CIVIL ENGINEERING

041056

Time : 3 hours | *Full Marks* : 200

Instruction :

(1) Answer ***all*** *Sections following directions of each question.*

(2) The figures in the margin indicate full marks for the questions.

SECTION—A

1. Answer any *ten* questions from the following : 4×10=40

(a) A cantilever beam 2 m long carries a u.d.l. of 2 kN/m acting downward and its self-weight is 1 kN/m. What are the support reactions (force and moment)? Show directions of reactions.

(b) A soil has porosity of 0·6. Find its void ratio.

(c) The Young's modulus of an ideally elastic material is 100 MPa. What will be its bulk modulus of elasticity?

(d) One end of a beam is fixed to the free end of a cantilever beam, forming an L shape in plan. A vertical load is applied on the free end of the L-shaped beam. Enumerate the types of stresses that will develop in the L-shaped beam.

(e) Enumerate four factors influencing the permeability of a soil.

(f) A truss is hinged at two of its end supports and roller supported at a middle support. Find the static indeterminacy of its support reactions.

(g) What are the different types of supports used in two-dimensional structures and what are their corresponding degrees of freedom?

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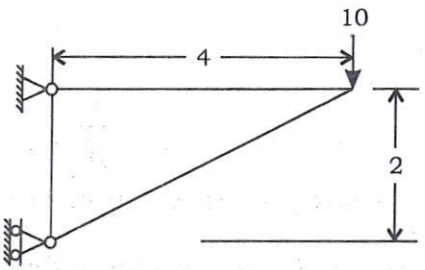
(h) Write what are the natures of forces (tension or compression) in each of the members (vertical, horizontal, inclined) of the truss shown in the figure given below :



(i) The nominal length of a chain is 30 m, but its actual length is 29·90 m. A distance *AB* measured using the chain is found to be 900 m. What is the correct distance between *A* and *B*?

(j) A saturated clay layer is 10 m thick. It was subjected to an average stress increment of 100 kPa, because of which it has settled by 10 cm. What is its modulus of volume compressibility?

(k) What is neutral equilibrium of a submerged or partially submerged body?

(l) A soil has $\phi = 30°$, $c = 30$ kPa, $\gamma = 20$ kN/m^3. Up to what depth the soil can be cut vertically without shoring?

SECTION—B

2. Answer any *ten* questions from the following : 6×10=60

(a) The moment of inertia of a thin circular plate about the axis passing through the centre perpendicular to the plate is $\pi/512$ m^4. Find its radius of gyration.

(b) A lift has a mass of 1000 kg and it can accommodate 10 persons with a total mass of 700 kg. It has a maximum acceleration of 1 m/s^2. A cable pulls it up. What is the maximum force on the cable?

(c) A man is sitting on a rotating stool with arms spread out. The stool is rotating at *n*1 rotations per minute. The man brings his arms close to his chest. Will rotating speed increase or decrease? Explain giving reasons.

(d) A block of material is subjected to a vertical stress of 100 kPa and a horizontal stress of 50 kPa. What is the maximum shear stress generated inside the block? What is the angle made by the plane of maximum shear with the horizontal? What is the normal stress on this plane?

(e) What are the forces that act on a well foundation?

(f) The following are the bearings of a closed traverse after necessary corrections :

Line	*AB*	*BC*	*CD*	*DA*
Bearings	135°	45°	315°	225°

If the side *AB* is 10 m long, find the area enclosed by the traverse.

(g) Draw a cross-section of a wing of an aeroplane and explain how the aeroplane gets lifted in air.

(h) The first portion of L length of a bar has a cross-sectional area A. The next portion of length $2L$ has a cross-sectional area of $2A$. The bar is pulled from both ends by a force P. The Young's modulus of the bar is E. What is its strain energy due to elongation?

(i) A glass jar is 50 mm in diameter. Water is kept at the bottom 10 cm. Over that, a 10 cm deep layer of oil is kept. What is the maximum pressure created by these two fluids and where will it act and in which direction? Sp. Gr. of the oil is 0·9.

(j) Find the critical depth of a rectangular channel carrying water at the rate of 31·3 m^3/s. The width of the channel is 10 m. What is the critical velocity of the channel? 3+3

(k) A channel carries water in supercritical flow with a depth of 1 m. It becomes subcritical after a jump, depth being 2 m. What is the energy loss?

(l) The following are the data of grain size analysis of a soil :

$D10 = 0 \cdot 50$ mm, $D30 = 1 \cdot 5$ mm, $D60 = 2$ mm

Is the soil well-graded? Why?

SECTION—C

3. Answer any *four* questions from the following : 10×4=40

(a) Draw the SFD and BMD for a beam of length L simply supported at $L/4$ distance inside from both ends and loaded with a concentrated load W at each end.

(b) Find the net safe load a square footing can carry in a clay soil. The unit weight of soil is 20 kN/m^3 and its undrained cohesion is 25 kPa. The footing base is 1·5 m below ground surface. The footing size is 1 m × 1 m. Use a factor of safety of 2·5.

(c) A theodolite with constants $K = 100$ and $C = 1$ was placed at a station A and a levelling staff was held vertically on a benchmark (B). The top, middle and bottom hair readings on the staff at B when focused from A are 2·5 m, 2 m and 1·55 m respectively. The vertical scale reading of the theodolite is 15° above the horizontal. Height of instrument from ground to the trunnion axis is 1·2 m. If the RL of the benchmark is 100 m, what is the RL of station A?

(d) In an experiment in a trapezoidal channel, the uniform discharge was 1 m^3/s. The section properties were—bottom width = 1 m, side slope = 1:1, depth of flow = 0·5 m. The bed slope was 1 in 500. Find Manning's n for the channel material.

(e) What is hoop stress? Derive the hoop stress in a thin cylinder with internal gas pressure p.

(f) What are the different types of bearing capacity failures and in what situations do they occur?

SECTION—D

4. Answer any *three* questions from the following : 20×3=60

(a) A hollow rectangular beam of depth $d = 100$ mm, width $b = 40$ mm, thickness $t = 5$ mm and span $L = 5$ m is simply supported at both ends. It is subjected to a concentrated vertical load W at mid-span.

(i) Find the maximum longitudinal bending stresses developed in the beam in terms of W.

(ii) If the maximum allowable stress in the material of the beam is $\sigma_a = 215$ MPa, what is the maximum value for W that the beam can support? 10+10=20

(b) (i) Deduce an expression for Euler's buckling load for a column with both ends fixed.

(ii) Using Euler's formula, determine the limiting length of a both end hinged column of section 60 mm × 100 mm so that the critical stress is limited to 250 N/mm^2. Assume $E = 2 \times 10^5$ N/mm^2.

12+8=20

(c) Where and why is a venturi meter used? Explain the working principle of a venturi meter with neat drawing.

(d) The following are the data of straight-linear section *AB* of an unfinished road. Complete the table. From the completed table, comment on the nature of the profile, whether undulating or sloping up or sloping down :

Distance from A	*BS*	*IS*	*FS*	*Rise*	*Fall*	*RL*	*Remark*
0	0·780					90·880	TBM
10		1·535					
20		1·955					
30		2·430					
40		2·985					
50	1·155		3·480				Change Point
60		1·960					
70		2·365					
80		2·665					
90			2·810				

(e) What is elastic curve? What is flexural rigidity? Write the flexural equations or the differential equation of elastic curve. How can slope, shear force and intensity of distributed load be found from this equation?

3+4+4+3+3+3=20

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