DESIGN OF REINFORCES CONCRETE STRUCTURES

Subject Code: CE**502**PC

Regulations: R**16 -** JNTUH

Class : III Year B.Tech CE I Semester

Department of Civil Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

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DESIGN OF REINFORCES CONCRETE STRUCTURES (CE502PC)

COURSE PLANNER

I. COURSE OVERVIEW:

Civil Engineers are required to learn the fundamentals of design, analysis, and proportioning of reinforced concrete members and structures. Learn design concepts and modes of failure. Methods for analysis and design of these elements under flexure, shear, and axial loads will be examined. Learn how to make design decisions considering realistic constraints such as safety, economy and serviceability. Learn how to use the latest technology in solving structural analysis and design problems. To impart adequate knowledge on how to analyze and design reinforced concrete members and connection. To understand the mechanical properties of structural concrete. To understand the behavior of reinforced concrete elements under normal force, shear, moment and torsion. Concept of ultimate design of reinforced concrete beams, floor systems and columns are to understood. To develop an understanding of and appreciation for basic concepts in the behavior and design of reinforced concrete systems and elements. To help the student develop an intuitive feeling about structural and material wise behavior and design of reinforced concrete systems and elements.

II. PREREQUISITE(S):

Level	**Credits**	**Periods/week**	**Prerequisites**
UG	**4**	**5**	**Engineering Mechanics, Strength of Materials.**

III. COURSE OBJECTIVES:

The objective of the teacher is to impart knowledge and abilities to the students to:

1. Develop an understanding and appreciation for basic concepts in the behavior and design of reinforced concrete systems and elements.
2. Differentiate between working stress design and limit state design.
3. Understand the basic concepts for reinforced concrete sectional design mainly in accordance with ultimate strength.
4. Assess the structural and material behavior for the design of reinforced concrete systems and elements.

IV. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Understand the general mechanical behavior of reinforced concrete in accordance with IS456:2000.
2. Identify and apply the applicable industry design codes relevant to the design of reinforced concrete members.
3. Analyze and design reinforced concrete flexural members with detailing.
4. Design and check for serviceability (crack and deflection) and ultimate limit state conditions.
5. Assess the stresses and design vertical and horizontal shear reinforcements in reinforced concrete members with detailing.
6. Understand and design reinforced concrete compression members or columns.
7. Analyze and design footings and understand the need for development length of reinforcement.
8. Design footings and staircase with detailing of steel reinforcements.

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	S	Assignments, Exams
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	S	Assignments, Exams
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and	S	Assignments
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	S	Assignments
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	-	-
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	S	Exams
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	S	Exams, Assignments
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	Quizzes, Discussions
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	S	Lectures, Discussions
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to	S	Lectures, Discussions

PO11	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	S	Possible Projects
PO12	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	S	Discussions

N – Not Applicable S – Supportive H - Highly Related

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program specific outcomes		Level	Proficiency Assessed By
PSO1	**ENGINEERING KNOWLEDGE:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	H	Lectures, Assignments, Exams
PSO2	**BROADNESS AND DIVERSITY:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	S	Lectures, Assignments, Exams
PSO3	**SELF-LEARNING AND SERVICE:** Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	S	Guest Lectures, Possible Group Projects,Industrial Internship

VII. SYLLABUS:

UNIT – I

Concepts of RC. Design – Working Stress Method - Limit State method – Material Stress-Strain Curves – Safety factors – Characteristic values. Stress Block parameters – IS – 456 –2000.

Beams: Limit state analysis and design of singly reinforced, doubly reinforced, T and L beam sections

UNIT – II

Limit state analysis and design of section for shear and torsion – concept of bond, anchorage and development length, I.S. code provisions. Design examples in simply supported and continuous beams, detailing; Design of canopy.

UNIT – III

Short and Long columns – under axial loads, uniaxial bending and biaxial bending – I S Code provisions.

UNIT – IV

Footings: Different types of footings – Design of isolated, square, rectangular, circular footings and combined footings.

UNIT - V

Design of one way slab, Two-way slabs and continuous slab Using I S Coefficients Limit state design for serviceability for deflection, cracking and codal provision. Design of doglegged staircase.

SUGGESTED BOOKS:

TEXT BOOKS:

1. Reinforced concrete design by by S. Unnikrishna Pillai & Devdas Menon, Tata McGraw Hill, New Delhi.
2. Limit state designed of reinforced concrete – P. C. Varghese, Prentice Hall of India,New Delhi.
3. Limit state designed of reinforced concrete – P. C. Varghese, Prentice Hall of India, New Delhi.

REFERENCES:

1. Design of Reinforced Concrete Structures by I. C. Syal and A. K. Goel, S. Chand & company.
1. Fundamentals of reinforced concrete by N.C. Sinha and S.K Roy, S. Chand publishers
2. Design of concrete structures – Arthus H. Nilson, David Darwin, and Chorles W. Dolar, Tata McGraw-Hill, 3rd Edition, 2005.

NPTEL WEB COURSE:

nptel.ac.in/courses/105105105/

NPTEL VIDEO COURSE:

nptel.ac.in/courses/105105105/#

GATE SYLLABUS:

- Basic working stress and limit state design concepts,
- Analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods.

IES SYLLABUS:

- Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings.
- Working stress method of design of R.C. members.

VIII. COURSE PLAN:

Lecture No	Week	Unit	Topics to be covered	Learning Objective	References
1.	1	1	**UNIT - I** Concepts of RC Design, IS-456:2000 – Working stress method	**Explain** the concepts of reinforced concrete design. Discuss IS 456: 2000 code. Explain the concept of working stress method.	T4: 2.1 to 2.2
2.	1	1			
3.	1	1			
4.	1	1	Limit state method Material Stress–Strain curves – Safety factors	**Explain** Relation between stress and strain for mild steel. **Understand** working stress and factor of safety.	T4: 2.3 to 2.6
5.	2	1			
6.	2	1			
7.	2	1	Material Stress–Strain curves – Safety factors	**Explain** Relation between stress and strain.	T4: 2.7 to 2.9
8.	2	1			
9.	3	1	Characteristic values – Stress block parameters	Explain the characteristics values and stress block parameters.	T4: 3.1 to 3.6
10.	3	1			
11.	3	1	Limit state analysis and design of singly reinforced beam sections.	Explain the concept of limit state analysis for singly reinforced beam sections. Solved problems.	T4: 3.8 to 3.10
12.	3	1			
13.	4	1			
14.	4	1	Limit state analysis and design of doubly reinforced beam sections.	Explain the concept of limit state analysis for doubly reinforced beam sections. Solved problems.	T4: 4.1 to 4.6
15.	4	1			
16.	4	1			
17.	5	1			
18.	5	1	Limit state analysis and design of T and L beam sections.	Explain the concept of limit state analysis for T and L beam sections. Solved problems.	T4: 6.1 to 6.3
19.	5	1			
20.	5	1			
21.	6	2	Limit state analysis and design of section for shear and torsion.	Explain the concept of limit state analysis and design of section for shear and torsion.	T4: 7.1 to 7.6
22.	6	2			
23.	6	2			
24.	6	2			
25.	7	2	concept of bond, anchorage and development length, I.S. code provisions	Explain the concept of bond, anchorage and development length with I.S. code provisions. Solved problems.	T4: 8.1 to 8.9
26.	7	2			
27.	7	2			
28.	7	2			
29.	8	2	Design examples in simply supported and continuous beams,	Solved problems for design of simply supported and continuous beams	T1:9.6-11
30.	8	2			
31.	8	2			
32.	8	2	Detailing Design of canopy	Solved problems for design of canopy	T4: 10.1 to10.7
33.	9	2			
34.	9	2			
35.	9	3	Short And Long Columns - Axial loads,	Differentiate short and long columns and design them for axial loads. Solved problems	T4: 16.1 to 16.9
36.	9	3			
37.	10	3			

38.	10	3	Short And Long Columns – uni-axial bending I.S. Code provisions.	Design short and long columns for uni-axial loads. Solved problems	T1: 17.1 to 17.6
39.	10	3			
40.	10	3			
41.	11	3	Short And Long Columns - bi-axial bending	Design short and long columns for bi-axial loads. Solved problems	T4: 18.1 to 18.6
42.	11	3			
43.	11	3			
44.	11	4	Footings: Different types of footings	Footings types.	T4: 7.1-3
45.	12	4			
46.	12	4			
47.	12	4	Design Of Footings – Isolated (square, rectangle)	Design Of square and rectangle footings with solved problems.	T4: 7.1-3
48.	12	4			
49.	13	4			
50.	13	4	Design Of Footings – Combined Footings.	Design Of combined footings with solved problems.	T4: 7.4-7
51.	13	4			
52.	13	4			
53.	14	4			
54.	14	5	Design of One-way Slabs	Design of one way slabs with examples.	T4: 11.4 to 11.7
55.	14	5			
56.	14	5	Design of Two-way Slabs	Design of two way slabs with examples.	T4: 12.1 to 12.3
57.	15	5			
58.	15	5	Design of Continuous slabs using I.S. coefficients,	Design of Continuous slabs using I.S. coefficients with examples.	T4: 12.4 to 12.6
59.	15	5			
60.	15	5	Limit state design for serviceability for deflection	Solved problems for detailing and Limit state design for serviceability for deflection,	T4: 10.1 to10.7
61.	16	5	Cracking and codal provision	Solved problems for cracking and codal provision.	T4: 10.1 to10.7
62.	16	5			
63.	16	5	Design of dog legges staircase	Solved problems for dog legges staircase	T4: 10.1 to10.7
64.	16	5			

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S	H								H	S	S	H	H	S
II		H			H					S	S	S	H	H	
III			S	H							S	S		H	S
IV		H	S							H	S	S	H	H	S

QUESTION BANK
UNIT-I
SHORT ANSWER QUESTIONS

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	List different methods of design for reinforced concrete structural elements?	Understand	1
2.	State four objectives of the design of reinforced concrete structure.	Understand	1
3.	Explain the working stress method.	Understand	1
4.	What do you mean by characteristic strength and characteristic load?	Understand	1
5.	What are the different kinds of loads?	Understand	1
6.	Explain the limit state method of design?	Understand	2
7.	Differentiate between WSM and LSM.	Understand	2
8.	List the different categories of limit state design.	Understand	2
9.	Define the factored load.	Understand	3
10.	Write a note on partial safety factors for material.	Understand	3
11.	Explain the limiting moment of resistance	Understand	2
12.	What is a doubly reinforced beam?	Understand	2
13.	What do you mean by neutral axis?	Understand	2
14.	What are the merits and demerits of Working stress method?	Understand	2
15.	State assumptions made in limit stress method?	Understand	2
16.	Give the idealized stress-strain curve for concrete and steel.	Understand	2
17.	State the assumption for limit state design in flexure.	Understand	3

LONG ANSWER QUESTIONS

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Enumerate the five limit states commonly used in limit state design and state briefly how they are provided in the design.	Understand	1
2.	State and explain the significance of the six assumptions of design of flexural members employed in limit state of collapse.	Understand	1
3.	Draw the cross-section of singly reinforced rectangular beam and show the strain and stress diagrams.	Understand	1
4.	Explain the limiting moment of resistance and give the expression for this value for Fe 250 and Fe 415 grade steel?	Understand	1
5.	Explain the terms balanced, overreinforced and underreinforced section in bending. Explain which of these should be recommended in design.	Understand	2
6.	Determine the depth of neutral axis for abeam section 250mmwide and 400mm deep (effective) . The beam is reinforced with 3 bars of 20mm diameter. Use fck= 20 N/mm2and fy= 415 N/mm2.	Understand	2
7.	Give the stress block parameters used in limit state method along with the stress diagram.	Remember	2
8.	Calculate the ultimate moment carrying capacity of a rectangular beam with b=250 mm, d=350 mm, Ast=1800mm2 assume grade of concrete M30 and Fe 250 steel.	Understand	2
9.	A singly reinforced R.C.C BEAM 250 mm wide and 400 mm deep (effective) is reinforced with 4 bars of 16 mm diameter. Find the depth of neutral axis, limiting depth of neutral axis and specify the type of beam. Use fck=20 N/mm2 and fy=415N/mm2.	Understand	3
10.	Enumerate the steps of design of doubly reinforced beam.	Understand	3
11.	What do you mean by neutral axis and leaver arm? Explain briefly with neat sketches.	Understand	3
12.	Determine the area of steel required for the beam b=300mm, d=675 mm for carrying a factored moment of 185 kNm. Assume fy= 415 N/mm2 and fck =20 N/mm2	Understand	4
13.	For T-beam of flange width 1200, depth100 mm and web clear depth 350,width 250 mm find reinforcement required for ultimate moment of 250 KN/m	Understand	4
14.	Explain with figure balanced, under reinforced, over reinforced sections	Understand	4

UNIT-II

SHORT ANSWER QUESTIONS

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	State modes of shear failures in R.C beams?	Understand	4
2.	Define 'development length'?	Understand	4
3.	Explain how bending shear stress produce tension cracks in concrete.	Understand	4
4.	What is the expression for spacing of vertical stirrups in R.C. beams for shear?	Understand	4
5.	What is meant by punching shear and how is it different from bending shear.	Understand	4
6.	What are the types of reinforcements used to resist shear? Explain the action of different types of shear steel.	Understand	4
7.	What are the Indian specifications for allowable shear in slabs?	Understand	4
8.	What are the different regions of cracks in the beam?	Understand	4
9.	What do you mean by bundling of bars? What is the maximum no of bars that can contribute to bundle?	Understand	4
10.	What do you understand by nominal shear stress? Write the formula for uniform formulae for rectangular section?	Understand	4

LONG ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	Explain modes of failures in R.C beams?	Remember	4
2.	Step by step design procedure for shear reinforcement.	Remember	4
3.	A simply supported reinforced concrete beam is 250 mm wide and 500mm effective depth and is reinforced with 4-20 mm diameter as tensile steel. If the beam is subjected to a factored shear of 65 KN at the support. Find the nominal shear stress at the support. Use M20 concrete and Fe 250 steel.	Remember	4
4.	What are the various remedial measures for control of cracking?	Remember	4
5.	Explain the different types of shear reinforcement with neat sketches.	Remember	4
6.	The T-beam and slab system of a structure are made of beams spaced at 2.4m with clear span of 7.5m between masonry walls of 300mm thick. For the T beam Df= 120mm, bw = 300mm, D= 600mm if fck= 20N/mm2 and fy=415N/mm2. Design the shear steel. Assume that two nos. 28mm bars of tensile steel are continued to support and LL=8KN/m2	Remember	4
7.	Explain the critical sections for design shear as per IS 456 with requisite sketches.	Remember	4

8.	Explain the approaches for control of deflection in bending members as per IS 456. What are the measures for reducing deflection?	Remember	4
9.	A tied column of a multistoried building has 32mm rods for longitudinal steel. Assuming fck=25N/mm2 and fy=415N/mm2 a) Calculate the lap length required b) State how this length can be reduced to make savings in steel consumption.	Remember	4
10.	A reinforced concrete beam of 4m span requires 7 - Fe 415 bars of 16mm, as tension bars. Find the distance from the centre of the beam where the central bar can be curtailed. Assume fck=15N/mm2 and d=300mm.	Remember	4

UNIT-III

SHORT ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	Differentiate between column and pedestal.	Understand	7
2.	What are the limits of percentage of the longitudinal reinforcement in a column?	Understand	7
3.	Define effective length of column?	Understand	7
4.	What is slenderness ratio? Explain.	Understand	7
5.	What is the purpose of lateral ties in a RC column?	Understand	7
6.	What is the difference between behavior of a short and long column?	Understand	7
7.	Explain unsupported length of column?	Understand	7
8.	Define equivalent length of a column.	Understand	7
9.	What is the maximum slenderness ratio of reinforced columns allowed by IS:456-2000.	Understand	7
10.	Explain braced and un braced column.	Understand	7
11.	What is minimum diameter of bars used in longitudinal steel for columns?	Understand	7
12.	Why high grade concrete mixes are recommended for reinforced concrete column?	Understand	7
13.	What is the minimum eccentricity specified for design of column?	Understand	7
14.	What are the methods available in IS: 456-2000 to determine the effective length of column?	Understand	7
15.	What are the assumptions for limit state design of columns failing in pure compression as given in IS456?	Understand	7
16.	Explain the modes of failure of columns.	Understand	7

LONG ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	Write the design procedure for slender columns for both braced and unbraced column.	Understand	7
2.	Differentiate between Unsupported length and effective length of a compression member.	Understand	7
3.	A column 400 x 400mm has an unsupported length of 7m and effective length of 4.5m. Can it be designed as a short column under axial compression, if the load is placed centrally on it?	Understand	7
4.	Outline the procedure for design of axially loaded reinforced concrete column?	Understand	7
5.	Design an axially loaded tied column 400 x 400 mm pinned at both ends with an unsupported length of 3m for carrying a factored load of 2300KN. Use grade M20 concrete and Fe 415 steel.	Understand	7
6.	Design a circular pin ended column 400mm dia and helically reinforced with an unsupported length of 4.5m to carry a factored load of 900KN. Assume M30 concrete and Fe 415 steel.	Understand	7
7.	Discuss the important provisions for design of lateral ties for columns as per IS 456.	Understand	7
8.	Explain the step-by-step procedure for design of centrally loaded short columns.	Understand	7
9.	A concrete column is reinforced with 4 bars of 20 m dia. Determine the ultimate load capacity of the column, using M 20 grade concrete and Fe 415 grade steel, if the size of the column of the coli=umn is 450 mm x 450mm .what will be the allowable service load?	Understand	7
10	RC column 400mm x 600mm is subjected to an axial ultimate load of 3000N. The column is bent in single curvature about minor axis with ultimate moment My=100 N-m at top and My=125 N-m at bottom. Taking the unsupported length as 7 m and effective length as 5.6 m on both axes, compute the design moments for the column. Assume reduction factor ka=1	Understand	7
11	Differentiate between i)Unsupported length and effective length of a compression member. ii) Braced and unbraced column.	Understand	7
12	How columns are classified on the basis of different criteria?	Understand	7
13	A column 300mm x 400 mm has an unsupported length of 3 m and effective length of 3.6 m. it is subjected to Pu=1100 KN; Mu=230KN-m about the major axes, determine the longitudinal steel using fck=25 N/mm2 and fy =415 N/mm2 assume d'=60mm.	Understand	7

UNIT-IV

SHORT ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	Give the classification of foundation.	Understand	8
2.	Discuss the design of slab type of staircases.	Understand	8
3.	Explain about one-way and two-way shear in footings.	Understand	8
4.	Explain about combined footing.	Understand	8
5.	Explain about the Minimum cover required in a footing.	Understand	8
6.	Show how the pressure distribution beneath footings.	Understand	8
7.	Give the provision of dowel bars as per IS: 456-2000 code of practice.	Understand	8
8.	Explain shear and bond in footings.	Understand	8
9.	Name five types of staircases based on geometrical configurations. Draw a typical flight and show: (a) Trade, (b) nosing, (c) riser, (d) waist and (e) going.	Understand	8
10	Explain about the following stair cases (A) A staircase (B) A dog leggedstair	Understand	8
11	Explain tread and rise in staircase?	Understand	8
12	Explain about isolated footing.	Understand	8

LONG ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	What are the different types of foundations? Explain with fig.	Understand	8
2.	Explain design procedure for footing as per IS: 456.	Understand	8
3.	Explain pressure distribution under footing with figure.	Understand	8
4.	Explain about one-way and two-way shear in footings.	Understand	8
5.	Write notes on the following (a) Stair slab spanning longitudinal (b) Stair slab spanning horizontally.	Understand	8
6.	What are the Indian standard code recommendations for design of footings as per IS: 456-2000?	Understand	8
7.	Discuss the principles of design of slab type staircases with necessary diagrams.	Understand	8
8.	(a)Explain the distribution of loading on stairs with fig. (b) Explain the procedure for estimation of dead weight of stairs.	Understand	8
9.	Give the procedure for one way and punching shear with necessary diagrams.	Understand	8
10	A solid footing has to transfer a dead load 1000 KN and imposed load of 400 KN from a square column 400 x 400 mm with 16 mm bars. Assuming fy =415 N/mm2 ;fck20 N/mm2 safe bearing capacity = 200 KN/m2. Design the footing.	Understand	8

UNIT-V

SHORT ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	What is difference between one-way and two-way slabs?	Understand	5
2.	Why do we need to provide cover in the design of reinforced concrete structures?	Understand	5
3.	Give the unit weight of PCC and RCC.	Understand	5
4.	Give the steps for checking deflection of two way slabs?	Understand	5
5.	How is the maximum shear in two way slabs calculated?	Understand	5
6.	What are the specifications as per IS code for Minimum and maximum reinforcement requirement for slabs.	Understand	6
7.	What are the considerations that govern thickness of one way and two way slabs?	Understand	6
8.	Which is the critical section to be considered for checking of shear in a slab support on beams?	Understand	6
9.	Sketch the reinforcement detailing of one way slab.	Understand	6
10.	Sketch the reinforcement detailing of one way slab.	Understand	6

LONG ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Course Outcome
1.	Write the procedure for design two way simply supported slabs.	Understand	5
2.	Give neat sketches for the reinforcement details for one way simply support and two way continuous slabs.	Understand	5
3.	Design the interior the span of continuous one way slab for an office floor continuous over T beams spaced at 4m centers. Assume fck=25N/mm2 and Fe 415 steel	Understand	5
4.	Explain the difference in the behavior of one-way and two-way slabs.	Understand	6
5.	What are the major factors which influence the crack width in flexural members?	Understand	6
6.	Discuss the Design procedure for two way slab?	Understand	6
7.	What are the various remedial measures for control of cracking?	Understand	6
8.	Design a R C slab for a room 4m x 5m from inside. The slab carries a LL of 2000 n/m2 and finished with 20 mm thick granolithic topping use M20 concrete and Fe 415 steel. The slab is simply supported at all four edges, with corners free to lift.	Understand	7
9.	Give neat sketches for the reinforcement details for one way simply support and two way continuous slabs.	Remember	7
10.	Explain IS: 456 code method for design of slab?	Remember	7

XI. OBJECTIVE QUESTIONS: JNTUH

UNIT-I

1. The $\frac{x_{u,max}}{d}$ value for Fe250 grade of steel is:
   a) 0.531 b) 0.479 c) 0.456 d) 0.5
2. The $\frac{x_{u,max}}{d}$ value for Fe415 grade of steel is:
   a) 0.531 b) 0.479 c) 0.456 d) 0.5
3. The $\frac{x_{u,max}}{d}$ value for Fe500 grade of steel is:
   a) 0.531 b) 0.479 c) 0.456 d) 0.5
4. For limit state of collapse, the partial safety factors recommended by IS 456:2000 for estimating the design strength of concrete and reinforcing steel are respectively (2009)
   a) 1.15 and 1.5 b) 1.0 and 1.0 c) 1.5 and 1.15 d) 1.5 and 1.0
5. In the limit state design method of concrete structures, the recommended partial material safety factor (γ_m) for steel according to IS: 456-2000 is
   a) 1.5 b) 1.15 c) 1.00 d) 0.87
6. The partial factor of safety for concrete as per IS: 456-2000 is
   a) 1.5 b) 1.15 c) 0.87 d) 0.446
7. For avoiding the limit state of collapse, the safety of R.C structures is checked for appropriate combinations of dead load (DL), imposed load or live load (Il), wind load (WL) and earthquake load(EL). Which of the following load combinations is NOT considered?

   (a) 0.9 DL+1.5 WL (b) 1.5 DL+ 1.5 WL
   (c) 1.5 DL+ 1.5 WL+ 1.5 EL (d) 1.2 DL+ 1.2 IL+ 1.2 WL
8. Un-factored maximum bending moments at a section of a reinforced concrete beam resulting from a frame analysis are 50, 80, 120 and 180 kN.m under dead, live, wind and earthquake loads respectively. The design moment (kN.m) as per IS: 456-2000 for the limit state of collapse (flexure) is
   a) 195 b) 250 c) 345 d) 372
9. The "Plane section remain plane" assumption in bending theory implies
   a) Strain profile is linear b) Stress profile is linear
   c) Both profiles are linear d) Shear deformation is neglected
10. As per IS 456:2000, in the limit state design of a flexural member, the strain in reinforcing bars under tension at ultimate state should not be less than
    a) $\frac{f_y}{E_x}$ b) $\frac{f_y}{E_x}+0.002$ c) $\frac{f_y}{1.15E_x}$ d) $\frac{f_y}{1.15E_x}+0.002$

UNIT-II

1. The basic value of span to effective depth ratio for cantilever is:
   a) 7 b) 20 c) 26 d) 30
2. The basic value of span to effective depth ratio for simply supported is:
   b) 7 b) 20 c) 26 d) 30
3. The basic value of span to effective depth ratio for continuous is:
   c) 7 b) 20 c) 26 d) 30

4. In the design of a reinforced concrete beam, the requirement for bond is not getting satisfied. The economical option to satisfy the requirement for bond is by

a) bundling of bars b) providing smaller diameter bars more in numberc) providing larger diameter bars less in number d) providing same diameter bars more in number

5. The minimum thickness of the cover at the end of a reinforcing bar should not be less than twicethe diameter of the bar subject to a minimum of

(A) 10 mm (B) 15 mm (C) 20 mm (D) 25 mm

6. For M 150 grade concrete (1:2:4) the moment of resistance factor is

(A) 0.87 (B) 8.50 (C) 7.50 (D) 5.80

7. The neutral axis of a T-beam exists

(A) Within the flange (B) At the bottom edge of the slab

(C) Below the slab (D) All the above

8. The spacing of transverse reinforcement of column is decided by the following consideration.

(A) The least lateral dimension of the column

(B) Sixteen times the diameter of the smallest longitudinal reinforcing rods in the column

(C) Forty-eight times the diameter of transverse reinforcement (D) All the above

9. In a simply supported slab, alternate bars are curtailed at

(A) 1/4th of the span (B) 1/5th of the span (C) 1/6th of the span (D) 1/7th of the span

10. In the zone of R.C.C. beam where shear stress is less than 5 kg/cm2, nominal reinforcement is provided at a pitch of

(A) One-half lever arm of the section (B) One-third lever arm of the section

(C) Lever arm of the section (D) One and half lever arm of the section

UNIT-III

1. The diameter of reinforcing bars shall not exceed _____ of the thickness of the slab

a) One-fourth b) one-sixth c) one-eighth d) one-tenth

2. A two-way slab is one

a) Which is supported on opposite edges Which is supported on four edges

b) In which reinforcement is provided along both directions

c) Whose long and short span ratio is less than 2

3. According to I.S. : 456, slabs which span in two directions with corners held down, are assumed to

4. be divided in each direction into middle strips and edge strips such that the width of the middle strip, is

(A) Half of the width of the slab (B) Two-third of the width of the slab

(C) Three-fourth of the width of the slab (D) Four-fifth of the width of the slab

5. The diameter of the column head support a flat slab, is generally kept

(A) 0.25 times the span length (B) 0.25 times the diameter of the column

(C) 4.0 cm larger than the diameter of the column

(D) 5.0 cm larger than the diameter of the column

6. If is the uniformly distributed load on a circular slab of radius fixed at its ends, the maximum positive radial moment at its centre, is

(A) 3WR2/16 (B) 2WR2/16 (C) WR2/16 (D) None of these

7. The maximum ratio of span to depth of a slab simply supported and spanning in one direction, is

(A) 35 (B) 25 (C) 30 (D) 20

8. The floor slab of a building is supported on reinforced cement floor beams. The ratio of the end and intermediate spans is kept
   (A) 0.7 (B) 0.8 (C) 0.9 (D) 0.6
9. In case the factor of safety against sliding is less than 1.5, a portion of slab is constructed downwards at the end of the heel slab, which is known as
   (A) A key (B) A cut-off wall (C) A rib (D) All the above
10. For a ribbed slab
   (A) Clear spacing between ribs shall not be greater than 4.5 cm
   (B) Width of the rib shall not be less than 7.5 cm
   (C) Overall depth of the slab shall not exceed four times the breadth of the rib
   (D) All the above

UNIT-IV

1. A pedestal is a compression member whose effective length does not exceed _____ times the least lateral dimension.
   a) Two b) three c) four d) five
2. The minimum amount of percentage of reinforcement in columns is:
   a) 0.4 b) 0.6 c) 0.8 d) 1.0
3. The maximum amount of percentage of reinforcement in columns is:
   a) 2 b) 3 c) 4.5 d) 6
4. The bars in a column shall not be less than _____ diameter
   a) 6 b) 8 c) 10 d) 12
5. The diameter of the column head support a flat slab, is generally kept
   (A) 0.25 times the span length (B) 0.25 times the diameter of the column
   (C) 4.0 cm larger than the diameter of the column
   (D) 5.0 cm larger than the diameter of the column
6. Pick up the correct statement from the following:
   (A) Lateral reinforcement in R.C.C. columns is provided to prevent the longitudinal reinforcement from buckling
   (B) Lateral reinforcement prevents the shearing of concrete on diagonal plane
   (C) Lateral reinforcement stops breaking away of concrete cover, due to buckling
   (D) All the above
7. Columns may be made of plain concrete if their unsupported lengths do not exceed their least lateral dimension
   (A) Two times (B) Three times (C) Four times (D) Five times
8. According to load factor method, the permissible load W on a short column reinforced with longitudinal bars and lateral stirrups, is
   (A) Stress in concrete × area of concrete (B) Stress in steel × area of steel
(C) Stress in concrete × area of concrete + Stress in steel × area of steel (D) None of these
9. Top bars are extended to the projecting parts of the combined footing of two columns L distance apart for a distance of
   (A) 0.1 L from the outer edge of column (B) 0.1 L from the centre edge of column
   (C) Half the distance of projection (D) One-fourth the distance of projection
10. The minimum clear cover for R.C.C. columns shall be
   (A) Greater of 40 mm or diameter (B) Smaller of 40 mm or diameter
   (C) Greater of 25 mm or diameter (D) Smaller of 25 mm or diameter

UNIT-V

1. The combined footing is provided when
   a) the columns are close to each other
   b) the bearing pressures of columns overlap with each other
   c) a column is close to the boundary line All of these
2. The minimum thickness of footing is:
   a) 100 mm b) 150 mm c) 200 mm d) 250 mm
3. A stair-case having mid-landing is called
   a) Dog-legged b) open well c) spiral d) folded plate
4. A very comfortable type of stairs is
   (A) Straight (B) Dog legged (C) Geometrical (D) Open newel
5. If is the net upward pressure on a square footing of side for a square column of side , the maximum bending moment is given by

(A) B.M = pb (c - a)/4 (B) B.M = pb (b - a)2/4 (C) B.M = pb (b - a)2/8 (D) B.M = pb (b + a)/8

6. To ensure uniform pressure distribution, the thickness of the foundation, is
   (A) Kept uniform throughout (B) Increased gradually towards the edge
   (C) Decreased gradually towards the edge (D) Kept zero at the edge
7. The self-weight of the footing, is
   (A) Not considered for calculating the upward pressure on footing
   (B) Also considered for calculating the upward pressure on footing
   (C) Not considered for calculating the area of the footing (D) Both (b) and (c)
8. If the bearing capacity of soil is 10 tonnes/cm2 and the projection of plain concrete footing from walls, is a cm, the depth D of footing is
   (A) D = 0.0775 a (B) D = 0.775 a (C) D = 0.775 a (D) D = 0.775 a2
9. A raft foundation is provided if its area exceeds the plan area of the building by
   (A) 10 % (B) 20 % (C) 40 % (D) 50 %
10. According to I.S.: 456, 1978 the thickness of reinforced concrete footing on piles at its edges, is kept less than
    (A) 20 cm (B) 30 cm (C) 40 cm (D) 75 cm

XII. GATE QUESTIONS:

1. An R.C.C. beam of 6 m span is 30 cm wide and has a lever arm of 55 cm. If it carries a U.D.L. of 12 t per m and allowable shear stress is 5 kg/cm2, the beam
   (A) Is safe in shear (B) Is safe with stirrups
   (C) Is safe with stirrups and inclined bars (D) Needs revision of section
2. According to I.S. : 456, slabs which span in two directions with corners held down, are assumed to be divided in each direction into middle strips and edge strips such that the width of the middle strip, is
   (A) Half of the width of the slab (B) Two-third of the width of the slab
   (C) Three-fourth of the width of the slab (D) Four-fifth of the width of the slab
3. The load stress of a section can be reduced by
   (A) Decreasing the lever arm (B) Increasing the total perimeter of bars
   (C) Replacing larger bars by greater number of small bars
   (D) Replacing smaller bars by greater number of greater bars

4. The diameter of the column head support a flat slab, is generally kept
   (A) 0.25 times the span length (B) 0.25 times the diameter of the column
   (C) 4.0 cm larger than the diameter of the column
   (D) 5.0 cm larger than the diameter of the column
5. If is the uniformly distributed load on a circular slab of radius fixed at its ends, the maximum positive radial moment at its centre, is
   (A) $3WR^2/16$ (B) $2WR^2/16$ (C) $WR^2/16$ (D) None of these
6. The maximum ratio of span to depth of a slab simply supported and spanning in one direction, is (A) 35 (B) 25 (C) 30 (D) 20
7. If the width of the foundation for two equal columns is restricted, the shape of the footing generally adopted, is
   (A) Square (B) Rectangular (C) Trapezoidal (D) Triangular
8. The floor slab of a building is supported on reinforced cement floor beams. The ratio of the end and intermediate spans is kept
   (A) 0.7 (B) 0.8 (C) 0.9 (D) 0.6
9. Pick up the correct statement from the following:
   (A) Lateral reinforcement in R.C.C. columns is provided to prevent the longitudinal reinforcement from buckling
   (B) Lateral reinforcement prevents the shearing of concrete on diagonal plane
   (C) Lateral reinforcement stops breaking away of concrete cover, due to buckling
   (D) All the above
10. In case the factor of safety against sliding is less than 1.5, a portion of slab is constructed downwards at the end of the heel slab, which is known as
    (A) A key (B) A cut-off wall (C) A rib (D) All the above
11. Lapped splices in tensile reinforcement are generally not used for bars of size larger than
    (A) 18 mm diameter (B) 24 mm diameter (C) 30 mm diameter (D) 36 mm diameter
12. Minimum spacing between horizontal parallel reinforcement of the same size should not be less than
    (A) One diameter (B) 2.5 diameters (C) 3 diameters (D) 3.5 diameters
13. For a ribbed slab
    (A) Clear spacing between ribs shall not be greater than 4.5 cm
    (B) Width of the rib shall not be less than 7.5 cm
    (C) Overall depth of the slab shall not exceed four times the breadth of the rib
    (D) All the above
14. A very comfortable type of stairs is
    (A) Straight (B) Dog legged (C) Geometrical (D) Open newel
15. Columns may be made of plain concrete if their unsupported lengths do not exceed their least lateral dimension
    (A) Two times (B) Three times (C) Four times (D) Five times
16. The width of the flange of a L-beam, should be less than
(A) One-sixth of the effective span (B) Breadth of the rib + four times thickness of the slab
(C) Breadth of the rib + half clear distance between ribs (D) Least of the above
17. A pre-stressed concrete member is preferred because
    (A) Its dimensions are not decided from the diagonal tensile stress
    (B) Large size of long beams carrying large shear force need not be adopted
    (C) Removal of cracks in the members due to shrinkage (D) All the above

18. If the ratio of the span to the overall depth does not exceed 10, the stiffness of the beam will ordinarily be satisfactory in case of a
    (A) Simply supported beam (B) Continuous beam
    (C) Cantilever beam (D) None of these
19. A pile of length carrying a uniformly distributed load per metre length is suspended at two points, the maximum, B.M. at the centre of the pile or at the points of suspension, is
    (A) WL/8 (B) $WL^2/24$ (C) $WL^2/47$ (D) $WL^2/16$
20. If is the net upward pressure on a square footing of side for a square column of side , the maximum bending moment is given by
    (A) B.M = pb (c - a)/4 (B) B.M = pb $(b - a)^2/4$
    (C) B.M = pb $(b - a)^2/8$ (D) B.M = pb (b + a)/8

XIII. WEBSITES:

1. http://www.asce.org
2. http://www.icivilengineer.com
3. http://www.construction-guide.in

XIV. EXPERT DETAILS:

1. J. N. Bandhopadyaya, Professor, IIT-Kgp
2. Dr. Devadoss Menon, Professor, IIT-Chennai

XV. JOURNALS:

0970-1141	Thesis Digest on civil Engineering	1987
0973-8061	International Engineering and Technology Journal of Civil and Structure	2007
0975-5314	International journal of civil engineering	2009
0975-6744	Journal of information knowledge and research in civil engineering	2009
0976-6308	International journal of civil engineering and technology	2010
2249-426X	International Journal of Civil Engineering and Applications	2011
2249-8753	Recent Trends in Civil Engineering and Technology	2011
2277-5986	World Research Journal of Civil Engineering	2011
2277-7032	International Journal of Structural and Civil Engineering	2012
2278-9987	International Journal of Civil Engineering (IJCE)	2012
2319-6009	International Journal of Structural and Civil Engineering Research	2012
2320-723X	International Journal of Advanced Research in Civil, Structural, Environmental and Infrastructure Engineering and Developing	2013

XVI. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Limit State Design
2. Design Strength of Materials
3. Design Loads
4. Design of RCC Beams
5. Design of RCC Slabs
6. Design of RCC Column Footings
7. Design of RCC Columns

XVII. CASE STUDIES / SMALL PROJECTS:

- Design of Residential Buildings
- Design Of Bridges
- Design of Commercial Buildings
- Design of Cold Storages
- Design of Cement factories