mX5.5m. The vertical distance between the floor is 3.6m. Design the stairs. The LL on the stair is 4KN/m^2. Use M20 grade concrete and Fe415 steel.

3) Design a slab over a room of internal dimensions 4mX5m supported on 230mm thick brick wall all the edges are simply supported (the corners of the slab is held down). Live load on slab 3KN/m^2, floor finish 1KN/m^2. Take M20 concrete and Fe415 steel. Sketch the reinforcement details.

4) Design a rectangular footing for a column of size 300X500mm supporting an axial factored load of 1500KN. SBC of soil 200KN/m^2. Use M20 & Fe415 steel.

Model Questions Bank

Unit 1-Introduction:
Cognitive level –Remember
➢ Explain briefly limit state method of designing RC structures. ➢ List the basic assumption of design for limit state of collapse in flexure. ➢ Explain characteristic strength, characteristic load and partial safety factor. ➢ What are serviceability requirements satisfied by designing an RC structures? ➢ Explain the concept of shear in beams and mention its types. ➢ What is meant by development length and mention the codal provisions ? ➢ What is meant by curtailment of tension reinforcement ? ➢ Write a short note on cracking in structural concrete members. ➢ Write the effective flange width of an intermediate T-beam and an isolated T-beam. ➢ Explain yield line theory concept in slabs. ➢ Define the terms: One way slab, Restrained two way slab, Unrestrained two way slab, Cantilever slab, Continuous slab, Flat slab. ➢ Define the terms: Axially loaded, Eccentrically loaded column. ➢ Define the terms: Positive reinforcement, negative reinforcement, shear reinforcement, torsional reinforcement, lateral reinforcement, side face reinforcement.
Cognitive level –Understand
➢ Define Neutral axis, Limiting neutral axis, moment of resistance, Lever arm, Effective depth. ➢ Differentiate between under reinforced section and balanced section(Limiting section). ➢ Differentiate between analysis and design of an RC structure. ➢ List the different types of shear failure and how it is prevented. ➢ What are the factors which affects short term and long term deflection ? ➢ Distinguish between singly reinforced and doubly reinforced sections. ➢ List the conditions under which doubly reinforced beams are preferred. ➢ What are the advantages of a T-beam over a rectangular beam. ➢ Distinguish between T-beam and L-beam. ➢ Distinguish between a beam and a Lintel. ➢ Differentiate between one way slab and two way slab. ➢ Mention the section at which Max span moment, support moment, shear force occurs in case of a continuous slab or a beam. ➢ Under what conditions a slab is designed as two way. ➢ Differentiate between short column and long column. ➢ What are the points to be considered while designing long columns? ➢ Differentiate between uniaxial bending and bi-axial bending.
Cognitive level –Analysis

Singly reinforced Sections

Type 1 :

Given - Size of beam, A_{st}, effective span, grade of materials and exposure condition.
To find – Ultimate moment & super imposed UDL for SS beam & cantilever beam.
(Point load at mid span of SS beam, Point load at free end of a cantilever)

Typical Problem:

- An RCC rectangular beam of 200X500mm overall is used as a SS beam of an effective span of 6m. It is reinforced with a tensile steel of 4000mm^2. What maximum UDL can be allowed on the beam. Take effective cover 35mm. Use M20 & Fe415 steel.

- An RCC cantilever beam of 230X380mm overall of effective span 2m. It is reinforced with 2 of 16ϕ on tension side. Determine the super imposed load on the beam. Use M20 & Fe500 steel.

Type 2 :

Given – Breadth of beam, factored or working moment, grade of concrete & steel
To find – Minimum effective depth &A_{st}.

Typical Problem:

- Find the minimum effective depth and area of reinforcement required for a rectangular beam of 300mm width to resist a working moment of 150KN-m. Use M20 & Fe500 steel.

Type 3 :

Given – Size of beam, factored or working moment, grade of concrete & steel
To find – Ast.

Typical Problem:

- Find the area of reinforcement required for a SS beam of 230mm wide and 450mm effective depth to resist an ultimate moment of 80KN-m. Use M20 & Fe500 steel.

Type 4 :

Given – Thickness of slab, effective span, Dia of bar, spacing of bar, grade of concrete & steel
To find – Super imposed load UDL on slab.

Typical Problem:

- Find the safe super imposed UDL for one way slab of 125mm thick which is simply supported over an effective span of 3.2m. The slab is reinforced with 12mmϕ bars at 100mm c/c. Use M20 & Fe500 steel. Take clear cover 15mm.

Doubly reinforced Sections

Type 1 :

Given - Size of beam, Effective cover on both zones, A_{st} , A_{sc}, Effective span, grade of concrete & steel .
To find – Ultimate moment & super imposed UDL on beam.

Typical Problem:

- A doubly reinforced beam of size 230X600mm overall. The beam is reinforced with 4 of 16mmϕ as compression steel and 6 of 20mmϕ as tension steel at an effective cover of 40mm on both sides. Find the super imposed load over an effective span of 6m. Use M20 & Fe500 steel.

Type 2 :

Given – Size of beam, Effective cover on both sides, super imposed load, effective span, grade of concrete & steel .
To find – A_{st} and A_{sc}

Typical Problem:

- An RCC rectangular beam of size 230X600mm overall is to carry a super imposed load of 40KN/m over an effective span of 6m. Find the area of tension and compression reinforcement. Use M20 & Fe500 steel. Take effective cover 40mm on both sides.

T-Beam Sections

Unit 2- Design of Beams

Cognitive level –Application

Design of Singly reinforced Beams

Given – Clear span, bearing, super imposed UDL, end condition(SS & cantilever), grade of concrete or Exposure condition of concrete, grade of steel.

To find – Design the beam for flexure and shear. Check for deflection.

Typical Problem:

- Design a singly reinforced beam of clear span 6m to support a working live load of 15KN/m. Use M20 & Fe500 steel. Sketch the reinforcement details.

- Design a cantilever beam of clear span 3.5m to support a working live load of 15KN/m. Use M20 & Fe500 steel. Sketch the reinforcement details.

Design of Doubly reinforced Beams

Given – Clear span, bearing, super imposed UDL, Size of beam, effective cover on both sides, grade of concrete or Exposure condition of concrete, grade of steel.

To find – Design the beam for flexure (Find A_{st} and A_{sc})

Typical Problem:

- Design a simply supported beam of effective span 8m is subjected to an UDL of 35KN/m. Size of the beam is restricted to 300X700mm with an effective cover of 50mm. Use M20 & Fe500 steel. Sketch the reinforcement details.

Unit 3- Design of Slabs

Cognitive level –Application

Design of One way Slab

Typical Problem:

- A room has clear dimension 7mX3m. The live load on the slab is 3KN/m^2 and floor finish load of 1KN/m^2 using M20 grade concrete and Fe 415 steel. The slab is supported on 230mm thick wall.

Design of One way continuous Slab

Typical Problem:

- Design a one way continuous two span slab of effective span 4.5m each. The live load on the slab is 3KN/m^2 and a floor finish(imposed dead load) of 1.5KN/m^2. Use M20 grade concrete and Fe 500 grade steel.
- Design a continuous slab for an office floor. The slab is continuous over beams spaced at 4m c/c. It carries an imposed dead load of 1 kN/$m^2$and a live load of 4kN/m^2. Assume width of rib as 230mm. Use M20 grade concrete and Fe415 steel. (Design the slab for the maximum moment which occurs at support next to the end support). Take l/d ratio as 30 and sketch the reinforcement details.

Design of Two way slab (Corners are not held down)

Typical Problem:

- Design a slab over a room of internal dimensions 4mX5m supported on 230mm thick brick wall having a live load of 2KN/m^2, floor finish 1KN/m^2. All the edges are simply supported (The corners are free to lift). Take M20 concrete and Fe415 steel. Sketch the reinforcement

details.

- A slab over a room is 5mX5m. The edges of the slab is simply supported on all the sides and corners are not held down. The live load on the slab is 3KN/m^2, the slab has a bearing of 230mm on the supporting walls. Assume exposure condition to environment can be classified as mild. Grade of steel Fe415, design the slab.

Design of Two way slab (Corners are held down)

Typical Problem:

- Design a slab over a room of internal dimensions 4mX5m supported on 230mm thick brick wall all the edges are simply supported (the corners of the slab is held down). Live load on slab 3KN/m^2, floor finish 1KN/m^2. Take M20 concrete and Fe415 steel. Sketch the reinforcement details.

Unit 4- Design of Column and Footings
Cognitive level –Application

Design of Axially loaded short Column

Type 1 :

Given - Size of column, A_{sc}, grade of concrete & steel
To find – Ultimate and Working load.

Typical Problem:

- A reinforced concrete short square column of size 300mm is reinforced with 4 bars of 20mmϕ. Find the ultimate load capacity of the column using M20 & Fe415 steel. What will be the allowable service load?

Type 2 :

Given – Working axial load, shape of the column, grade of concrete & steel, assume A_{sc}=0.8 to 6%
To find – Size of column and A_{sc}

Typical Problem:

- Design an RCC rectangular short column to resist an axial load of 800KN. Use M20 concrete and Fe415 steel. Assume 0.8% steel of column area.

Type 3 :

Given – Size and shape of column, axial working load, effective length, grade of concrete & steel
To find – A_{sc} and Percentage of steel

Typical Problem:

- Design necessary reinforcement for an RCC column of size 400X600mm to carry an axial working load of 2000KN. The effective length of the column is 3m. Use M20 & Fe415 steel.

- Design a circular column of diameter 450mm subjected to a load of 1200 KN. The column is having lateral ties. The column is 3m long and is effectively held in position at both ends but not restrained against rotation. Use M25 concrete and Fe415 steel.

Design of uniaxial short Column

- Determine the reinforcement to be provided in a square column subjected to uniaxial bending with the following data :

- Size of the column = 450X450mm
- Grade of concrete = M25
- Grade of steel = 500N/mm^2
- Factored load = 2500kN
- Factored moment = 150kN-m
- Arrangement of reinforcement = On two sides.
  Assume 25mm bars with 40mm cover.

- Design the column from the following details using SP 16 charts.
  - Size of column = 300X450mm
  - Pu=1200KN
  - Assume d'=50mm
  - Mu=150kN-m
  - Use M25 and Fe415 steel. Provide reinforcement distributed equally on two sides.

Design of Isolated Footing (Sqaure& Rectangle)

Given - Size of column, Column load, SBC, grade of concrete & steel
To find – Design the size of footing, depth of footing , A_{st}, check for One way & Two way shear.

Typical Problem:

- Design a square footing to carry a column load of 1100KN from a 400X400mm column. The SBC of the soil is 100KN/m^2. Use M20 & Fe415 steel.

- Design a rectangular footing for a column of size 300X500mm supporting an axial factored load of 1500KN. SBC of soil 200KN/m^2. Use M20 & Fe415 steel.

Unit 5- Design of Staircase & Lintels

Cognitive level –Application

Design of Staircase

Typical Problem:

- The main stair of an office building has to be located in a hall measuring 3.3mX5.5m. The vertical distance between the floor is 3.6m. Design the stairs. The LL on the stair is 4KN/m^2. Use M20 grade concrete and Fe415 steel.

Design of Lintels

Typical Problem:

- Design a lintel using the following data:
  - Width of opening = 2.4m
  - Height of brick wall above lintel = 4m
  - Thickness of wall = 230mm
  - Bearing = 230mm
  - Grade of concrete = M20
  - Grade of steel = Fe415,
  - Density of brick wall = 19.2KN/m^3

  Check for flexure and shear. Sketch the reinforcement details.

- Design a lintel using the following data :
  - Width of opening = 2.4m
  - Height of brick wall above lintel = 1.5m
  - Thickness of wall = 230mm
  - Grade of concrete = M20
  - Grade of steel = Fe415,
  - Density of brick wall = 19.2KN/m^3

  Check for flexure and shear. Sketch the reinforcement details.

Unit 6- Pre-Stressed Concrete

Cognitive level –Remember

- Explain the principle of prestressing.
- What are the advantages and disadvantages of prestressing?
- Explain the grades of concrete and steel used in PSC.
- Mention the systems of pre-stress and its losses.

Cognitive level –Understand

- Distinguish between RCC and PSC.
- Difference between pre-tensioned and post-tensioned members.
- Under what circumstances PSC members are preferred.