A–JGPT–M–DJFO–A

CIVIL ENGINEERING

Paper—I

Time Allowed : Three Hours

Maximum Marks : 200

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are **EIGHT** questions in all, out of which **FIVE** are to be attempted.

Question no. **1** and **5** are compulsory. Out of the remaining **SIX** questions, **THREE** are to be attempted selecting at least **ONE** question from each of the two Sections A and B.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the answer book must be clearly struck off.

All questions carry equal marks. The number of marks carried by a question / part is indicated against it.

Answers must be written in **ENGLISH** only.

Unless other-wise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

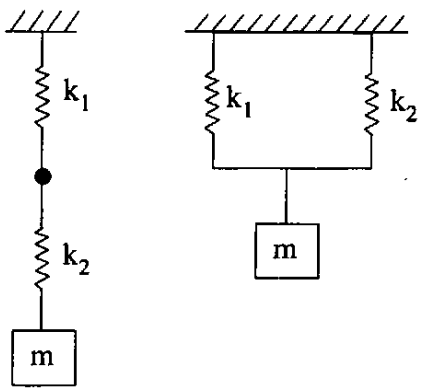
Neat sketches may be drawn, wherever required.

SECTION—A

Q. 1(a) Compute the bending moment and torsional moment diagram of the cantilever circular bow girder in the shape of quadrant of a circle of radius 2 m and carrying concentrated load (normal to plane of the structure) of 20 kN at the free end. 8

Q. 1(b) Write down the stiffness matrix of a truss member in a plane truss in member oriented axis. What will be its form for structure oriented coordinate axis ? Take L = Length of the member, A = Area of cross-section, E = Young's modulus, α = angle between member axis and structure oriented axis. 8

Q. 1(c) Find the time period of oscillations for a block of mass 'm' hangs as shown in Fig. 1 and 2. 4+4



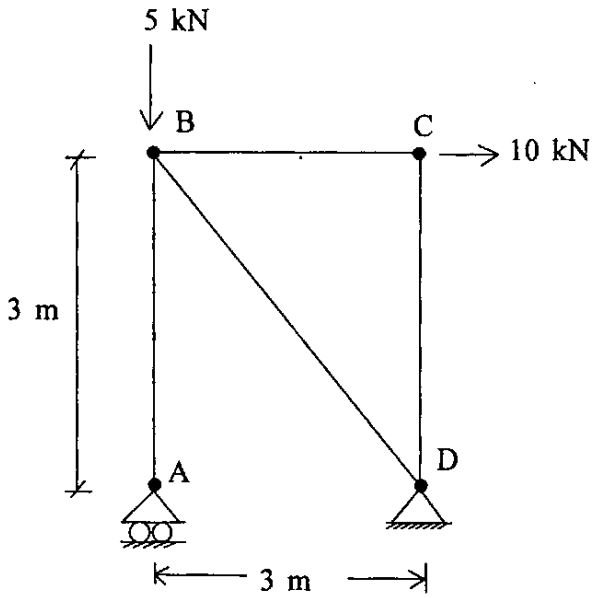
Q. 1(d) On a soft glacial clay layer 2 m thick with 45% liquid limit, the pressure intensity was increased from 400 kPa to 800 kPa. If the original void ratio was 0.67, calculate the settlement due to this pressure increment. 8

Q. 1(e) Determine the thickness of boundary layer at the trailing edge of smooth plate of 5.0 m length and 2.0 m width. The plate is moving with a velocity of 5.0 m/sec in a stationary air. The kinematic viscosity of air is 1.5×10^{-5} m^2/s. Also determine drag force on one side of a plate if density of air is 0.125 slug/m^3. 4+4

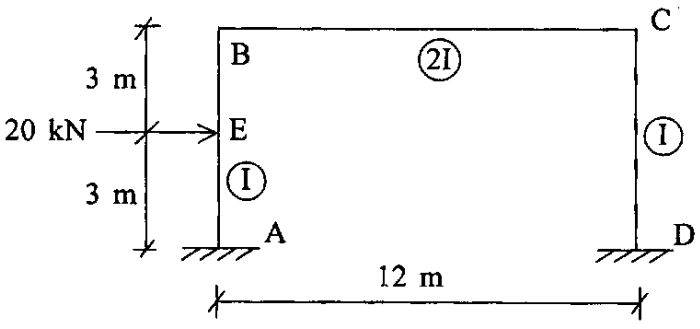
Q. 2(a) A cantilever beam of span 3 m is subjected to a vertical load of 1.0 kN at the free end. The cross-section of the beam consists of equal angles 100 mm × 100 mm × 12 mm with one of its legs placed vertically. Find the magnitude and direction of the resultant deflection. Given $I_{uu} = 329.3$ cm^4, $I_{vv} = 84.7$ cm^4, $E = 2 \times 10^5$ N/mm^2; centroidal distance = 29.2 mm. 15

Q. 2(b) A system of wheel loads 40 kN, 60 kN, 60 kN and 20 kN separated by distances 2 m, 2 m and 1 m respectively crosses a simply supported girder of 20 m span from left to right. Determine the absolute maximum bending moment in the girder. 15

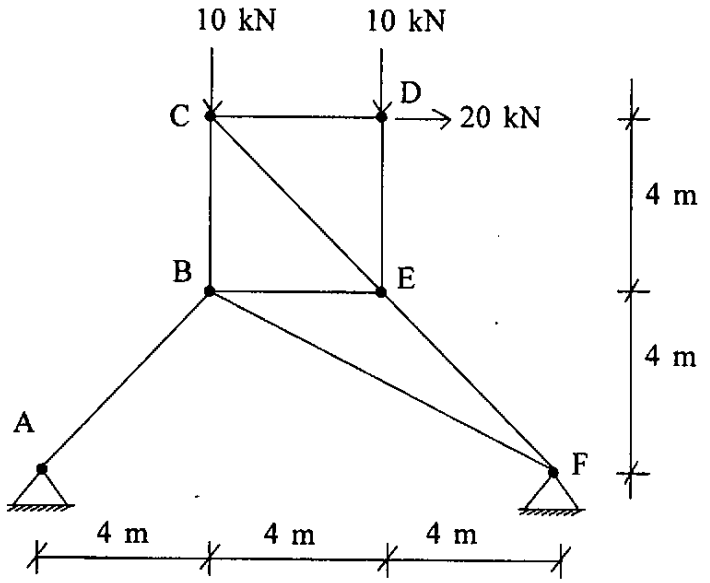
Q. 2(c) Determine the vertical displacement of the joint C of the frame as shown in Fig. Area of cross-section of each member is 850 mm^2 and E = 200 kN/mm^2. 10



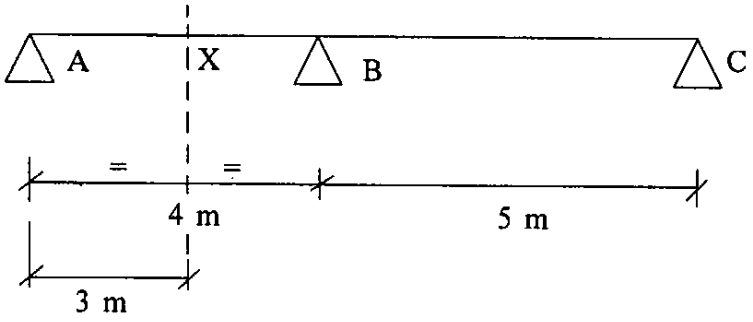
Q. 3(a) Analyse the portal frame as shown in Fig. by slope deflection method. Draw the bending moment diagram. 20



Q. 3(b) Determine the bar forces in the member CB, BE and EF of the truss as shown. 15



Q. 3(c) Draw the influence line diagram for reaction at A and shear force at X for the continuous beam as shown. (Detailed calculation is not required) 5



Q. 4(a) A prestressed Concrete Beam 200 mm wide and 300 mm deep is prestressed with wires (Area = 320 mm^2) located at a constant eccentricity of 50 mm, carrying an initial stress of 1000 N/mm^2. The span of the beam is 10 m. Calculate the percentage of loss of stress in wires when the beam is under post tensioning. Assume the following data :

E_S = 210 kN/mm^2; E_C = 35 kN/mm^2

Relaxation of steel stress = 5% of the initial stress

Shrinkage of concrete = 200×10^{-6}

Creep coefficient = 1.6, Slip at anchorage = 1 mm

Friction coefficient = 0.0015 per m. 10

Q. 4(b) Two triaxial tests are performed over a c-ϕ soil. In the first test, the cell pressure is 100 kPa and failure occurs at an additional axial stress of 450 kPa. In the second test, the cell pressure is 200 kPa and an additional axial stress of 725 kPa causes failure. Determine important soil parameters. 10

Q. 4(c) What are the desirable characteristics of Grouting in soils ? Illustrate some of the grouting methods adopted in practice. 5

Q. 4(d) A venturimeter is fitted in a 40 cms. diameter horizontal pipeline which has a throat diameter of 15 cms. The pressure intensity at the inlet is 1.4 kg/cm^2 and at the throat it is 40 cms. of mercury of vacuum pressure. Determine the flow of water. Assume 5% of differential head loss between inlet and throat. Find also the value of coeff. of discharge of venturimeter. 15

SECTION—B

Q. 5(a) The principal rafter of a steel roof truss consists of two unequal angles of 125 mm × 75 mm × 10 mm placed back to back on opposite sides of a 10 mm gusset plate with 75 mm legs turned out. The length of the rafter is 1500 mm. The purlin reactions is 20 kN and acts normal to the rafter at a distance of 600 mm from one of the nodal points. The rafter axial compressive force in the rafter is 200 kN. Check the adequacy of the section. Given the f_y = 250 N/mm^2. The following are the properties of the section

i.e. 2 $\angle^s$ 125 mm × 75 mm × 10 mm

Area A = 3804 mm^2;

I_{XX} = 6.006 × 10^6 mm^4

C_{xx} = 42.4 mm

Dead load (self wt.) = 292.3 N/m

r_{xx} = 39.7 mm

r_{yy} = 30.7 mm

(Refer to the Table-1 for Allowable Stress 'f_c' in axial compression) 8

Table-1

f_y (yield stress) = 250 N/mm^2

Slenderness Ratio (λ)	30	35	40	45	50	55
f_c-Compressive stress (N/m^2)	145	142	139	135.5	132	127

Q. 5(b) Define Mechanism. Sketch the common mechanism of failure in structures. (No explanation is needed.) 8

Q. 5(c) Determine the safe bearing capacity for a footing located at 1.5 m below ground level. The soil is silty sand and has the following properties :

C = 5 N/m^2, ϕ = 28°, γ = 18 kN/m^3, F.S. = 3

The water table may rise to the ground level. If the footing width is 2 m, find the load carrying capacity per metre.

Take N_c = 24, N_q = 14, N_σ = 16 for ϕ = 28°. 8

Q. 5(d) A semi circular channel carries uniform flow of 10.0 m^3/sec and it runs full. Consider Chezy's coeff. c = 60, bed slope = $\frac{1}{3600}$. Determine the diameter of the channel.

Also determine the cost of lining for 1.0 km long channel considering cost of lining at the rate of Rs. 800/sq.m. 8

Q. 5(e) An orifice meter having orifice diameter of 10 cms is fitted in a 200 mm dia pipe which is laid horizontally. The manometer reads 30 cms of height of mercury. Determine the discharge of oil flow of sp.gr. 0.8. Consider coeff. of discharge = 0.60. 8

Q. 6(a) Determine the bed width and depth of flow of most efficient trapezoidal channel to carry the discharge of 4.5 m^3/sec at a velocity of 1.2 m/sec. The side slopes are 1 : 1/2 (V : H). If Chezy's coeff. C = 55, determine bed slope. 10

Q. 6(b) A 40 × 20 cms venturimeter is fitted in a vertical pipe of 40 cms diameter which carries oil of sp.gr. 0.9. The difference of elevation of inlet and throat is 40 cms.

The U tube manometer reads 30.0 cms of mercury deflection.

Determine :

(i) The discharge in a pipe.

(ii) Difference of pressure between inlet and throat.

c_d of venturimeter = 0.98 and the flow is vertically upward. 15

Q. 6(c) Fig. 1 shows the section proposed for the top chord member of a Bridge truss. The effective length of the member is 4.75 m and it has to carry a maximum compressive load of 1000 kN. Investigate the safety of the member. Assume f_y = 250 N/mm^2.

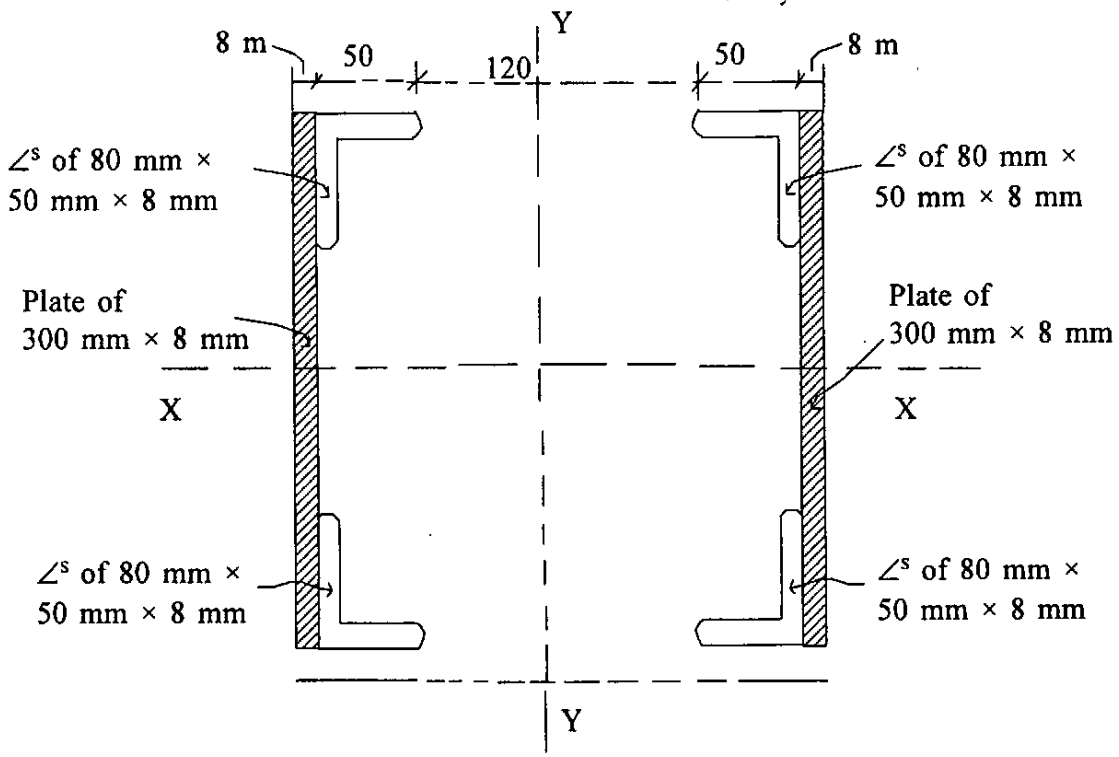


Fig. 1

Given :

Properties of the section adopted — 978 mm^2

C_{xx} = 27.3 mm; C_{yy} = 12.4 mm

$I_{XX} = 6.19 \times 10^5$ mm^4;

$I_{YY} = 1.85 \times 10^5$ mm^4. 15

Ref : Table-1 : Safe compressive stresses for steel of f_y = 250 N/mm^2

Table-1

Slenderness Ratio	35	40	45	50	55
Safe axial compressive stress (N/mm^2)	142	139	135.5	132	127

Q. 7(a) (i) Discuss the stress-strain curve of steel and its application under Plastic Analysis. 8

Q. 7(a) (ii) Prove that the shape factor for a triangular beam section as shown in Fig. 2 is 2.352. 12

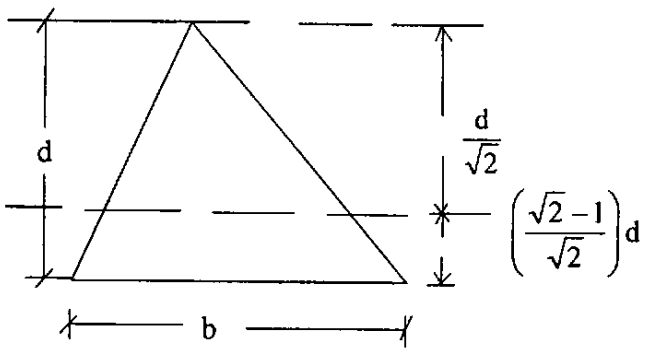


Fig. 2

Q. 7(b) A group of 9 piles, 5 m long and 200 mm in diameter, is arranged in a square form with spacing of 500 mm centre to centre. It carries a total load of 500 kN. The piles are embedded in normally loaded clay with γ_{sat} = 20 kN/m^3, LL = 40%, e = 1.05. Hard stratum is available at a depth of 7 m. Calculate the settlement of the pile group. 10

Q. 7(c) (i) Sketch the shear-stress distribution for the following sections (under pure shear) :

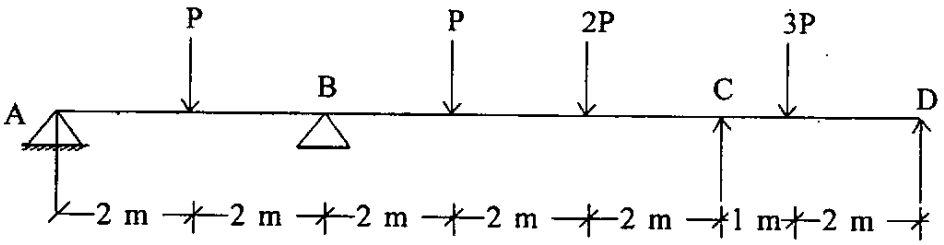
A. T-beam B. I-section. 2.5

Q. 7(c) (ii) Discuss the importance of Diagonal tension in R.C. Beams. 2.5

Q. 7(c) (iii) Explain the various components of Plate Girder. 2.5

Q. 7(c) (iv) Explain the serviceability requirements in the design of R.C. slabs. 2.5

Q. 8(a) Determine the value of 'P' at collapse of a three span continuous beam shown in Fig. The plastic moment capacity 'M_p' of the beam is constant for all spans. 20



Q. 8(b) In a 6.0 m wide rectangular channel the flow takes place at a velocity of 1.5 m/sec with a depth of 0.75 m. Determine :

(i) Critical depth.

(ii) Whether the flow is super critical or sub critical ?

(iii) The alternate depth of this depth of 0.75 m. 10

Q. 8(c) A 1.0 m diameter well is sunk to a depth of 15 m in a bed of soil with permeability of 0.1 cm/minute. The ground water table is 2 m below surface. The depth of water in the well is not to fall below 1.0 m while the drawdown at a radius of 1.0 km is to be limited to a maximum of 0.5 m. Calculate the yield of the well assuming there is no pumping and the water table is horizontal. 10

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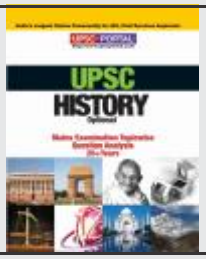

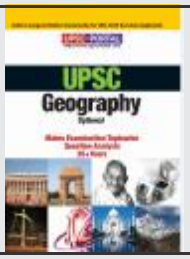

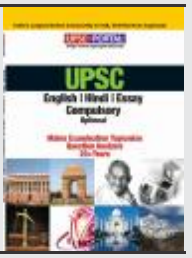

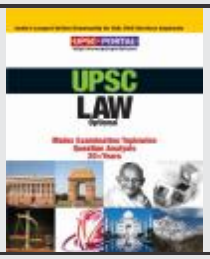

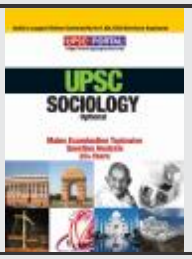

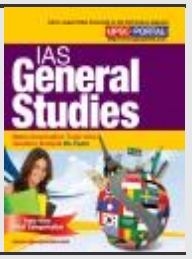

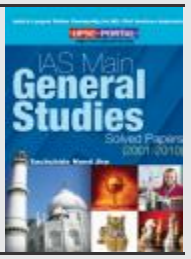

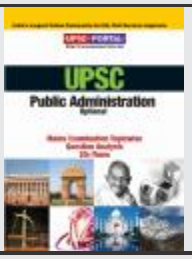

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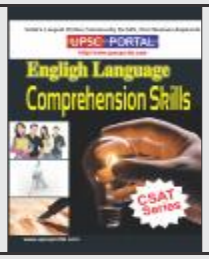

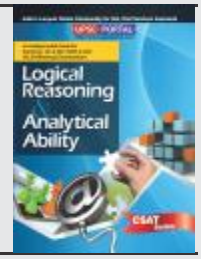

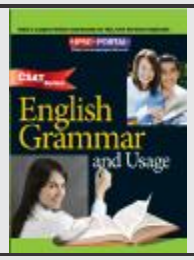

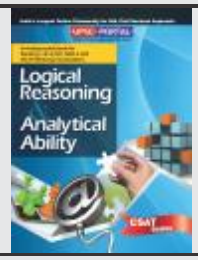

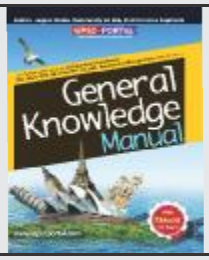

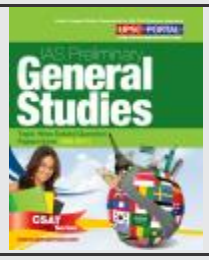

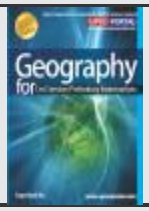

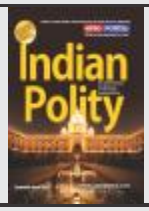

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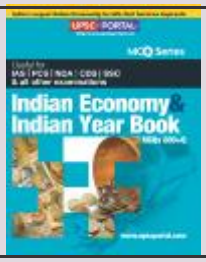

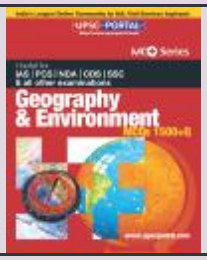

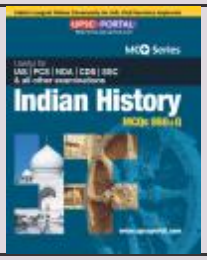

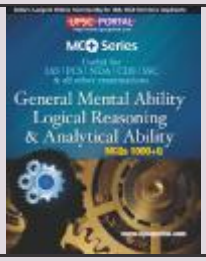

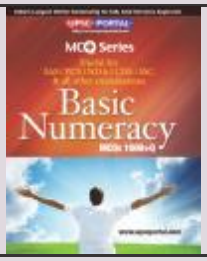

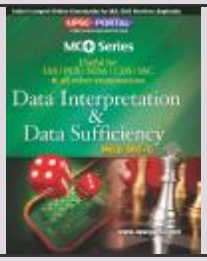

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