

Time : 3 hours

Full Marks : 200

Instruction :

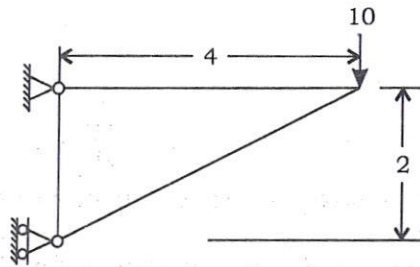
- (1) Answer **all** Sections following directions of each question.
- (2) The figures in the margin indicate full marks for the questions.

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?

- (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 $\phi = 30^\circ$, $c = 30$ kPa, $\gamma = 20$ kN/m³. 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 $\pi/512$ m⁴. 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/s². 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 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 $31.3 \text{ m}^3/\text{s}$. 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 :
 $D_{10} = 0.50 \text{ mm}$, $D_{30} = 1.5 \text{ mm}$, $D_{60} = 2 \text{ mm}$
 Is the soil well-graded? Why?