CSM—20/24

PART—II/PAPER—VI

CIVIL ENGINEERING

PAPER—I

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Time : 3 Hours

Full Marks : 250

The question paper contains **18 (Eighteen)** *questions in* **GROUP—A, (12)** *and* **GROUP—B, (06)** *together.*

GROUP—A

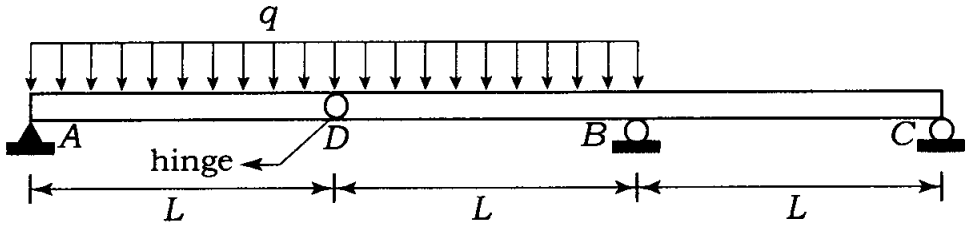
Candidates to attempt **10 *(ten)*** *questions within word limit of* **250**.

Each question carries **15** *marks.*

1. A simply supported beam of length 4 m carries a point load of 3 kN at a distance of 1 m from each end. If $E = 2 \times 10^5$ N/mm^2 and $I = 10^8$ mm^4 for the beam, then using conjugate beam method determine slope and deflection at each end and under each load.

2. Find the slope of the free water surface in a rectangular channel of width 20 m, having depth of flow 5 m. The discharge through the channel is 50 m^3/s. The bed of the channel has a slope of 1 in 4000. Take the value of Chezy's constant $C = 60$.

3. A beam, shown in the figure, is subjected to a uniformly distributed downward load of intensity q between supports A and B. Considering the upward reactions as positive. Find out the support reactions.



4. A new canal is excavated to a depth of 5 m below ground level. Through a soil having the following characteristics : $c = 14\ kN/m^2$; $\varphi = 15°$; $e = 0{\cdot}8$ and $G = 2{\cdot}70$. The slope of banks is 1 in 1. Calculate the factor of safety with respect to cohesion when the canal runs full. If it is suddenly and completely emptied, what will be the factor of safety?

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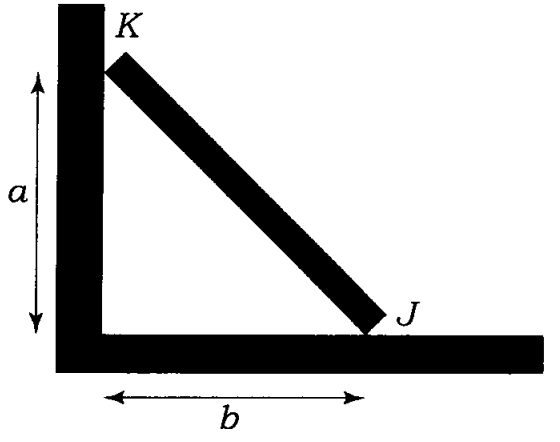
$\Phi \rightarrow$ / $i \downarrow$	0°	5°	10°	15°	20°
90°	0·261	0·239	0·218	0·199	0·182
75°	0·219	0·195	0·173	0·152	0·134
60°	0·191	0·162	0·138	0·116	0·097
45°	0·170	0·136	0·108	0·083	0·062
30°	0·156	0·110	0·075	0·046	0·0625
15°	0·145	0·068	0·023	—	—

5. A uniform rod KJ of weight w, as shown in the figure, rests against a frictionless vertical wall at the point K and a rough horizontal surface at point J. It is given that $w = 10$ kN, $a = 4$ m and $b = 3$ m. Draw a free-body diagram and determine the minimum coefficient of static friction that is required at the point J to hold the rod in equilibrium.



6. At the foot of a spillway, water flows at a depth of 23 cm with a velocity of 8·1 m/s, as shown in the figure. The flow enters as an M-3 profile in the long, wide rectangular channel with bed slope = 1/1800 and Manning's $n = 0{\cdot}015$. A hydraulic jump is formed at a certain distance from the foot of the spillway. Assume that the acceleration due to gravity, g is 9·81 m/s^2. Just before the hydraulic jump, what is the depth of flow Y_1?

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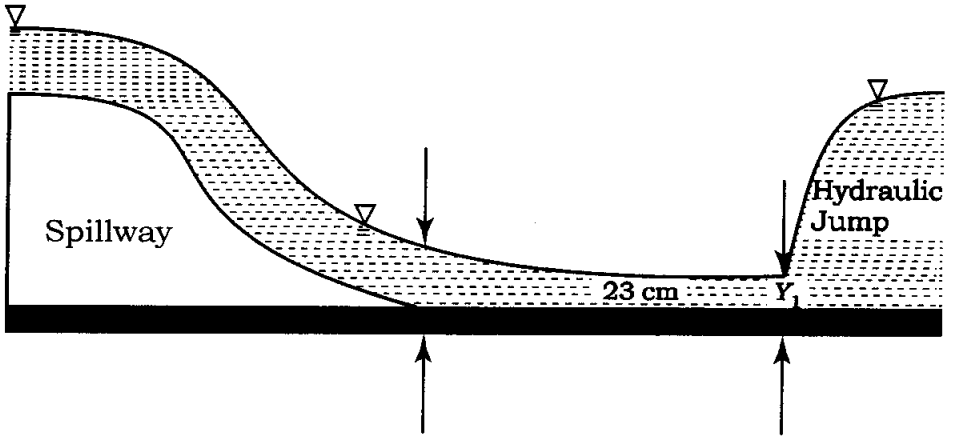

7. At a site, the data related to a normally consolidated clay layer are as follows :

Thickness of the clay layer = 3·0 m

Initial void ratio (e_0) = 0·85

Compression index (C_c) = 0·27

Average effective pressure on the clay layer (σ_0') = 130 kN/m^2

Increment of pressure due to construction ($\Delta\sigma_0'$) = 300 kN/m^2

Secondary compression index (C_a) = 0·02

What is the total consolidation settlement of the clay layer five years after the completion of primary consolidation?

Time for completion of primary consolidation : $t_0 = 2$ years.

8. A truss tie consisting of 2 ISA 75 × 75 × 8 mm carries a pull of 150 kN. At ends the two angles are connected, one each on either side of a 10 mm thick gusset plate, by 18 mm diameter rivets arranged in one row. The allowable stresses in the rivet are $f = 90{\cdot}0$ N/mm^2 and $f_1 = 250$ N/mm^2. Calculate maximum tensile stress in the tie in N/mm^2 and the minimum number of rivets required at each end.

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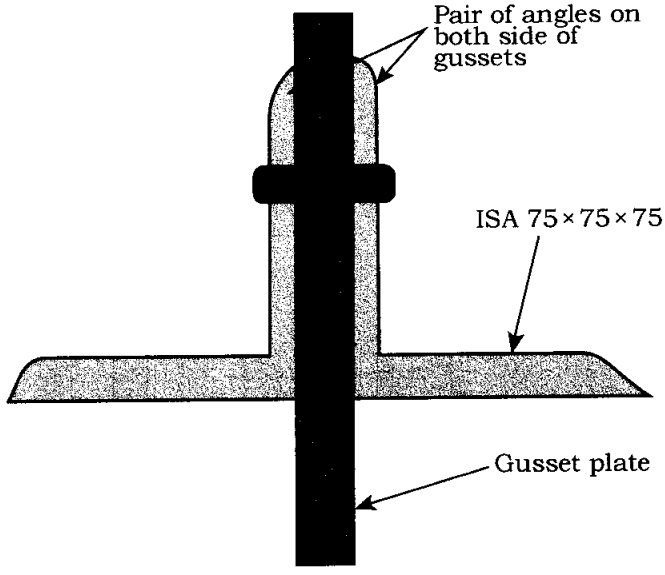
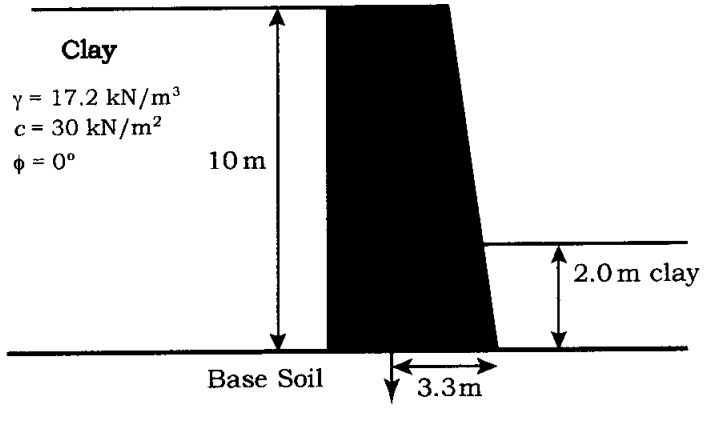


9. A retaining wall of height 10 m with clay backfill is shown in the figure (not to scale). Weight of the retaining wall is 5000 kN per m acting at 3·3 m from the toe of the retaining wall. The interface friction angle between the base of the retaining wall and the base soil is 20. The depth of clay in front of the retaining wall is 2·0 m. The properties of the clay backfill and the clay placed in front of the retaining wall are the same. Assume that the tension crack is filled with water. Use Rankine's earth pressure theory. Take unit weight of water, $y = 9{\cdot}81$ kN/m^2. What is the factor of safety (rounded off to two decimal places) against sliding failure of the retaining wall after ignoring the passive earth pressure?



10. A 4 m wide strip footing is founded at a depth of 1·5 m below the ground surface in a $C-\phi$ soil as shown in the figure. The water table is at a depth of 5·5 m below ground surface. The soil properties are $C' = 35$ kN/m^2, $\phi' = 28{\cdot}63°$, $\gamma_{sat} = 19$ kN/m^3, $\gamma_{bulk} = 17$ kN/m^3 and $\gamma_w = 9{\cdot}81$ kN/m^3. The values of bearing capacity factors for different ϕ' are given below :

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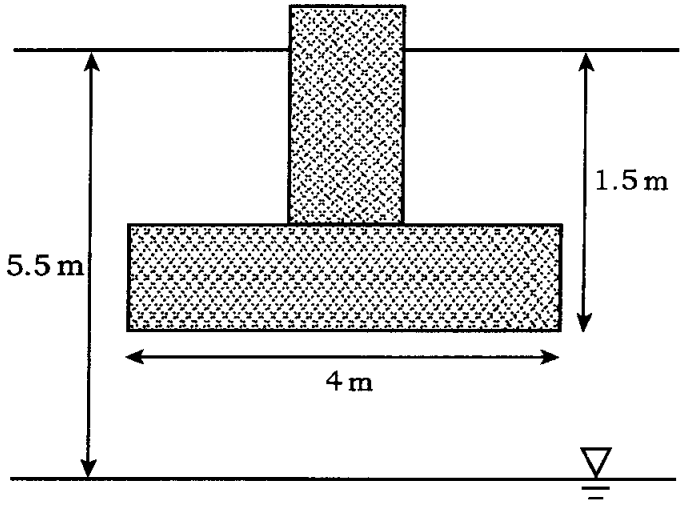
ϕ'	N_c	N_q	N_γ	ϕ'
15°	12·9	4·4	2·5	15°
20°	17·7	7·4	5·0	20°
25°	25·1	12·7	9·7	25°
30°	37·2	22·5	19·7	30°



Using Terzaghi's bearing capacity equation and a factor of safety $F_s = 2{\cdot}5$, calculate the net safe bearing capacity (expressed in kN/m^2) for local shear failure of the soil.

11. A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 r.p.m. Determine the maximum internal diameter, if the maximum stress in the shaft is not to exceed 60 N/mm^2.

12. Derive the equation for the Euler's equation of motion.

GROUP—B

Candidates to attempt **05** ***(five)*** *questions within word limit of* **300**.

Each question carries **20** *marks.*

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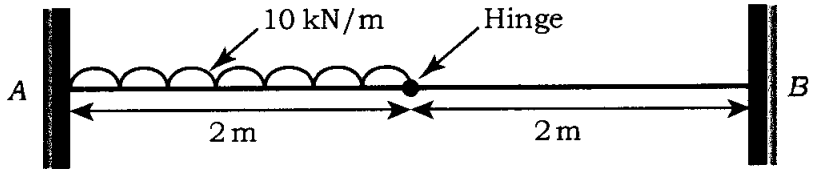
13. Draw the bending moment and shear force diagram for the beam shown below :



14. A single-acting reciprocating pump is to raise a liquid of density 1200 kg per cubic metre through a vertical height of 11·5 metres, from 2·5 metres below pump axis to 9 metres above it. The plunger, which moves with S.H.M., has a diameter of 125 mm and a stroke of 225 mm. The suction and delivery pipes are 75 mm diameter and 3·5 metres and 13·5 metres long respectively. There is a large air vessel placed on the delivery pipe near the pump axis. But there is no air vessel on the suction pipe. If separation takes place at 8·829 N/cm^2 below atmospheric pressure, calculate maximum speed at which the pump can run without separation taking place and power required to drive the pump, if $f = 0{\cdot}02$. Neglect slip for the pump.

15. Find the discharge of water through the pipe, the velocity of venturimeter throat and the pressure 600 cm above the venturimeter using Bernoulli's theorem.

Given :

Diameter of vertical pipe = 15 cm

Venturimeter throat = 7 cm

Absolute pressure at throat = 1 atm

Pressure at 600 cm below the venturimeter = 5 atm

16. The following data were recorded in a constant head permeability test :

Internal diameter of permeameter = 7·5 cm

Head lost over a sample length of 18 cm = 24·7 cm

Quantity of water collected in 60 s = 626 ml

Porosity of the soil sample was 44%. Calculate the coefficient of permeability of the soil. Also determine the discharge velocity and the seepage velocity during the test. If the test was carried out at a temperature of 25 °C, estimate the permeability of the soil for a porosity of 39% and at 20 °C.

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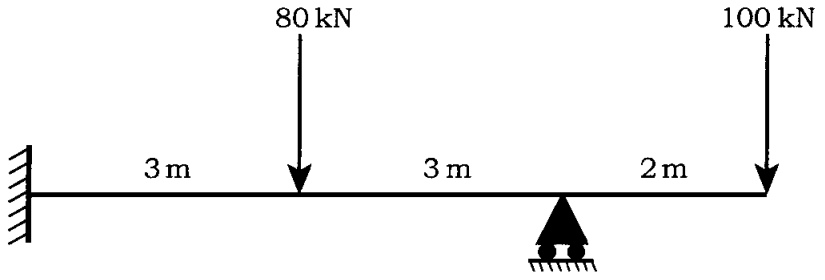
17. Analyse the beam loaded as shown in the figure by the deflection method and draw bending moment diagram and shear force diagram. *EI* is constant.



18. Consolidated undrained type triaxial test were carried out to failure on two identical specimens of silty clay with pore water pressure measurements as given below. Determine the shear strength parameters, if construction is done at a faster rate, construction is done slowly.

Sl. No.	Confining Pressure (kPa)	Deviator Stress (kPa)	Pore Pressure (kPa)
1	100	150	40
2	200	220	70

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SPACE FOR ROUGH WORK

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