INDIAN FOREST SERVICE P (EXAM)-2014

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 Nos. **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 Question-cum-Answer Booklet 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.

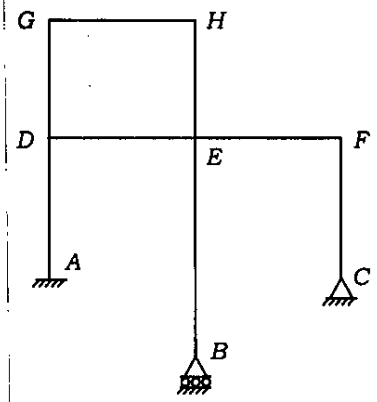
Unless otherwise mentioned, symbols and notations have their usual standard meanings.

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

Neat sketches may be drawn, wherever required.

SECTION—A

1. *(a)* Determine the degree of indeterminacy of the rigid plane frame shown in the figure. If two additional hinges are introduced in member *GH*, what will be the number of indeterminacy? 10



(b) List out five important factors affecting the strength of concrete and briefly discuss their influence on strength. 10

(c) The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as

$$u = \frac{y^3}{3} + 2x - x^2y \quad \text{and} \quad v = xy^2 - 2y - \frac{x^3}{3}$$

(i) Verify that the functions represent a possible case of fluid flow.

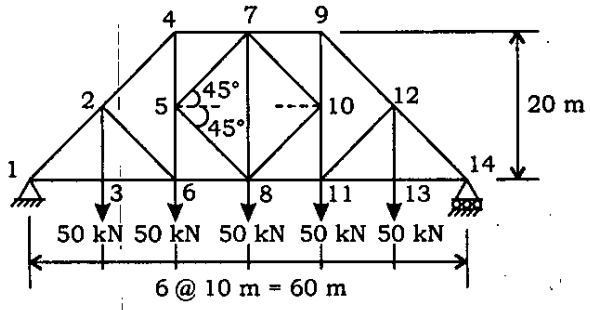
(ii) Show that these functions represent a possible case of an irrotational flow. 5+5=10

(d) The *in situ* void ratio of a granular soil deposit is 0·5. The maximum and minimum void ratios of the soil were determined to be 0·75 and 0·35. If the specific gravity of the soil solids is 2·67, determine the following : 10

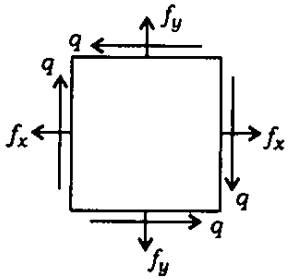
(i) Relative density

(ii) Relative compaction of the soil deposit

2. *(a)* Determine the forces in members meeting at joint 5 of the truss shown in the figure. Use method of sections. 20



(b) A circle of diameter 200 mm is inscribed inside a mild steel plate before it is stressed as shown in the figure. After the application of tensile stresses f_x and f_y and the shear stress q, the circle deforms into an ellipse. Calculate the lengths of the major and minor axes of the ellipse and their directions if $f_x = 150\ N/mm^2$, $f_y = 250\ N/mm^2$ and $q = 25\ N/mm^2$ respectively. Take $E = 2 \times 10^5\ N/mm^2$. 20



3. A steel column 12 m long is hinged at both ends and carries an axial load of 1000 kN. Design a built-up section consisting of double channels placed back-to-back at a spacing and connected by double lacing inclined at 45° with vertical axis. Use 22 mm diameter rivets for lacing. $f_y = 260\ N/mm^2$.

Try with channel sections ISMC 350 for which the sectional properties are given below :

For one channel MC 350

Area = 5365 mm^2

$I_x = 10008 \times 10^4\ mm^4$; $r_x = 136{\cdot}6$ mm

$I_y = 430{\cdot}6 \times 10^4\ mm^4$; $r_y = 28{\cdot}3$ mm

Thickness of web = 8·1 mm

Thickness of flange = 13·5 mm

Distance of CG from the face of web = 24·4 mm

For two channels placed back-to-back at a distance of x mm

Area of sections = 10732 mm^2

$I_{xx} = 20016 \times 10^4\ mm^4$

Modulus of section $Z_{xx} = 1143{\cdot}8 \times 10^3\ mm^3$

Radius of gyration $r_{xx} = 136{\cdot}6$ mm

Spacing x (mm)	I_{yy} 10^4 (mm^4)	Z_{yy} 10^3 (mm^3)	r_{yy} (mm)
180	14906·4	784·6	117·9
200	17469·4	873·5	127·6
220	20246·8	964·1	137·4
240	23238·9	1056·3	147·2

Gauge distance between rivet lines = 60 mm

Slenderness ratio (l/r)	70	80	90	100	110	120	130
Permissible compressive stress (N/mm^2)	115	103	92	82	73	64	57

40

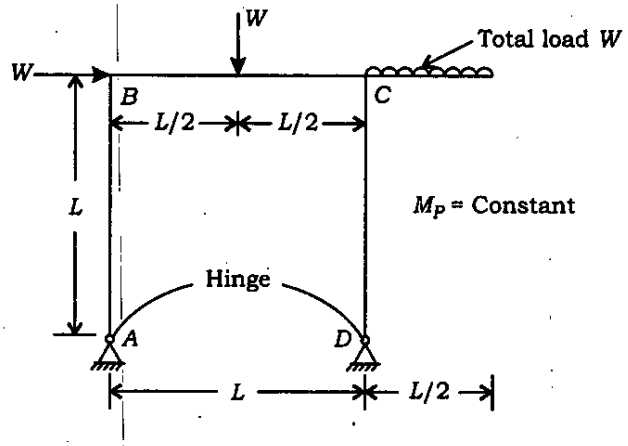
4. *(a)* An open channel is to be constructed of trapezoidal section and with side slopes 1 vertical to 1·5 horizontal. Find the proportions, that is, the relation between bottom width and depth of flow for minimum excavation (that is, best hydraulic section). If the flow is to be 2·7 m^3/s, calculate the bottom width and the depth of flow assuming Chezy's C as 44·5 and the bed slope as 1 in 4000. 15

(b) A partially open sluice gate discharges water at 10 m s^{-1} with a depth of 0·5 m in a horizontal rectangular channel of width 10 m. Predict whether a hydraulic jump will occur and if so, calculate the salient features of the jump. 15

(c) Find the ratio of average permeability in the horizontal direction to that in the vertical direction for a soil deposit of three layers with thicknesses in the ratio 1 : 2 : 3. The permeability of the second layer is twice that of the first and of the third is twice that of the second. 10

SECTION—B

5. *(a)* A portal frame with overhanging beam is hinged at supports as shown in the figure. Sketch all the possible failure mechanisms, clearly marking the plastic hinge locations and mode of failure in each case. 10



(b) Explain soundness test for cement. 10

(c) A spillway 7·2 m high and 150 m long discharges 2150 m^3/s under a head of 4 m. If a 1 : 16 model of the spillway is to be constructed, find the model dimensions, head over the model and the model discharge. 10

(d) Triaxial shear tests were conducted on two identical soil samples. The confining pressure for the first sample was 200 kN/m^2 and failure occurred at an additional axial stress of 770 kN/m^2. The second sample failed at a deviator stress of 1370 kN/m^2 under an all-round pressure of 500 kN/m^2. Determine the shear strength parameters of the soil. 10

6. (a) How can one estimate the settlement of a pile group in clayey soil, as per the Indian Standards? 10

(b) A cantilever retaining wall is required to retain earth for a height of 5 m above the ground level. The backfill is horizontal and level with the top of the wall. Unit weight of earth is 16 kN/m^3 and angle of internal friction is 35°. Safe bearing capacity of soil is 180 kN/m^2. Coefficient of friction between soil and concrete is 0·5. Fix suitable dimensions for base slab and stem, and check for the stability of the retaining wall. Structural design is not required. M_{20} concrete and Fe_{415} steel are used. 30

7. (a) In a water pipeline, there is an abrupt change in diameter, from 140 mm to 250 mm. If the head lost due to separation when the flow is from the smaller to the larger pipe is 0·6 m greater than the head lost when the same flow is reversed, determine the flow rate. Table below shows the experimental values of C_c.

A_2 / A_1	0·1	0·3	0·5	0·7	1·0
C_c	0·61	0·632	0·673	0·73	1·0

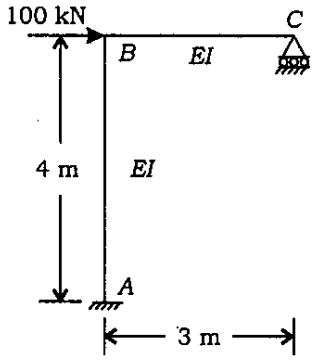
20

(b) A centrifugal pump having an overall efficiency of 75% delivers 1820 litres of water per minute to a height of 18 m through a pipe of 100 mm diameter and 90 m length. If $f = 0 \cdot 012$, calculate the horsepower to drive the pump. (Note : Use $H_f = \frac{f l}{d} \frac{v^2}{2g}$) 10

(c) Define bulk modulus of elasticity of a fluid. What is the SI unit of bulk modulus of elasticity? Discuss the factors influencing the bulk modulus of elasticity of a fluid. Liquids are generally considered incompressible. Why? 10

8. (a) A weight of 5 kN is dropped on a closely coiled helical spring consisting of 20 coils. Find the height from which the weight can be dropped before it strikes the spring so as to cause a compression of 200 mm in the spring. The coil of the spring has 100 mm mean diameter and 20 mm wire diameter. Assume $G = 8 \cdot 5 \times 10^4$ N/mm^2. 10

(b) Analyze the frame shown in the figure by the method of moment distribution. Draw bending moment diagram on the tension side of the members. 20



(c) Design a double-angle discontinuous strut to carry a load of 90 kN. The length of the strut is 3 m between intersections. The two angles are placed back-to-back (with long legs connected) on the same side of 10 mm thick gusset plate and are tack riveted. $f_y = 250$ MPa.

Properties of angle sections

Angle	ISA 65×65×8 mm	ISA 70×70×8 mm	ISA 80×80×6 mm	ISA 80×80×8 mm
Area (mm^2)	976	1058	929	1221
r_{xx} (mm)	19·6	21·2	24·6	24·4
r_{yy} (mm)	19·6	21·2	24·6	24·4

Permissible compressive stresses

l/r	100	110	120	130	140	150	160	170
σ_{ac} (MPa)	80	72	64	57	51	45	41	37

10

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