[3 hrs] **[80 marks]**

N. B. (1) Question No. **1** is **compulsory**.
(2) Solve any **three** questions from remaining questions.
(3) Assume suitable data wherever required and state them clearly.
(4) Use of IS 456 not permitted.

1. (a) What are partial safety factors for load and material strength? What is their significance in limit state method of design? **4**

   (b) Compute the area of reinforcement required for a balanced section of width 200 mm and effective depth 425 mm as per limit state design. Use M 25 grade concrete and Fe 415 grade steel. **4**

   (c) What are the functions of longitudinal and transverse reinforcement in columns? **4**

   (d) Explain the concept of effective flange width for analysis and design of T beams **4**

   (e) Explain one way shear and two way shear in footings. **4**

2. (a) A reinforced concrete beam section of size 250 x 500 mm (overall depth) is reinforced with 4 bars of 20 mm diameter on the tension side at an effective cover of 30mm. Determine the concentrated load that the beam can support at the centre on an effective simply supported span of 5m. The grades of concrete and steel used are M20 and Fe 415 respectively. **10**

   (b) Design a reinforced concrete beam with its size restricted to 200 x 400 mm deep overall due to architectural considerations. The beam is subjected to a maximum factored moment of 180kNm at the midspan. Adopt M 20 concrete and Fe 415 steel at an effective cover of 35 mm **10**

d' / d	**0.05**	**0.10**	**0.15**	**0.20**
f_{sc} (N/mm^2)	**355.1**	**351.9**	**342.4**	**329.2**

3. (a) Draw Whitney's Stress block and hence determine the ultimate moment of resistance of a beam 300 mm wide and 500mm deep considering it as a balanced section. Take σ_{cu} = 20 N/mm^2 and σ_{sy} = 425 N/mm^2. **05**

   (b) Design a combined footing for two columns of a multi-storey building. The columns are of sizes 400mm x 400mm, transmit a working load of 300 kN each and they are spaced at 5m c/c. The safe bearing capacity of 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. **15**

4. (a) A R.C. beam 250 mm x 450 mm effective depth is subjected to an ultimate moment of resistance of 225 kN-m. Calculate the steel reinforcement required for the beam. Assume σ_{cu} = 20 N/mm^2 and σ_{sy} = 425 N/mm^2. Use Ultimate Load Method. **10**

   (b) A rectangular R.C beam 300mm x 400 mm deep is subjected to an ultimate torsional moment of 6 kNm, ultimate BM of 40kNm and ultimate shear force of 80kN. Design the torsion reinforcement if the grades of concrete and steel are M 20 and Fe 415 respectively. Assume effective cover to reinforcement as 40mm **10**

p_t	≤0.15	0.25	0.50	0.75	1.0	1.25	1.50	1.75	2.00
τ_c	0.28	0.36	0.48	0.56	0.62	0.67	0.72	0.75	0.79

5. (a) Design a slab on a hall of size 3 m x 5 m effective. The slab is simply supported on 230 mm wall on all four sides. Consider LL 4 kN/m^2 and floor finish 1 kN/m^2. Assume M 20 grade of concrete and Fe 415 steel **12**

Ly/Lx	1.1	1.2	1.3	1.4	1.5	1.75	2.0
α_x	0.074	0.084	0.093	0.099	0.104	0.113	0.118
α_y	0.061	0.059	0.055	0.051	0.046	0.037	0.029

   b) Design a reinforced concrete T beam section with the following dimensions: **8**
   Width of flange = 1250mm
   Thickness of flange = 110 mm
   Width of rib = 275mm
   Effective depth of beam = 550 mm.
   The beam is subjected to a factored moment of 475kNm. Use concrete of grade M 20 and steel of grade Fe 415.

6. (a) A rectangular column of dimensions 250 mm x 500 mm is subjected to an ultimate axial load of 1200kN. Design an isolated footing for the column assuming safe bearing capacity of soil to be 210 kN/m^2. Adopt grade of concrete M 20 and grade of steel Fe 415. **12**

   (b) Design a short square column subjected to a factored load of 2000kN. Adopt grade of concrete M 20 and steel Fe 415. **8**

Values of (k) for Solid Slabs

Overall Slab Depth (mm)	≥ 300	275	250	225	200	175	≤150
(k)	1.00	1.05	1.10	1.15	1.20	1.25	1.30

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