

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK



SEMESTER - V

CE3562–DESIGN OF REINFORCED CEMENT CONCRETE ELEMENTS

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Prepared by

Mr. Sattainathan Sharma A,
Assistant Professor – Civil Engineering

Prepared by – Mr. Sattainathan Sharma A – Assistant Professor (Sr.G) – Civil Engineering



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SUBJECT CODE: CE 3562

SUBJECT NAME: DESIGN OF REINFORCED CEMENT CONCRETE ELEMENTS

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UNIT I - METHODS OF DESIGN OF CONCRETE STRUCTURES

Objective of structural design - Concept of reinforced concrete structures – Properties of Concrete and Reinforcing Steel - Different grades of concrete and steel used in RCC Load and loading standards as per IS:875 - Concept of Elastic method, ultimate load method and limit state method - Design of beams by working stress method.

PART-A

S.No.	Questions	BT Level	Competence
1	In working stress method, the distance of lever arm under balanced condition for concrete grade M25 and steel grade Fe415 for a beam of 300mm × 400mm, clear cover 25 mm, reinforcement 3-20mm dia is ?	BT-1	Remember
2	What are the different types of loads that have to be considered in the design of a building?	BT-1	Remember
3	Enlist the methods used for the design of RCC members.	BT-1	Remember
4	What is the formula used to find the critical neutral axis in working stress method?	BT-1	Remember
5	Give the values of partial safety factor for concrete and steel.	BT-1	Remember
6	What are the disadvantages of working stress method?	BT-1	Remember
7	Define modular ratio.	BT-1	Remember
8	Sketch the stress – strain curve of concrete.	BT-1	Remember
9	What is characteristic load and characteristic strength of a material?	BT-1	Remember
10	Write about cover of concrete.	BT-2	Understand
11	Write the formula for the neutral axis depth factor 'K' in working stress design.	BT-2	Understand
12	State the main concept of elastic method or working stress method.	BT-2	Understand
13	What is permissible bending stress in concrete?	BT-2	Understand
14	Write down the advantages of limit state method over other methods.	BT-1	Remember
15	What are the expressions recommended by the IS 456-2000 for Modulus of Elasticity and Flexural Strength of concrete?	BT-1	Remember
16	Examine the assumptions made in limit state of collapse by flexure.	BT-2	Understand
17	Find the target mean compressive strength of M20 grade concrete (assume standard deviation as per IS 456:2000).	BT-2	Understand

18	Distinguish between under reinforced and over reinforced sections.	BT-2	Understand
19	Differentiate and justify LSM from WSM.	BT-2	Understand
20	Order the various Limit state as per IS 456 – 2000.	BT-2	Understand
21	What is the modulus of elasticity of concrete having mean target strength 40 MPa as per IS 456:2000?	BT-1	Remember
22	Solve the modular ratio for M20, M30 grade of concrete.	BT-1	Remember
23	What is the split tensile strength of the concrete having cylinder compressive strength of 40 MPa?	BT-2	Understand
24	What is the flexural tensile strength of concrete having cylinder compressive strength 50 MPa (As per IS 456:2000)?	BT-1	Remember

PART-B

1	a) What are the main loads, forces and effects to be considered while designing the structures? b) Give the stress – strain diagram of mild steel and TOR steel. c) Distinguish between singly and doubly reinforced concrete beams.	BT-2	Understand
2	How do the stress-strain diagrams for materials differ between the Working Stress Method (WSM) and the Limit State Method (LSM) in structural design?	BT-3	Application
3	a) Brief the properties on concrete. b) Discuss the various properties of reinforcing steel.	BT-3	Application
4	Discuss about various RCC sections for design of beams.	BT-3	Application
5	Compare and Contrast LSM, ULM and WSM.	BT-2	Understand
6	Derive the design constants for the following material considering balanced design for singly reinforced section. The materials are M20 grade of concrete and mild steel reinforcement.	BT-3	Application
7	a) The dimension of a rectangular section is 250 mm × 350 mm. The clear cover is 25 mm. The tensile reinforcement is provided with 3 nos. 16mm HYSD bars. The grade of concrete used is M25. Which of the following is true for the section, following Working Stress Method? b) The dimension of a rectangular section is 300 mm × 400 mm. The clear cover is 25mm. The tensile reinforcement is provided with 3 nos. 20mm HYSD bars and M20 grade of concrete. Comment on the section of the beam given.	BT-3	Application
8	A reinforced concrete beam 200 mm × 400 mm effective depth is used over an effective span of 5 m. It is subjected to a uniformly distributed load of 7 kN/m inclusive of its own weight. Find the necessary steel reinforcement at the centre of the span. Take allowable stresses in steel and concrete as 130 N/mm ² and 4 N/mm ² respectively and m16.	BT-3	Application
9	Design a beam section to resist the maximum bending moment in a SSB of span 5m to support a load of 15 kN/m (inclusive of self-weight). Using M20 and Fe415 grade of steel using WSM method.	BT-5	Evaluate

10	A rectangular beam of width 200 mm and effective depth 460 mm is reinforced with three 16 mm diameter bars. The section is subjected to a characteristic moment of 30 kNm. Determine the maximum stress in steel and concrete. The materials used are M20 grade concrete and mild steel reinforcement. Also, find the moment of resistance (M.R) of the section.	BT-4	Analyze
11	Find the moment of resistance (M.R) of a beam having a width of 230 mm and an effective depth of 560 mm, reinforced with three 20 mm diameter bars. Also, state the type of beam. The materials used are M20 grade concrete and Fe 415 grade steel.	BT-3	Application
12	A singly reinforced rectangular beam of 250 mm wide and effective depth as 320 mm with the #4 – 16 mm diameter bars as reinforcement. This carries an moment of 32 kN.m. Determine stresses in steel and concrete respectively.	BT-4	Analyze
13	For a balanced rectangular section (bxd) of a singly reinforced beam, determine (i) depth of neutral axis (ii) moment of resistance and (iii) percentage of steel using M 20 concrete and Fe 415 steel.	BT-4	Analyze
14	Determine the moment of resistance of a singly reinforced beam 160 mm wide and 300 mm deep to the centre of reinforcement, if the stresses in steel and concrete are not to exceed 140 N/mm ² and 5 N/mm ² . The reinforcement consists of 4 bars of 16 mm diameter. Take m=18. If the above beam is used over an effective span of 5 m, find the maximum load the beam can carry, inclusive of its own weight.	BT-4	Analyze
15	Design a reinforced concrete beam subjected to a bending moment of 20 kNm. Use M20 grade concrete and Fe 415 grade steel. Keep the width of the beam equal to half of the effective depth.	BT-5	Evaluate
16	Design a beam subjected to a bending moment of 40kNm by working stress design. Adopt width of beam equal to half the effective depth. Assume the permissible stresses in the concrete and steel are not to exceed 5N/mm ² and 140 N/mm ² . Take m=18	BT-5	Evaluate
17	a) Distinguish PCC and RCC. b) Brief about various types of elastic modulus of steel. c) Why steel is used as reinforcement in concrete sections? Justify d) Give the different types of steel reinforcement used.	BT-2	Understand
18	A rectangular, singly reinforced beam, 300 mm wide and 500 mm effective depth is used as a simply supported beam over an effective span of 6 m. The reinforcement consists of 4 bars of 20 mm diameter. If the beam carries a load of 12 kN/m. inclusive of the self-weight, determine the stresses developed in concrete and steel. Take m=19.	BT-5	Evaluate

UNIT II – LIMIT STATE DESIGN OF BEAMS

Analysis and design of singly and doubly reinforced rectangular and flanged beams– Use of IS codes and design aids for Flexure - Behaviour of rectangular RC beams in bond, anchorage, shear and torsion - Design of RC members for combined Bending, Shear and Torsion .

PART-A

Q. No.	Questions	BT Level	Competence
1.	Sketch the stress block diagram of concrete.	BT-2	Understand
2.	Sketch the stress distribution of an RC singly reinforced beam of rectangular section.	BT-2	Understand
3.	Write down the value of design bond stress for M 20 & M 30 grade concrete.	BT-1	Remember
4.	Recall the term bond and anchorage.	BT-1	Remember
5.	On what circumstances doubly reinforced beams are to be adopted?	BT-1	Remember
6.	Argue that concrete is good in compression not in tension?	BT-1	Remember
7.	Find the minimum strain at failure in the tensile reinforcement of Fe500 of a RCC beam as per limit state method.	BT-2	Understand
8.	Differentiate characteristic strength and characteristic load.	BT-2	Understand
9.	Differentiate flexural bond and anchorage bond.	BT-2	Understand
10.	Differentiate between design mix and nominal mix concrete.	BT-2	Understand
11.	Identify the reason why steel is most preferred as a reinforcement material over other material?	BT-1	Remember
12.	What is the permissible stress in bond for M 20 and M30 grade of concrete?	BT-1	Remember
13.	Give the compatibility and constitutive equations.	BT-1	Remember
14.	Discuss about the distribution of torsional reinforcement as per IS 456:2000.	BT-2	Understand
15.	Enlist the concrete grade that can be used for reinforced concrete work.	BT-1	Remember
16.	Differentiate shear failure and bending failure.	BT-2	Understand
17.	Define development length.	BT-1	Remember
18.	Show the difference between under reinforcement and over reinforcement section.	BT-2	Understand
19.	Find the effective length of the flange of a simply supported T-Beam having effective span 6m and C/C distance of adjacent panel is 3.0 m. Breadth of the web is 350 mm and thickness of the slab is 100 mm.	BT-1	Remember
20.	What is the depth of neutral axis of a singly reinforced beam of breadth 230 mm reinforced with 4 bars of 16 mm diameter? Use M20 and Fe415 grade of materials.	BT-1	Remember
21.	Enlist the types of shear failure in reinforced concrete beams?	BT-1	Remember
22.	Write the formula for effective flange width of isolated L-beam and T-beam?	BT-1	Remember
23.	Distinguish between lap length and development length.	BT-2	Understand

24.	What are the basic assumptions in the design of flexural members for the limit state of collapse?	BT-1	Remember
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PART-B

1.	a) Find the depth of the neutral axis of a singly reinforced RC beam of 230 mm width and 450 mm effective depth. It is reinforced with 4 bars of 16 mm diameter. Use M20 concrete and Fe415 bars. Also, comment on the type of beam. b) Find the depth of the neutral axis of a singly reinforced RC beam of 250 mm width and 500 mm effective depth. It is reinforced with 4 bars of 20 mm diameter. Use M20 concrete and Fe415 bars. Also, check the type of section.	BT-3	Application
2.	a) Determine the ultimate MOR of rectangular RC beam having a width of 350 mm and effective depth of 700 mm is reinforced with #2 -28mm and #2-25mm. Use concrete grade M20 and steel grade Fe415. b) A singly reinforced concrete beam of 250 mm width is reinforced with 4 bars of 25 mm diameter at an effective depth of 400 mm. If M20 grade concrete and Fe415 bars are used, compute the ultimate moment of resistance of the section.	BT-3	Application
3.	A rectangular beam of effective size 300 mm × 500 mm is used as a simply supported beam for an effective span of 6.5 m. Determine the superimposed load on the beam if the maximum percentage of steel is provided, only on the tension side. Use M20 concrete and Fe415 steel. Determine the amount of steel to be provided.	BT-4	Analyze
4.	A cantilever R.C. beam of span 2 m is rectangular in cross-section, 230 × 380 mm. It is reinforced with 3 – 16 mm dia bars on the tension side. Determine the superimposed load on the beam in addition to its self-weight. Use M20 concrete and Fe415 steel.	BT-4	Analyze
5.	A rectangular section of 230 mm × 500 mm is used as a simply supported beam for an effective span of 6 m. The beam consists of tensile reinforcement of 400 mm ² and the center of reinforcement is placed at 35 mm from the bottom edge. What maximum total UDL can be allowed on the beam? Use M20 concrete and Fe415 steel.	BT-3	Application
6.	A doubly reinforced beam of width 230 mm and 600 mm total depth is reinforced with 4 bars of 16 mm diameter as compression reinforcement and 6 bars of 20 mm diameter as tension steel at an effective cover of 40 mm on both sides. Find the superimposed load if the beam is simply supported over an effective span of 6 m. Use M20 grade concrete and Fe415 steel.	BT-3	Application
7.	Design the singly reinforced concrete beam to suit the following data: Clear Span = 4 m Width of supports = 300 mm Service load = 5 kN/m Grade of concrete = M 20 & Grade of steel = Fe 415 HYSD bars	BT-4	Analyze
8.	A doubly reinforced concrete section is 250 mm wide and 450 mm deep to the center of the tensile reinforcement. It is reinforced with 2 bars of 16 mm	BT-4	Analyze

	diameter as compression reinforcement at an effective cover of 50 mm and 4 bars of 25 mm diameter as tensile steel. Using M20 concrete and Fe250 steel, calculate the ultimate moment of resistance of the section.		
9.	Design a doubly reinforced concrete beam of rectangular section using the following data: Effective span = 5m Width of beam = 250mm Overall depth = 500mm Service load (DL+LL) = 40 kN/m. Effective cover = 50mm M20 grade of concrete and Fe415 HYSD bars	BT-4	Analyze
10.	A T-beam of flange width 1400 mm, flange thickness 100 mm, rib width 250 mm has an effective depth of 500 mm. The beam is reinforced with 4 bars of 20 mm diameter. Find the ultimate moment of resistance. Use M20 concrete and Fe415 steel. Use limit state method.	BT-3	Application
11.	A T-beam of flange width 1200 mm, flange thickness 100 mm, rib width 275 mm has an effective depth of 550 mm and is reinforced with 6 bars of 25 mm diameter and 4 bars of 16 mm diameter. Find the ultimate moment of resistance. Use M 20 grade of concrete and Fe 415 grade of steel bars.	BT-3	Application
12.	Calculate the ultimate moment of resistance of a T-beam using following data: - Width of flange = 1500 mm - Depth of flange = 100 mm - Overall depth of beam = 600 mm - Width of rib = 300 mm - Area of tension steel = 2455 mm² - Effective cover = 40 mm $f_{ck}=15$ MPa, $f_y=415$ MPa	BT-3	Application
13.	A simply supported beam of 300 mm × 1010 mm effective depth has a span of 7 m carrying a UDL of 45 kN/m throughout the span and is provided with tensile steel of 6 bars of 22 mm diameter. If concrete M20 and Fe415 steel are used, design shear reinforcement.	BT-4	Analyze
14.	a) A simply supported RCC beam subjected to a design shear force of 180 kN. Size of beam 250 x 600 mm depth to the centre of reinforcement. It is reinforced with 4 bars of 20 mm diameter. Use M20 concrete and Fe415 steel. Comment on its shear design. b) A simply supported R.C.C. beam is 250 mm wide and 500 mm effective depth and is reinforced with 4 bars of 22 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 and design the shear reinforcement. Use M20 concrete and Fe 250 steel. Use limit state method. c) A 230 mm wide and 550 mm deep RC beam is reinforced with 2L - 10 mm inclined stirrups at 200 mm c/c with $\alpha=60^\circ$. Longitudinal steel consists of 4 bars of 25 mm with an effective cover of 50 mm. Use M20 and Fe 415 grade of materials. Calculate the strength of the section in shear.	BT-4	Analyze

15.	Design a shear reinforcement for a simply supported beam of effective span = 7 m subjected to UDL of 45 kN/m throughout the span. The beam is reinforced with 6 Nos of 22 mm diameter bars. The gross section of the beam = 300 × 1010 mm effective depth. Take Percentage of steel = 0.75%. Use M20 and Fe415 steel.	BT-4	Analyze
16.	A simply supported R.C.C. beam is 250 mm wide and 500 mm effective depth and is reinforced with 4 bars of 22 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 and design the shear reinforcement. Use M20 concrete and Fe 250 steel. Use limit state method.	BT-3	Application
17.	a) Calculate the anchorage length in tension and compression for - Single mild steel bar of diameter ϕ in concrete of grade M20 - An HYSD bar of grade Fe415 of diameter # in concrete of grade M20. b) A simply supported beam is 25 cm by 50 cm and has 2-20 mm HYSD bars going into the support. If the shear force at the centre of support is 110 kN at working loads, determine the anchorage length. Assume M20 mix and Fe415 grade steel.	BT-3	Application
18	Design the reinforcement required for a rectangular beam of Size of the beam : 500 mm X 700 mm Concrete Mix : M 15 & Steel grade : Fe 415 Factored moment : 130 kNm Factored torsion : 10 kNm Factored Shear : 130 kN	BT-4	Analyze

UNIT III DESIGN OF SLABS AND STAIRCASES

Analysis and design of Cantilever - one way - two way - continuous slabs for various boundary conditions. Staircases - Types of Staircases - Design of staircases (ordinary and doglegged).

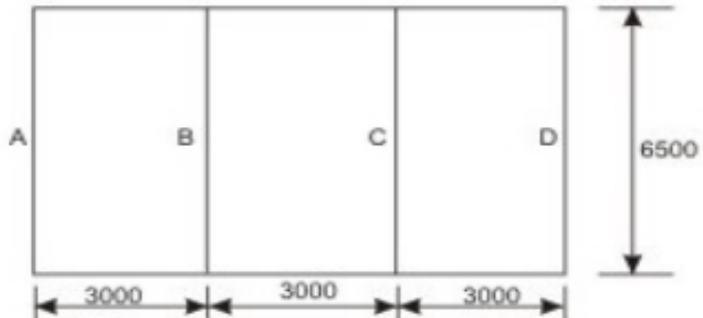
PART A

1	List the types of slab.	BT-1	Remember
2	What are the rules to be followed in the design of slabs as per IS 456-2000?	BT-1	Remember
3	Why is secondary/distribution reinforcement provided in RC slab?	BT-1	Remember
4	Why corner reinforcement is provided in a two way slab?	BT-1	Remember
5	Brief about the torsional reinforcement.	BT-1	Remember
6	List the advantages of cantilever slab.	BT-1	Remember
7	Sketch the load distribution of one-way and two-way slab.	BT-2	Understand
8	Distinguish between one-way and two-way slab.	BT-2	Understand
9	Enlist the serviceability requirement for one-way slab.	BT-1	Remember
10	Outline the codal provisions for minimum reinforcement to be provided main and secondary reinforcement in slab and their spacing.	BT-1	Remember
11	Sketch the typical reinforcement detailing of one-way slab.	BT-2	Understand
12	In what way, the deflection limit differed for two-way slab as per IS 456-2000?	BT-1	Remember
13	Give the formula for maximum bending moments per unit width in a slab.	BT-1	Remember

14	Give the condition for reinforcement in two-way slab for continuous edge and discontinuous edge.	BT-1	Remember
15	When cantilever slab are provided?	BT-1	Remember
16	Distinguish between transverse span and longitudinal span stair case.	BT-2	Understand
17	Sketch a typical stair case and mention the basic nomenclature.	BT-2	Understand
18	Sketch the typical reinforcement detailing of any one stair case.	BT-2	Understand
19	Write down the different types of staircase.	BT-1	Remember
20	Recall tread and rise.	BT-1	Remember
21	Tell about Flight and Going.	BT-1	Remember
22	What is the minimum rise and tread in residential and public buildings?	BT-1	Remember
23	Define the term flight and going in staircase.	BT-1	Remember
24	Sketch the plan of various stair cases.	BT-2	Understand

PART B

1	a) Discuss about various types of slabs b) Sketch the load transfer mechanism in slab	BT-3	Application
2	Distinguish between one-way and two-way slab in detail.	BT-3	Application
3	Design a cantilever balcony slab projecting 1 m from a beam. Adopt live load of 3 kN/m ² . Adopt M-20 grade concrete and Fe 415 HYSD bars.	BT-3	Application
4	Design a one-way slab with a clear span of 3.5 m, simply supported on 200 mm thick concrete masonry walls to support a live load of 4 kN/m ² . Adopt M-20 grade concrete and Fe 415 HYSD bars.	BT-4	Analyze
5	Design a RC roof slab for the following details. Live load = 2 kN/m ² Dimensions of room = 3.3 m X 7.5 m Width of support = 230 mm Edges are simply supported M20 & Fe 415 grade of materials.	BT-4	Analyze
6	A residential building floor slab of 130 mm thick with steel rods of 10 mm at 100 mm c/c. The effective span of the slab is 3m. Find the safe UDL it can carry including its self-weight. Take the grade of materials as M 25 & Fe 415. The slab is simply supported on all four sides.	BT-4	Analyze
7	Design the concrete slab to carry a live load of 3 kN/m ² . The slab is supported on all four sides. The slab is supported on brick wall of 230 mm thick and the slab thickness is 130 mm. Inside dimension of room is 3m X 7m. Use M20 and Fe 415 grade of materials.	BT-4	Analyze
8	Design the one-way continuous slab of Fig. subjected to uniformly distributed imposed loads of 5 kN/m ² using M 20 and Fe 415. The load of floor finish is 1 kN/m ² . The span dimensions shown in the figure are effective spans. The width of beams at the support = 300 mm.	BT-4	Analyze

			
9	Design the R.C Slab for a room size 3.5 m X 3.5 m. The slab is simply supported on all four edges. With corners are not held down, the slab carries a live load of 3.5kN/m^2 and width of wall is 230 mm. Adopt M-20 grade concrete and Fe 415 HYSD bars. Use IS code method.	BT-4	Analyze
10	Design the roof slab of a hall having the size of 3m X 4.7 m. Slab is simply supported on 4 edges and free to lift at corners. The width of the bearing is 230 mm. Live load on the slab is 1.5kN/m^2 . Adopt M-20 grade concrete and Fe 415 HYSD bars.	BT-4	Analyze
11	Design a one way slab for an office floor which is continuous over T-beam spaced at 3.5 m intervals. Assume live load as 4 kN/m^2 . Adopt M-20 grade concrete and Fe 415 HYSD bars.	BT-4	Analyze
12	a) The tread depth of a step is 250mm, the going depth of a step is 250mm, the rise height of a step is 150mm and the depth of waist slab is 150mm. Take unit weight of reinforced concrete as 25.0kN/m^3. Determine the weight of each step (including waist). b) The tread depth of a step is 250mm, the going depth of a step is 250mm, the rise height of a step is 150mm and the depth of waist slab is 150mm. The thickness of floor finish is 15mm. Take unit weight of reinforced concrete as 25.0kN/m^3 and unit weight of floor finish as 23.5kN/m^3. Determine the weight of each step (including waist). c) The floor to floor height of a building is 3.0m. The tread depth of a step is 250mm and the rise height of a step is 150mm. The total number of steps to be provided for accessing next floor is equal to?	BT-4	Analyze
13	Design a dog legged stair case for a residential building hall measuring 2.2 m x 4.7 m. The width of the landing is 1m. The distance between floor to floor is 3.3 m. The rise and tread may be taken as 150mm and 270mm respectively. The weight of floor finish is 1 kN/m^2 . The materials used are M20 grade concrete and Fe415 grade steel. Sketch the details of steel. Here flight and the landing slabs spans in the same direction i.e, Flight spans longitudinally.	BT-3	Application
14	Design one of the flight of a dog-legged stairs spanning between landing beams using following data Number of steps in a flight = 10 Tread = 300 mm Rise = 150mm Width of landing beams = 300mm	BT-3	Application
15	Discuss about various types of stairs.	BT-3	Application

16	Design a stair for a residential building having floor height of 3.30 m. Take LL = 3kN/m ² , M20 and Fe 415. The landing slabs are supported by walls at its ends.	BT-4	Analyze
17	Sketch a typical dog-legged stair case and recall all the technical terms and its components.	BT-3	Application
18	Write the design procedure of a two-way slab with reinforcement detailing as per IS 456 – 2000.		

UNIT IV - LIMIT STATE DESIGN OF COLUMNS

Types of columns – Braced and unbraced columns – Design of short Rectangular and circular columns for axial, uniaxial and biaxial bending - Design of Slender columns using SP-16.

PART-A

Q. No.	Questions	BT Level	Competence
1	Define Column.	BT-1	Remember
2	Sketch a typical column interaction diagram showing the salient points.	BT-2	Understand
3	Distinguish between long column and short column.	BT-2	Understand
4	Give the various types of columns.	BT-1	Remember
5	According to IS code “All the columns shall be designed for minimum eccentricity”. Justify the reasons for this statement.	BT-1	Remember
6	What are the specifications for pitch of lateral ties in columns?	BT-1	Remember
7	What is a slender column?	BT-1	Remember
8	What is the minimum eccentricity to be adopted while designing columns?	BT-1	Remember
9	Find the effective length of a column for the following end conditions of fixed at both ends and pinned at both ends having unsupported length of 3.5 m.	BT-1	Remember
10	Enlist the function of lateral ties in a RC column.	BT-1	Remember
11	What are the factors involved in load carrying capacity of column?	BT-1	Remember
12	Write down the expression for minimum eccentricity.	BT-1	Remember
13	Define slenderness ratio.	BT-1	Remember
14	Differentiate between braced and unbraced column.	BT-2	Understand
15	Name the failure modes of column.	BT-1	Remember
16	Differentiate between uniaxial and biaxial bending.	BT-2	Understand
17	Write down the formula for ultimate load carrying capacity of a short axially loaded column.	BT-1	Remember

18	Sketch the typical reinforcement for any two column sections.	BT-2	Understand
19	Differentiate single and double curvature in a column.	BT-2	Understand
20	Distinguish a pedestal and column.	BT-2	Understand
21	What are the points to be considered while designing longitudinal reinforcement for columns.	BT-1	Remember
22	What are the factors to be considered while selecting pitch and diameter of lateral ties for columns?	BT-1	Remember
23	Write any two code requirements on slenderness limit?	BT-1	Remember
24	Define Slender column	BT-1	Remember

PART –B

1	a) A concrete column is reinforced with 4 bars of 20mm dia. Determine the load capacity of the column using M25 grade concrete and Fe 415 grade steel if the size of the column is 400mm x 400mm? b) A square column of 5.0m unsupported length restrained in position and direction at both ends carries an axial load of 1200 kN. Assuming M20 and Fe 415 and 1% of steel, what would be the dimension of the column?	BT-4	Analyze
2	a) A square column of 5.0m unsupported length restrained in position and direction at both ends carries an axial load of 1200 kN. Assuming M20 and Fe 415 and 1% of steel and dimension of 500 mm x 500 mm, 25 mm dia bars, what is the required number of bars to be provided? b) A rectangular column of size 400mm × 400mm is loaded with $P_u = 1200\text{kN}$ and $M_{ux} = 50\text{kNm}$. For using interaction curve of column, the non-dimensional form of load and moment will be (M20 grade of concrete)?	BT-4	Analyze
3	Design an axially loaded tied column 400 mm x 400 mm pinned at both ends with an unsupported length of 3m to carry a factored load of 2300 kN. Use M20 grade concrete and Fe-415 grade steel.	BT-4	Analyze
4	a) Determine the load carrying capacity of a column of size 300 x 400 mm reinforced with six rods of 20 mm diameter. The grade of concrete and steel are M20 and Fe 415 respectively. Assume that the column is short. b) Determine the steel required to carry a load of 980kN on a rectangular column of size 300 x 400 mm. The grade of concrete and steel are M20 and Fe 415 respectively. Assume that the column is short.	BT-4	Analyze
5	Design a square or circular column to carry a working load of 980kN. The grade of concrete and steel are M20 and Fe 415 respectively. Assume that the column is short.	BT-4	Analyze
6	Design a rectangular column to carry an ultimate load of 2500kN. The unsupported length of the column is 3m. The ends of the column are	BT-3	Application

	effectively held in position and also restrained against rotation. The grade of concrete and steel are M20 and Fe 415 respectively.		
7	Design a circular column with ties to carry an ultimate load of 2500kN. The unsupported length of the column is 3m. The ends of the column are effectively held in position but not against rotation. The grade of concrete and steel are M20 and Fe 415 respectively.	BT-3	Application
8	a) The size of a rectangular column is 300mm × 400mm The effective length about X axis is equal to 5.0m. The axial force, P_u in column is 1200.0kN. The additional moment about X axis due to slenderness will be equal to? b) The size of a rectangular column is 300mm × 400mm The effective length about Y axis is equal to 5.0m. The axial force, P_u in column is 1200.0kN The additional moment about Y axis due to slenderness will be equal to?	BT-4	Analyze
9	Determine the reinforcement to be provided in a square column subjected to uniaxial bending with the following data: Size of column 450 x 450 mm Concrete mix M 25 Characteristic strength of steel 415 N/mm² Factored load 2500 kN Factored moment 200 kN.m Arrangement of reinforcement: (a) On two sides (b) On four sides Assume moment due to minimum eccentricity to be less than the actual moment. Assuming 25 mm bars with 40 mm cover.	BT-5	Evaluate
10	Determine the reinforcement to be provided in a circular column with the following data: Diameter of column 500 mm Grade of concrete M20 Characteristic strength 250 N/mm² Factored load 1600 kN Factored moment 125 kN.m Lateral reinforcement: (a) Hoop reinforcement (b) Helical reinforcement	BT-5	Evaluate
11	Design the required reinforcements in a column of 400 mm x 600 mm size subjected to a characteristic axial load of 2000 kN. The column has an unsupported length of 3 m and is braced against the sidesway in both dimensions. Use M20 concrete and Fe-415 steel.	BT-5	Evaluate
12	Determine the cross-section and reinforcement for an axially loaded column with following data Factored load = 2000 kN Concrete grade = M20 Characteristic strength of steel = 415 N/mm² Unsupported length of column = 3 m	BT-3	Application

13	A column of size 300 mm x 400 mm has effective length of 3.6 m and is subjected to a factored load of 1100 kN and a factored moment of 150 kNm about the major axis. Design the column using M25 concrete and Fe-415 steel. Adopt limit state method.	BT-3	Application
14	Design the reinforcement required for a circular column of 450 mm dia subjected to a factored load of 1000 kN and a factored moment of 100 kN.m M20 grade concrete and Fe-415 steel were used. Assume $d'/D=0.10$.	BT-4	Analyze
15	A short column located at the corner of a multistoried building is subjected to an axial factored load of 2000 kN together with factored moments of 75 kN.m and 60 kN.m acting in perpendicular planes. The size of the column is 450 mm x 450 mm. Design suitable reinforcements in the column section. Adopt M20 grade concrete and Fe-415 grade steel.	BT-4	Analyze
16	Determine the reinforcement to be provide in a short column subjected to biaxial bending with the following data: Size of column = 45cm x 60cm Concrete mix = M25 Characteristic steel strength = 500MP _a Factored load $P_u = 3300\text{kN}$ Factored moment acting parallel to larger dimension $M_{ux} = 150\text{kN.m}$ Factored moment acting parallel to smaller dimension $M_{uy} = 100\text{kN.m}$ Moments due to minimum eccentricity are less than the value given above. Reinforcement is distributed equally on four sides.	BT-4	Analyze
17	Verify the adequacy of the short column section 500 mm x 300 mm under the following load conditions: $P_u = 1400\text{ kN}$, $M_{ux} = 125\text{ kNm}$, $M_{uy} = 75\text{ kNm}$. The design interaction curves of SP 16 should be used. Assume that the column is a 'short column' and the eccentricity due to moments is greater than the minimum eccentricity.	BT-3	Application
18	Deduce the ultimate load the column can carry having 6# 16 mm diameter bars and diameter of column is 380 mm. Both ends held in position and restrained against rotation. Unsupported length = 3m. Find the ultimate load for the following conditions a) Circular tie column b) Spiral tie of 8 mm @ 75 mm pitch	BT-4	Analyze

UNIT V - LIMIT STATE DESIGN OF FOOTINGS

Concept of column footing - Design of wall footing – Design of axially and eccentrically loaded Square, Rectangular and sloped footings – Design of Combined Rectangular and Trapezoidal footing for two columns - Principles of design of mat foundation.

PART – A

Q. No.	Questions	BT Level	Competence
1.	What are the factors that influence the selection of number of lifting and hoisting locations of a long beam during its erection process?	BT-1	Remember
2.	Define punching shear.	BT-1	Remember

3.	Brief the concept of proportioning of footing.	BT-1	Remember
4.	Tell me when rectangular, trapezoidal and strap footings are preferred?	BT-1	Remember
5.	What do you mean by eccentric footing?	BT-1	Remember
6.	Classify the different types of combined footing.	BT-2	Understand
7.	Enlist the different condition for usage of footing.	BT-1	Remember
8.	Discuss about Pad footing.	BT-3	Application
9.	What are the factors governing to decide the depth of footing?	BT-1	Remember
10.	On what circumstances combined rectangular footings are suitable?	BT-1	Remember
11.	Draw a neat sketch of a wall footing.	BT-2	Understand
12.	Sketch the placement of steel in rectangular footing with a non-central load.	BT-2	Understand
13.	Sketch the reinforcement detailing of any one footing.	BT-2	Understand
14.	Sketch the soil pressure distribution under footing for cohesive and cohesionless soil.	BT-1	Remember
15.	Sketch and show the Critical Section for Moment in Isolated Footings.	BT-1	Remember
16.	Show the critical section for shear and moment for a column footing.	BT-2	Understand
17.	Explain about eccentric loading on a footing.	BT-3	Application
18.	Why punching shear is not encouraged in design of footing?	BT-1	Remember
19.	Why dowel bars are provided in footing?	BT-1	Remember
20.	List any two situations in which combined footings are preferred to isolated footings	BT-1	Remember
21.	Under what the circumstances a trapezoidal footing becomes necessary?	BT-1	Remember
22.	Define mat foundation.	BT-1	Remember
23.	List out the different types of footing.	BT-1	Remember
24.	Compare one way and two way shear in footing.	BT-2	Understand

PART –B

1.	Design a RC footing for 250 mm thick brick masonry wall which support a load of 200 kN/m if the SBC of the soil is 150kN/m ² . Use M20 and Fe415. Angle of repose = 30 degree and unit weight of soil is 20 kN/m ² .	BT-5	Evaluate
2.	Write down the different types of footing and their suitability.	BT-5	Evaluate
3.	Design a sloped square footing for a column of size 450 mm x 450 mm transmitting a load of 1450 kN. The column is reinforced with 4 # 20 and 4 # 25. Safe bearing capacity of the soil is 180kN/m ² . Use M 25 and Fe 415 grades of concrete and steel respectively.	BT-3	Application
4.	A circular column of 480 mm diameter transfers an axial dead load of 650 kN and an axial live load of 500 kN. The column has 8 steel bars of 18 mm		

	diameter. The safe bearing capacity of the soil is 140 kN/m ² . Design a circular footing to support the circular column. Use M20 concrete and Fe415 steel.		
5.	Design an isolated square sloped footing for a column 500 mm x 500 mm, transmitting an axial load of 1200 kN. The column is reinforced with 8 bars of 20 mm diameter. The safe bearing capacity of soil is 120 tonnes/m ² . Use M 20 concrete and Fe 415 steel reinforcement.	BT-5	Evaluate
6.	a) A square isolated footing (size :1800mm × 1800mm) is made for a square column of size 300mm×300mm to transfer the characteristic load, P=750kN to the ground. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. The bending moment due to soil reaction computed at the required section for design will be? b) Sketch the critical section for shear and moment for a column footing. c) Sketch the Critical Section for Moment in Isolated Footings.	BT-4	Analyze
7.	a) A square isolated footing (size :1800mm × 1800mm) is made for a square column of size 300mm×300mm to transfer the characteristic load, P=750kN to the ground. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. Determine the one-way shear force due to soil reaction at the required section for design. b) A square isolated footing (size :1800mm × 1800mm) is made for a square column of size 300mm×300mm to transfer the characteristic load, P=750kN to the ground. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. Determine the two-way shear force due to soil reaction at the required section for design.	BT-4	Analyze
8.	a) A square isolated footing having dimension 1500mm×1500mm is made to transfer a characteristic load, P=600kN to the ground, through a column of 350mm×350mm. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. The one-way shear force due to soil reaction at the critical section for design will be equal to b) A square isolated footing having dimension 1500mm×1500mm is made to transfer a characteristic load, P=600kN to the ground, through a column of 350mm×350mm. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of	BT-5	Evaluate

	reinforcement provided is 12mm. The two-way shear force due to soil reaction at the required section for design will be equal to c) A square isolated footing having dimension 1500mm×1500mm is made to transfer a characteristic load, $P=600\text{kN}$ to the ground, through a column of 350mm×350mm. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm. The diameter of reinforcement provided is 12mm. The bending moment due to soil reaction computed at the required section for design will be equal to		
9.	Design a rectangular isolated footing of uniform thickness for R.C. column bearing a vertical load of 600 kN, and having a base size of 400 x 600 mm. The safe bearing capacity of the soil may be taken as 120 kN/m ² . Use M 20 concrete and Fe 415 steel.	BT-5	Evaluate
10.	Design a strap footing for two column C_1 and C_2 300 mm x 300 mm carries load of 600 kN and 850 kN, respectively spaced at 5m c/c. The column C_1 is on the property line. SBC of soil is 180 kN/m ² , use M20 grade concrete and Fe415 steel.	BT-5	Evaluate
11.	A rectangular column of size 400 mm × 600 mm carries a live load of 2000 kN. The safe bearing capacity of the soil is 150 kN/m ² . Using M20 concrete and Fe415 steel, design a rectangular footing to support the column. Adopt limit state design method.	BT-5	Evaluate
12.	a) A square isolated footing for a square column of size 300mm × 300mm is made to transfer the characteristic load, $P=750\text{kN}$ to the ground. Consider weight of footing as 10% of the characteristic axial load. The safe bearing capacity of soil is 150 kN/m². What will be the dimension of the square footing? b) A square isolated footing (size :1800mm×1800mm) is made for a square column of size 300mm × 300mm to transfer the characteristic load, $P=750\text{kN}$ to the ground. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. Determine the soil reaction for limit state design.	BT-4	Analyze
13.	a) An isolated footing of size 2000mm × 3000mm is made to transfer the characteristic load, $P=800\text{kN}$ to the ground. Consider weight of footing as 10% of the characteristic axial load. What will be the safe bearing capacity of soil? b) A rectangular isolated footing of size 2000mm × 3000mm is made to transfer the characteristic load, $P=750\text{kN}$ and $M=50\text{kNm}$ to the ground. Consider weight of footing as 10% of the characteristic axial load. What is the minimum pressure developed under foundation? c) A rectangular isolated footing of size 2000mm × 3000mm is made to transfer the characteristic load, $P=750\text{kN}$ and $M=50\text{kNm}$ to the ground. Consider weight of footing as 10% of the characteristic axial load. Take longer dimension along the plane of action of the moment. The maximum pressure under foundation developed will be?	BT-4	Analyze

14.	Write the step by step design procedure for circular footing.	BT-3	Application
15.	Write the step by step design procedure for trapezoidal combined footing	BT-3	Application
16.	Write the step by step design procedure for rectangular combined footing.	BT-3	Application
17.	Write the step by step design procedure for strap footing.	BT-3	Application
18.	Design a combined footing for two columns at a multistorey building. The columns of size 400 mm × 400 mm transmit a working load of 500 kN each, and they are spaced at 5 m centres. The safe bearing capacity of the soil at site is 200 kN/m ² . Adopt M20 grade concrete and Fe415 grade steel. Sketch the details of reinforcements in the combined footing.	BT-5	Evaluate

