Sample Question Paper
'I' – Scheme

Programme name : Civil Engineering
Programme code : CE/CR/CS
Semester : Sixth
Course Title : Advanced Design of Structures
Marks : 70

22607

Duration: 4 Hours

Instructions:
(1) All questions are compulsory.
(2) Illustrate your answers with neat sketches wherever necessary.
(3) Figures to the right indicate full marks.
(4) Assume suitable data if necessary.
(5) Preferably, write the answers in sequential order.

Q.1.Attempt any FIVE of the following. (10 Marks)
   a. List two types of steel sections used as a tension member and show it on the neat sketches.
   b. List two end conditions of column along with their equivalent length.
   c. Write B. I. S. specifications for effective flange width of T and L beam.
   d. State four categories of stairs from design point of view.
   e. State effective span of stairs without stringer beams for two cases with neat sketch.
   f. Draw the diagram showing distribution of loading on stairs with open walls, where spans partly crossing at right angles.
   g. List types of columns as per slenderness ratio.

Q.2 Attempt any Three of the following. (12 Marks)
   a) A tension member consists of 2 ISA 100 x100 x 10 mm connected back to back at same face of gusset plate. Calculate its net area if 20 mm diameter bolts are used for the connection.
   b) A T beam has flange width of 1.5 m and an effective depth of 600 mm. The slab thickness is 100 mm and the breadth of web is 300 mm. The beam is reinforced on tension side only with total steel area 4500 mm^2. Calculate the limiting moment of resistance, if concrete grade M20 and steel grade Fe415 are used.
   c) A circular column 500 mm in diameter is provided with six bars of 20 mm diameter. Calculate the working load carrying capacity if Fe415 steel and M20 concrete are used. Check the column for minimum eccentricity if effective length is 3 m.
   d) A 4 m high column is effectively held in position at both ends and restrained against rotation at one end. If the diameter of the column is restricted to 400 mm, calculate the reinforcement to carry a factored axial load of 1900 kN. Use concrete grade M20 and steel grade Fe415.

Q.3) Attempt any Two of the following. (12 Marks)
   a) A tension member consists of two angles 75 x 50 x 6 mm which are provided on either sides of a 10 mm thick gusset plate. 20 mm diameter bolts of grade 4.6 are used in one row for connecting the member to the gusset plate. Calculate the design tensile strength of member and number of bolts required to carry design tensile strength.
   b) Design a tension member to carry an axial service load of 210 kN. Double angle section with gusset plate in between is to be used. Bolts of 16 mm diameter and 4.6 grade are to be used. Angle sections are available as per following table:

Size of angles	Cross section area in mm^2
65 x 65 x 6	744
70 x 70 x 6	806
80 x 80 x6	929
70 x 70 x 8	1058

c) A single angle section 90 x 90 x 8 mm is used as a strut. The center to center distance between intersection points at each end is 2.75 m. Calculate the design strength of the strut if it is effectively held in position but not restrained against rotation at both ends. Two bolts are provided at each end.

Q.4) Attempt any Two of the following. (12 Marks)

a) A discontinuous double angle strut is composed of two ISA 90 x 60 x 8 mm connected to a gusset plate of 10 mm thickness. The length of the strut from center to center of fastenings is 3 m. Calculate its design strength when the longer legs of angles are connected on either side of the gusset plate.

b) Design a principal rafter of a roof truss carrying a service load of 200 kN in compression and having center to center length of 2.36 m between the joints. The thickness of gusset may be taken as 10 mm. Angle sections are available as per following table:

Size of angles	A (mm^2)	r_{xx} (mm)	I_{yy} (mm^4)	C_{xx} (mm)	C_{yy} (mm)
90 x 60 x 8	1137	28.4	32.4 x 10^4	29.6	14.8
80 x 50 x 10	1202	24.9	74.7 x 10^4	28.1	13.2
90 x 60 x 10	1401	28.1	110.9 x 10^4	30.4	15.5

c) A rectangular beam of 300 mm x 600 mm (overall) has been reinforced with 4 bars of 16 mm diameter and 5 bars of 20 mm diameter respectively on compression and tension sides. Cover on both sides is 35 mm. Calculate its moment of resistance if M15 grade of concrete and grade I steel are to be used.

Q.5) Attempt any Two of the following. (12 Marks)

a) A beam 300 mm x 600 effective is subjected to a factored moment of 320 kNm at some section. Calculate area of steel required for the beam. Assume d' as 30 mm. Use M15 grade concrete and Fe415 steel. Use following table for f_{sc} calculation:

Ratio d'/d	0.05	0.10	0.15
f_{sc} in MPa	355	333	342

b) A doubly reinforced beam 230 x 600 mm (overall) has to carry a factored moment of 150 kN.m. Calculate the amount of steel required on compression side and tension side, if cover on both sides is 40 mm. Use M15 concrete and grade I mild steel.

c) Calculate the area of reinforcement in a singly reinforced flanged beam having following data: (i) clear span = 6 m, (ii) center to center distance = 6.45 m, (iii) spacing of T beam ribs = 2.75 m, (iv) live load on slab = 40kPa, (v) slab thickness = 100 mm, (vi) concrete grade = M15, (vii) steel grade = Fe250

Q.6) Attempt any Two of the following. (12 Marks)

a) Calculate the ultimate moment of resistance of a T beam having following data : (i) width of flange 1.5 m, (ii)depth of flange = 100 mm, (iii) depth of beam = 600 mm, (iv) width of rib = 300 mm, (v) A_{st} = 3000 mm^2, (vi) effective cover = 60 mm Concrete grade M15 and steel grade Fe415 is to be used.

b) Design a dog legged stair case for residential building having following details:
(i) floor to floor distance = 3.30 m, (ii) staircase hall 3 m x 4.5 m, (iii) live load = 3 kPa, (iv) Concrete grade = M20, (v) Steel grade = Fe45,(vi) M. Factor =1.60

c) Design an isolated uniform depth square footing for a square column of 300 mm side carrying an axial load of 800 kN. Safe bearing capacity of soil is 200 kPa. Use M20 concrete and Fe415 steel. Check for two way shear may not be taken.

$$f_{cd} = \frac{\dfrac{f_y}{\gamma_{m_0}}}{\phi + \sqrt{\phi^2 - \lambda^2}} = \frac{\chi f_y}{\gamma_{m_0}} \leq \frac{f_y}{\gamma_{m_0}}$$

$$\phi = 0.5\,[1 + \alpha\,(\lambda - 0.2) + \lambda^2]$$

$$\lambda = \sqrt{\frac{f_y}{f_{cc}}} = \sqrt{\frac{f_y \left(\dfrac{kL}{r}\right)^2}{\pi^2 E}}$$

$$\varkappa = \frac{1}{\phi + \sqrt{\phi^2 - \lambda^2}}$$

$$\lambda_e = \sqrt{k_1 + k_2\,\lambda_{vv}^2 + k_3 \lambda_\phi^2}$$

$$\lambda_{vv} = \frac{\left(\dfrac{l}{r_{vv}}\right)}{\varepsilon \sqrt{\dfrac{\pi^2 E}{250}}} \quad \text{and} \quad \lambda_\phi = \frac{(b_1 + b_2)}{\varepsilon \sqrt{\dfrac{\pi^2 E}{250}} \times 2t}$$

$$T < A_n \cdot f_u$$

$$T_{dn} = \frac{T}{\gamma_{m1}} = \frac{A_n\, f_u}{\gamma_{m1}}$$

$$T_{dn} = 0.9 \frac{A_{nc}\, f_u}{\gamma_{m1}} + \beta \frac{A_{go}\, f_y}{\gamma_{mo}}$$

$$\beta = 1.4 - 0.076\,\frac{w}{t} \times \frac{f_y}{f_u} \times \frac{b_s}{L_c}$$

$$T_{db1} = \frac{A_{vg}\, f_y}{\sqrt{3} \cdot \gamma_{mo}} + 0.9 \frac{A_{tn} \cdot f_u}{\gamma_{m1}}$$

$$T_{db2} = \frac{A_{tg} \cdot f_y}{\gamma_{mo}} + 0.9 \frac{A_{vn} \cdot f_u}{\sqrt{3} \cdot \gamma_{m1}}$$

Note: Formulae must be provided in the question paper related to numericals based on design of steel tension and compression members.(As shown in above Sample Question Paper)

Programme Name : **Civil Engineering**

Programme Code : **CE/CR/CS**

Semester : **Sixth**

Course Title : **Advanced Design of Structures**

Marks : **20**   **Duration:1.15 Hours**

22607

Instructions: All questions are compulsory
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  3. Assume suitable data if necessary
  4. Preferably, write the answers in sequential order

Q.1 Attempt any FOUR.   (8 Marks)
  a) State meaning of strength due to yielding of gross section.
  b) Write the equation to determine strength due to rupture at net section along with the meaning of each term used in it.
  c) State the reason to provide built up column.
  d) State conditions where doubly reinforced section are provided.
  e) Draw cross section, strain diagram and stress diagram used in the analysis of doubly reinforced section.

Q.2 Attempt any THREE.   (12 Marks)
  a) A single unequal angle ISA 100×50×6 mm is used as a tension member connected to 8mm gusset plate with 4 nos. of 16mm diameter bolts. The bolts are pitched at 40 mm and edge distance is 30mm. Determine block shear strength. Take ultimate stress and yield stress in the angle section as 410MPa and 250MPa respectively.
  b) State the purpose of lacing and battening system and draw sketch to show double lacing system and double batten system.
  c) Calculate the moment of resistance of RCC beam of rectangular section 250mm wide and 480mm deep (overall), if it is reinforced with 4 numbers of bar of 16mm diameter on tension side and 2 numbers of bar of 16mm diameter on compression side. Assume steel grade Fe415 and concrete grade M20. Take effective cover of 40mm and use following table for f_{sc} calculation:

Ratio d'/d	0.05	0.10	0.15
f_{sc} in MPa	355	333	342

  d) Design a doubly reinforced section for rectangular beam at mid span having effective span of 4m and superimposed load of 50 kN/m. The size of the beam is limited to 250mm × 400mm (overall). Take d'=30mm, f_{sc}=350MPa. Use M20 grade concrete, Fe415 grade steel, diameter of bar on compression side as 12mm and diameter of bar on tension side as 20 mm.
  e) A single angle section 100 mm x 75 mm x 10 mm is used as a tension member of a truss. The longer leg of the angle is connected to the gusset plate with four bolts of 20 mm diameter. Calculate the net effective area of the angle.

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Q.1 Attempt any FOUR. **(8 Marks)**
  a) State the requirements to be satisfied by slab acting as compression flange in 'T' beam and 'L' beam as per IS456:2000.
  b) Write the IS 456:2000 clause regarding effective width of T-beam and L-beam.
  c) State the clause to calculate effective span of stairs spanning on to the edge of landing slab.
  d) State the condition to be satisfied by column with helical reinforcement such that its strength is 1.05 times the compressive strength of column with lateral ties. Also state meaning of each term.
  e) Draw sketch of any four types of footing.

Q.2 Attempt any THREE. **(12 Marks)**
  a) A T-beam has an ultimate moment of resistance of 340kN-m with following data: flange width =1100mm, flange thickness=1200mm, width of web=230mm, overall depth=480mm effective cover=50mm, concrete M20 grade and steel Fe415 grade. Calculate area of tension reinforcement.
  b) Design a doglegged staircase of an office building in a room measuring 2.8m×5.8m. It is subjected to live load of 3kn/m^2. Take floor to floor distance 3.6m, No. of risers =12, No. of treads =11, T=300mm, R=150 mm and width of wall = 230mm to support stairs on it provided at the end of outer edges of landing slab. Use M20 grade concrete and Fe415 steel.
  c) Design helical reinforcement for a circular column of 400mm diameter with 6-20mm diameter bars on longitudinal reinforcement. Use M25 concrete and Fe415 steel.[Co-f]
  d) A rectangular column 400mm×600mm carries ultimate load of 2500kN. The ultimate bearing capacity of soil is 225kN/m^2. Using M20 concrete and Fe415 steel, design rectangular footing to support the column for flexure.
  e) Calculate the limiting moment of resistance of a flanged concrete beam having following details: (i) width of flange 1900 m, (ii)depth of flange = 150 mm, (iii) effective depth of beam = 650 mm, (iv) width of rib = 230 mm, (v) A_{st} = 4900 mm^2, Concrete grade M20 and steel grade Fe415 is to be used.

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