

CIVIL ENGINEERING

Paper—I

Time : Three Hours

Full Marks : 300

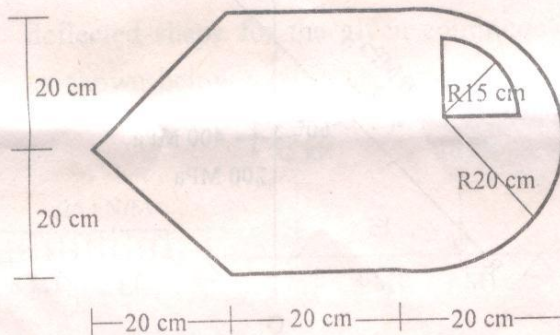
Candidates should attempt Question No. 1 from Section-A and Question No. 5 from Section-B which are compulsory, and any **THREE** of the remaining questions, selecting at least **ONE** from each Section.

All questions carry equal marks.

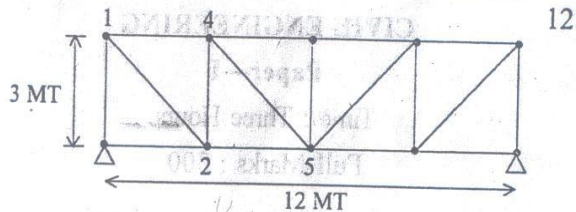
SECTION—A

1. Answer any **FIVE** of the following :—

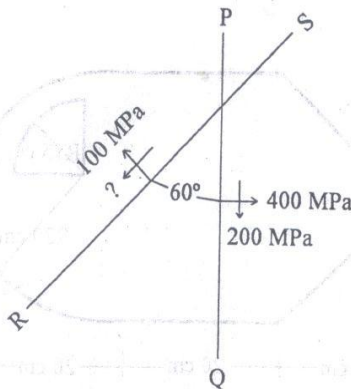
- (a) Find out the moment of inertia about centroidal YY-axis for the plane lamina shown in Fig. 12



- (b) Draw influence line diagram for members 1-2, 2-4 and 4-5 in given N truss as shown below :



- (c) A thin spherical shell 1 m in diameter with its wall of 12 mm thickness is filled with a fluid at atmospheric pressure. What intensity of pressure will be developed in it, if 175 cm^3 more of the fluid is pumped into it ? Also calculate the circumferential stress at that pressure and the increase in diameter. Take $E = 200 \text{ GPa}$ and Poisson's ratio $= 0.3$. 12
- (d) The state of stress at a point in a strained material is shown in Fig. Determine the shear stress on plane RS, principal stresses and maximum shear stress induced in the material. 12



- (e) A closely coiled helical spring has mean diameter of 75 mm and stiffness of 80 kN/m. It has 8 coils. What is the suitable diameter of the spring wire if maximum shear stress is not to exceed 250 MN/m^2 ? What is the maximum axial load the spring can carry? Consider $G = 80 \text{ GN/m}^2$.

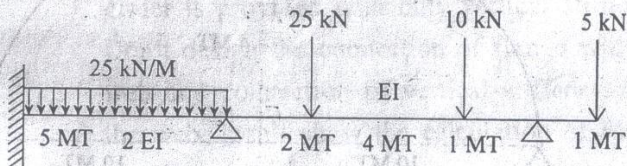
12

- (f) A horizontal line ABCD measuring 9 m is acted upon by forces of magnitude 400 N, 600 N, 400 N and 200 N at points A, B, C and D respectively with downward direction, these points are so located that $AB = BC = CD = 3 \text{ m}$. The line of action of the forces are inclined at 90° , 60° , 45° and 30° respectively with AB. Make calculations for the magnitude, position and direction of the resultant with point A.

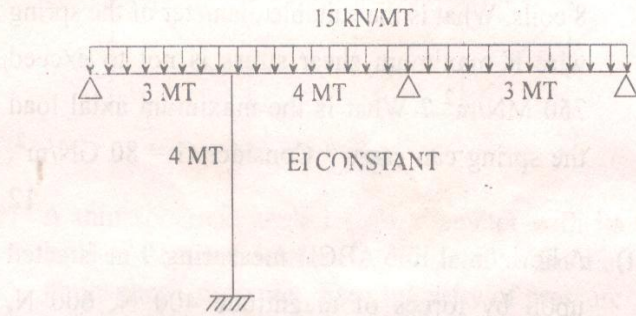
12

2. (a) Draw Shear Force, Bending Moment diagram and deflected shape for the given continuous beam as shown below :

20

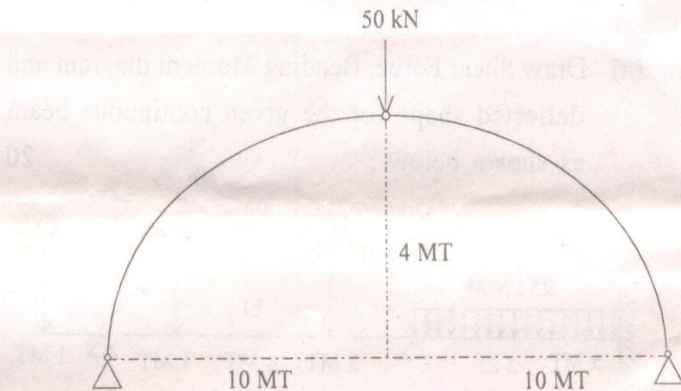


- (b) Draw BM diagram and deflected shape of the portal frame as shown below : 20



- (c) Three hinged Parabolic arch loaded and supported as shown below. Calculate the followings :—

- (1) Resultant Reactions.
 - (2) Draw bending moment diagram and deflected shape with all required points on the same.
- 20



3. (a) A Bridge Compression member carries a load of 1300 kN. The effective length of member is 7.5 m. Design the member using double channels placed back to back. Also design its suitable lacing system assuming welded connection. 20
- (b) Design built up beam consisting of ISMB 400 and suitable flange plates at top and bottom to carry UDL of 50 kN/m (excluding self weight) in addition to two equispaced point loads each of 80 kN. The span of the beam is 6.0 m. Apply all checks including checks for web buckling and web crippling ($h_2 = 31.25$ mm). 20
- (c) A Simply supported welded plate girder of span 20 M carries a UDL of 60 kN/m in a distance of 10 m from the left hand support. Design, (1) the cross-section at the most critical section (i.e. flange Plate and web plate) and (2) intermediate vertical stiffeners applying all necessary checks. Consider that plate girder is provided with only vertical stiffeners. Don't design the connection of flange with the web and connection of vertical stiffeners with the web. Don't show the calculation of Flange curtailment. 20

4. (a) A dog-legged staircase for a residential flat consists of total 18 steps (risers). There is an intermediate landing of 1.2 m width at the middle and both the flights are of equal number of risers (i.e. 9). The width of the flight is 1.2 m. Design and detail the staircase. Consider $LL = 3 \text{ kN/m}^2$, $FF = 1 \text{ kN/m}^2$. Tread = 300 and Riser = 180 mm. Use M20 grade concrete and Fe415 grade steel. 20
- (b) A slab beam-type combined footing is proposed for two columns C1 and C2 spaced at 3.0 m c/c. The characteristics loads on C1 and C2 are 750 kN and 900 respectively. Both the columns are of size 400 mm $\times$ 400 mm each. The width of the footing shall not exceed 2.1 m. The allowable bearing pressure on soil at 1.8 m depth is 200 kN/m^2 . The footing materials are M20 conc. and Fe 415 Steel. Determine the plan dimensions of footing. Also design and detail the footing. 20
- (c) Design a Cylindrical circular water tank with flexible base having capacity of 5,00,000 liters resting on ground. Assume the height of water tank 5 meters including free board. Draw neat sketches showing the reinforcement in vertical wall and base of the tank. 20

SECTION-B

5. Attempt any FIVE of the following :—

- (a) Compute the power required to convert 1 litre of water per minute at a temp. of 20°C into a mist having an average drop size equal to 4×10^{-3} mm. What will be the pressure intensity inside the mist droplets ignoring the thermal effects ? 12
- (b) Derive EULER's equation of motion. 12
- (c) Give examples with sketches of gradually varied flow profiles of mild slopes and steep slopes. 12
- (d) The rise of a liquid having specific weight γ and surface tension σ in a capillary tube of diameter d is h . Find an expression for h given that h is inversely proportional to r . 12
- (e) A long plate having roughness equal to 0.01 is moving through water of kinematic viscosity equal to 10^{-2} stokes. At a point in turbulent boundary layer, the boundary shear stress is 100 N/m^2 . Find (a) thickness of laminar sub-layer (b) check if boundary is smooth or rough hydrodynamically. 12
- (f) Discuss briefly types of pumped storage plants with neat sketches. 12

6. (a) Derive NAVIER STOKES EQ. used in fluid mechanics. 20
- (b) How centrifugal pumps are classified ? Discuss performance of the centrifugal pumps by characteristics curves. 20
- (c) Two reservoir are connected by a pipeline consisting of a 400 metre long pipeline of 20 cm diameter in series with a 600 metre long pipe of 30 cm diameter. The difference in water levels between reservoirs is 8 m. If friction factor for bigger pipe is 0.01 and for smaller pipe is 0.016, find discharge accounting for all losses. Sketch hydraulic gradient and total energy lines. 20
7. (a) Differentiate between Boussinesq's and Westergaards theory for stresses below ground. Discuss Darcy's law and Terzaghi's theory of one dimensional consolidation. $8+4+8=20$
- (b) What are different types of slope failures ? What are various methods of slope stability analysis ? Discuss any one method in detail. $4+8+8=20$
- (c) Discuss the assumptions of Rankine's and Coulomb's earth pressure theories and Terzaghi's theory for determination of bearing capacity for Shallow foundation. $10+10=20$

8. (a) Discuss various types of Triaxial Shear Strength tests and under what situation they are applicable ? $10+10=20$
- (b) What are the factors which affect soil compaction ? How it is determined in the lab ? Discuss various methods of oil stabilization also. $8+4+8=20$
- (c) Describe different types of pile foundation and situations where they can be used. What is negative skin friction and its effect on pile ? $8+4+8=20$