B.TECH/CE/5TH SEM/CIVL 3102/2021

DESIGN OF RCC STRUCTURES
(CIVL 3102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable. Use of IS codes are allowed in the examination hall.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Structural concrete members should meet the criterion of
(a) strength (b) serviceability
(c) strength and serviceability (d) durability.

(ii) Reinforced concrete beams designed with under reinforced sections results in
(a) explosive failure (b) progressive failure
(c) failure by yielding of steel (d) failure by crushing of concrete.

(iii) The critical section for shear in a reinforced concrete beam is located at
(a) quarter span
(b) mid span
(c) at support
(d) at a distance equal to the effective depth from the support.

(iv) When there is limited space to accommodate the staircase, the ideal type to be selected is
(a) dog-legged (b) open-well
(c) spiral (d) quarter turn.

(v) Reinforced concrete columns should be designed for minimum eccentricity of
(a) 25 mm (b) 0.05 times the lateral dimension
(c) 20 mm (d) 12 mm

(vi) The minimum percentage of tension reinforcement (P_t) in a beam shall not be less than that
(a) $0.85/f_y$ (b) $85/f_y$ (c) $8.5/f_y$ (d) $0.87/f_y$

(vii) The maximum spacing of shear reinforcement measured along the axis of member shall not exceed
(a) 0.75d (b) 300 mm
(c) lesser of 0.75d and 300 mm (d) greater of 0.75d and 300 mm

(viii) The maximum bar diameter in a slab of total thickness t cannot exceed
(a) $D/8$ (b) $t/8$ (c) $8D$ (d) $8t$

(ix) When shear reinforcement is not provided, the calculated shear stress at critical section shall not exceed
(a) $1.5\ k_s\tau_c$ (b) $1.25\ k_s\tau_c$
(c) $k_s\tau_c$ (d) $0.5\ k_s\tau_c$

(x) If effective span of the slab is 4m, then the width of each edge strip is
(a) $500\ mm$ (b) $550\ mm$
(c) $3000\ mm$ (d) $1000\ mm$.

Group – B

2. (a) Analyse a rectangular beam section of 300 mm width and 500 mm effective depth to determine the ultimate moment of resistance for tension reinforcement 4 × 12 mm Φ. Consider concrete of grade M20 and steel of grade Fe415. [(CO1, CO2, CO4)(Analyse/IOCQ)]

(b) A rectangular beam section of 300 mm width and 500 mm effective depth is reinforced with 4 × 12 mm Φ tension bars. Evaluate the stresses induced in the top compression fibre of the concrete and steel when it is subjected to a moment of 50 kNm. Consider concrete of grade M20and steel of grade Fe415. [(CO1, CO2, CO4)(Evaluate /HOCQ)]

6 + 6 = 12

3. (a) Evaluate the area of reinforcement required for a singly reinforced concrete section having a breadth of 300 mm and overall depth of 535 mm to resist a factored moment of 150 kN m. Adopt f_{ck}=20N/mm^2 and f_y=415N/mm^2. Illustrate the cross section of the beam. [(CO1, CO2, CO4) (Evaluate/HOCQ)]

(b) A reinforced concrete beam of rectangular section 250 mm wide by 500 mm deep has a clear span of 5.5 m. The beam has 2-20 mm Φ bars going into the support. Factored shear force is 140 kN, using f_{ck} = 20 N/mm^2 and fy = 415 N/mm^2, Illustrate the development length requirement at the junction of column and beam. [(CO1, CO2, CO4) (apply/IOCQ)]

6 + 6 = 12

Group – C

4. (a) Evaluate the flexural and shear reinforcement for a factored bending moment of 115 KNm and factored shear force of 65 KN for a singly reinforced rectangular beam of effective depth 435 mm and width 230 mm. Assume M 25, Fe 500. [(CO3, CO4) (Analyze/IOCQ)]

(b) Classify T beams as per IS code provisions. Calculate the moment of resistance T beam section having the following details:
Width of flange, b_f=700 mm, effective depth d=325 mm, width of web, b_w=250mm, A_{st}= 5nos.20 mm # bars, thickness of flange, D_f = 95 mm assume grade of concrete M20 grade, grade of steel Fe 415. [(CO3, CO4)(Analyze/IOCQ)]

6 + 6 = 12

5. (a) Outline the differences between one way and two way slab based on IS code 456:2000 recommendation. [(CO3, CO4) (Understand/LOCQ)]
   (b) Design and detail a two way slab simply supported on all four edges with clear span 4.0 m, wall thickness 230 mm, live load intensity 4 KN/sq.m, assume floor finish = 1.5 kN/sq.m, Grade of concrete M 20, grade of steel Fe 415. [(CO3, CO4, CO6) (Create/HOCQ)]

4 + 8 = 12

Group – D

6. Design one of the flights of a dog-legged stairs spanning between landing beams using the following data.
   Type of staircase: Dog-legged with waist slab, treads and risers.
   Number of steps in the flight=10
   Tread T=300 mm
   Rise R=150 mm
   Width of flight=landing width=1.25 m
   Live load=5.0 kN/m^2
   Floor finish load=0.6 kN/m^2
   Width of landing beams =300 mm
   M20 grade concrete and Fe 415 HYSD bars are used.
   [(CO2, CO3, CO4, CO6) (Create/HOCQ)]

12

7. Design the reinforcement in a short column 400 mm × 400 mm at the corner of a multi-storeyed building to support an axial factored load of 1500kN, together with biaxial moments of 50 kN m acting in perpendicular planes. Adopt M20 grade concrete and Fe415 HYSD bars. [(CO1, CO3, CO4) (create/HOCQ)]

12

Group – E

8. (a) Illustrate with a flow chart the various losses in prestressed concrete. Describe in brief the advantages of prestressing. [(CO1, CO5) (Apply/IOCQ)]
   (b) Describe in brief the various types of analysis of prestressed concrete member at transfer and under service loads. [(CO5) (Understand/LOCQ)]

6 + 6 = 12

9. (a) Illustrate the different types of footings with figures. [(CO1) (Apply/IOCQ)]
   (b) Design an isolated footing for a column, 300 mm × 400 mm, subject to a factored axial load P_u=600 kN at the column base. The Safe bearing capacity of soil may be taken as q= 150 kN/m^2 at a depth of 1.5 m. Unit weight of soil = γ_s=19 kN/m^3. The angle of repose =φ =30˚. Use M 25 concrete and Fe 500 steel for the footing. [(CO3,CO4) (Create/HOCQ]

3 + 9 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	14.28%	42.86%	42.86%

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand material properties and design methodologies for reinforced concrete structures.
2. Assess different type of loads and prepare layout for reinforced concrete structures.
3. Identify and apply the applicable industrial design codes relevant to the design of reinforced concrete members.
4. Analyse and design various structural elements of reinforced concrete building like beam, slab, column, footing, and staircase based on both strength and serviceability criteria.
5. Understand the basic concept and mechanical behaviour of prestressed concrete.
6. Prepare structural drawings and detailing and produce design calculations and drawing in appropriate professional format.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
CE & SEC A	https://classroom.google.com/w/NDA0ODQ1OTA1MDcy/t/all
CE & SEC B	https://classroom.google.com/w/NDA0ODQ1OTA1MjU3/t/all