Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(CE-(O))/SEM-4/CE-405/2012

2012

STRUCTURAL DESIGN-I

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) Minimum grade of concrete to be used in reinforced concrete as per IS 456 – 2000 is

a) M 30 b) M 25

c) M 20 d) M 15.

ii) In beams of effective depth '*d*' the longitudinal spacing of vertical stirrups for shear should not be more than

a) *d*/2 b) (3 / 4) *d*

c) 300 mm d) smaller of (b) & (c).

iii) A simply supported beam of 6 m effective span has to be designed with Fe 415 grade reinforcing bars and M 20 grade concrete. From vertical deflection consideration, the ratio of effective span (l) to minimum effective depth (d) before multiplication by modification factors may normally be taken as

a) 26 b) 20

c) 7 d) none of these.

iv) The limits of percentage of longitudinal reinforcenment in a column is

a) 0·15% – 0·96% b) 0·2% – 0·8%

c) 0·8% – 6·0% d) 0·8% – 8·0%.

v) Other things remaining more or less same, the quantity of mixing water per 50 kg of cement will have a minimum value for concrete mix

a) M 30 b) M 25

c) M 20 d) M 15.

vi) Concrete cover for longitudinal reinforcing bars in a beam under moderate exposure condition shold not be less than

a) 30 mm

b) diameter of bar

c) larger of (a) and (b)

d) 5 mm more than maximum nominal size of aggregate.

vii) Maximum diameter of reinforcing bars in a slab of 128 mm overall depth should not exceed

a) 8 mm b) 10 mm

c) 12 mm d) 16 mm.

viii) Lateral spacing of parallel main reinforcing bars in a slab of 90 mm effective depth should not be more than

a) 270 mm b) 300 mm

c) 450 mm d) none of these.

ix) Maximum flexural compressive strain at the outermost layer in a reinforced concrete beam under limit state of collapse is

a) 0·35 b) 0·035

c) 0·02 d) 0·0035.

x) Uniformly distributed live load on stairs of dwelling houses is generally taken as

a) 1 kN/m^2 b) 2 kN/m^2

c) 3 kN/m^2 d) 4 kN/m^2 .

xi) Total maximum deflection in a reinforced concrete beam of span 6 m should not be greater than

a) 24 mm

b) 30 mm

c) 50 mm

d) none of these.

xii) Minimum percentage of longitudinal tensile reinforcement of Fe 415 grade steel in a beam is about

a) 0.002% b) 0.2%

c) 2.0% d) none of these.

xiii) The ratio of the characteristic strength of reinforcing steel to its ultimate design strength in limit state method of design is called

a) design strength factor

b) factor of safety

c) partial safety factor for material strength

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What is meant by "Balanced section" in limit state method of design for flexure ? Show the distribution of stress and strain along the depth of a rectangular balanced reinforeced concrete section. Also show that the ratio of balanced depth of neutral axis in a rectangular beam with M 20 concrete and Fe 415 steel to the effective depth of the section is approximately equal to 0.48.

3. Define 'Limit State' of a structure. What are the different limit states ? Why the working stress method of design is considered as less rational than limit state method of design ?

4. A reinforced concrete one-way slab is 130 mm thick, the centre of main reinforcement being 25 mm from the bottom. The reinforcement consists of 10 Φ Fe 415 grade steel bars placed at 100 mm c/c. Find the safe moment of resistance per metre width of the slab section under working load condition either by working stress method or by limit state method of design.

5. A reinforced concrete rectangular beam, 250 mm × 500 mm overall depth, has an effective cover of 50 mm to the centre of reinforecement. What will be the balanced ultimate moment of resistance of this section and the corresponding area of steel if the beam has M 20 concrete and Fe 415 grade of steel. Find the necessary area of steel to resist an ultimate (factored) bending moment of 190 kN by this section.

6. A simply supported rectangular beam, 250 mm × 550 mm overall depth, has a clear cover of 30 mm for its bottom tensile reinforecement. At support the beam has 3-20 Φ Fe 415 grade steel bars. The beam has a factored uniformly distributed load of 100 kN/m over an effective span of 6.5 m. Is this section adequate for resisting the maximum shear developing at the critical section of the beam if the grade of concrete is M 20 ? Design for shear reinforecement for the beam near at the support.

7. Find the ultimate moment of resistance of the T-beam having the following sectional properties :

   Width of flange = 1100 mm, Thickness of flange = 100 mm, Width of rib = 250 mm, Effective depth = 600 mm, Area of steel = 2000 mm^2. Assume M 20 grade concrete and Fe 415 grade steel.

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. Design a simply supported rectangular reinforced concrete beam of 6 m effective span if the beam has to carry a factored live load of 50 kN/m. Use M 20 grade of concrete & Fe 415 grade of steel bars. The ratio of effective depth-to-width may be assumed approximately as 2.

9. An office floor slab panel has the following data :

   Size of office room : 4.2 m × 6.3 m clear dimensions.

   Edge condition : supported by 250 mm wide monolithically cast beams with only one discontinuous longer edge.

   Provision of future partition walls, floor finish & celiling plaster : 1.75 kN/m^2.

   Materials : M 20 concrete and Fe 415 steel.

   Live load : 3 kN / m^2

   Design the slab & draw neat sketch of a plan showing details of torsional and flexural reinforcements and also a section along the shorter direction of the slab.

10. A 3-span continuous one-way slab with clear span of 3.25 m each is supported on 250 mm wide RC beams. The slab is subjected to a live load of intensity 3.5 kN/m^2 and a dead load of 1.25 kN/m^2 due to floor finish, ceiling plaster & partition etc. excluding the self weight of the slab. Design the slab for flexure by using co-efficients as per IS-456. Use M 20 concrete & Fe 415 grade of steel. Assume mild exposure conditon. Show details of reinforecement for first two spans in a section taken along the direction of the span.

11. A rectangular reinforced concrete column of braced frame has a clear unsupported length of 4 m along all four faces. The column has a total axial load of 1900 kN under working load condition. The effective length of the column can be assumed to be 0.75 times the unsupported length about both axes. Use M 20 concreate and Fe 415 grade steel to design the rectangular column section where one dimension of this section is fixed at 450 mm. Show details of longitudinal and transverse reinfrocement in a neat sectional sketch of the column.

12. Design a square footing for a column, 300 mm × 300 mm in cross-section, to carry an axial working load of 850 kN. The column has 8-20 mmΦ HYSD longitudinal bars with 8 mm ties @ 200 mm C/C. The soil under the footing has a bearing capacity of 120 kN/m^2. Use M 20 grade of concrete, Fe 415 grade of steel and partial safety factor for load of 1.5 under limit state of collapse.

13. Design a dog-legged staircase having clear dimensions 2.6 m × 4.8 m in plan for a R.C. framed residential building having floor to floor height of 3 m. Assume live load of 3 kN/m^2, 250 mm × 250 mm RC columns at four corners of the stair room with 250 mm wide beams and 250 mm thick walls. Use M 20 concrete and Fe 415 grade of reinforcing bars. Show the reinforcement details in a section of an intermediate flight.