

Sl. No. 18769

A-GUG-K-DFA

## CIVIL ENGINEERING

### Paper—I

( Conventional )

Time Allowed : Three Hours

Maximum Marks : 200

### INSTRUCTIONS

Candidates should attempt any FIVE questions.

The number of marks carried by each subdivision of a question is indicated at the end of the subdivision.

The total number of marks for each question will be 40.

Notations used are standard and will have their usual meanings, unless otherwise indicated.

Assume suitable data, if found necessary, and indicate them clearly. Newton may be converted to kgf using the relation 1 kilonewton (1 kN) = 100 kgf, if found necessary.

Answers must be written only in ENGLISH.

1. (a) Describe the procedure to list the soundness of cement. Name the constituents causing soundness. 10
- (b) What is ferrocement? List the properties of ferrocement. 10
- (c) Explain in detail the non-destructive testing of concrete using Rebound hammer. 10

(d) Write short notes on :

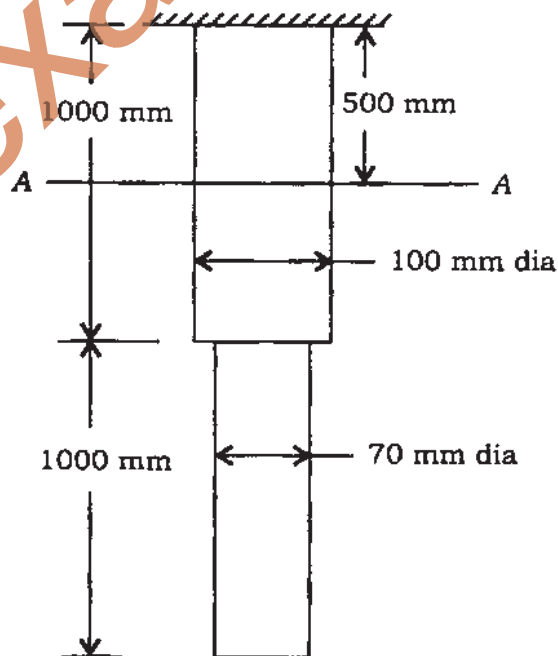
(i) Electrical seasoning of wood 4

(ii) Harmful ingredients in brick earth 3

(iii) Tests on brick to assess its suitability—list the names 3

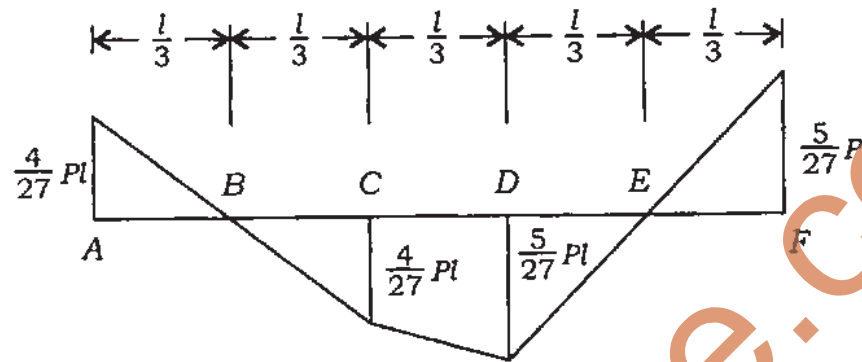
2. (a) A stepped bar with circular cross-section and supported at top, hangs vertically under its own weight. Dimensions of the bar are shown in the figure below. Calculate the elongation of the bar under its own weight. What is the change in diameter of the bar at section AA shown in the figure?  $E = 2 \times 10^5 \text{ N/mm}^2$ , density  $\gamma = 8 \times 10^{-5} \text{ N/mm}^3$  and Poisson's ratio  $\nu = 0.2$ .

20



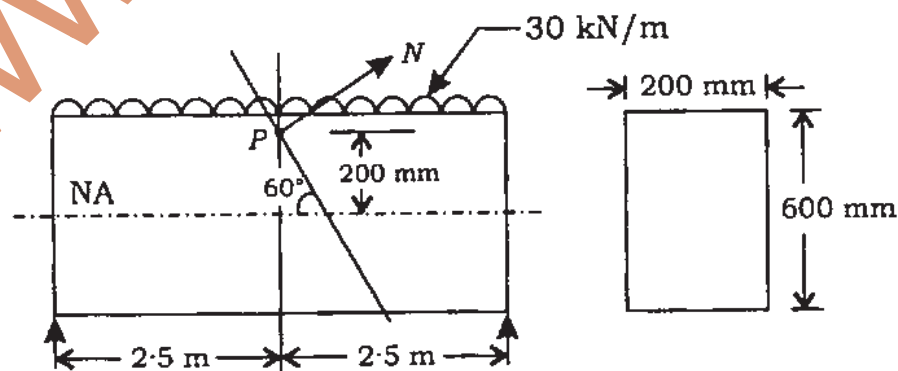
- (b) Bending moment diagram of a balanced cantilever beam is shown below. Draw the beam and find the loads acting on the beam.

10



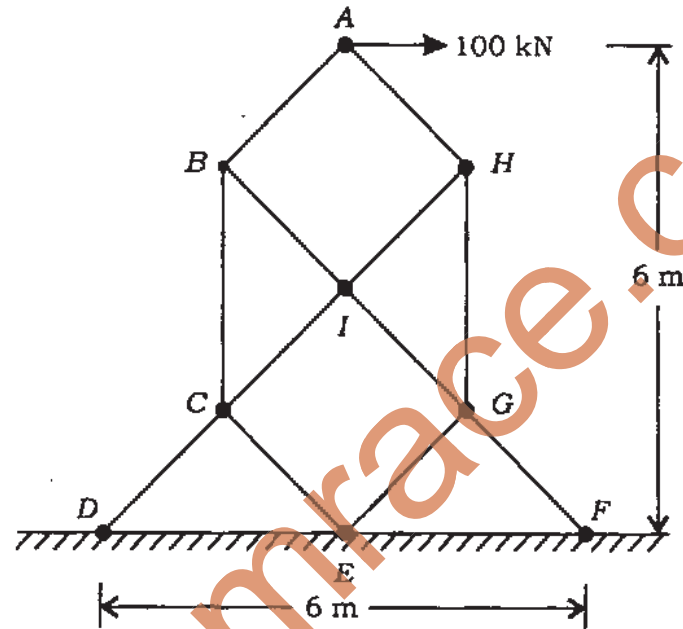
- (c) A simply supported beam of span 5 m and cross-section 200 mm  $\times$  600 mm is subjected to a uniformly distributed load of 30 kN/m including self-weight. A plane inclined at  $60^\circ$  to the axis of the beam is passing through a point  $P$  located on the central cross-section of the beam and 200 mm above the neutral axis. Find the normal stress and shear stress on the inclined plane at point  $P$ .

10



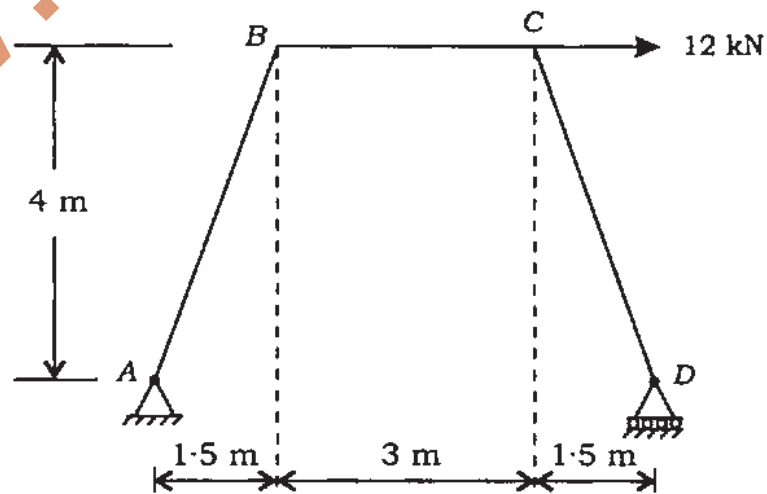
3. (a) Calculate the bar forces in all the members of the plane truss shown below which is used as a tower. All inclined members have a slope of  $45^\circ$  to the horizontal plane. Also, find reactions at supports  $D$ ,  $E$  and  $F$ .

20

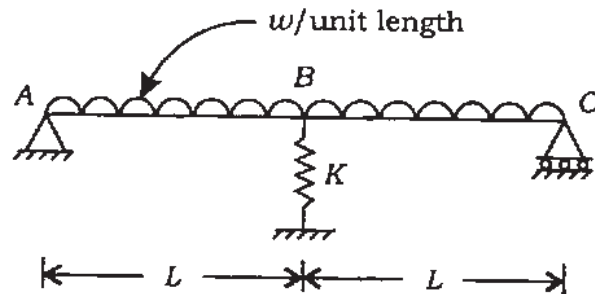


- (b) Find the reactions at supports  $A$  and  $D$  of the structure shown below. Draw BM diagram indicating BM values at salient points. Supports  $A$  and  $D$  are at the same level.

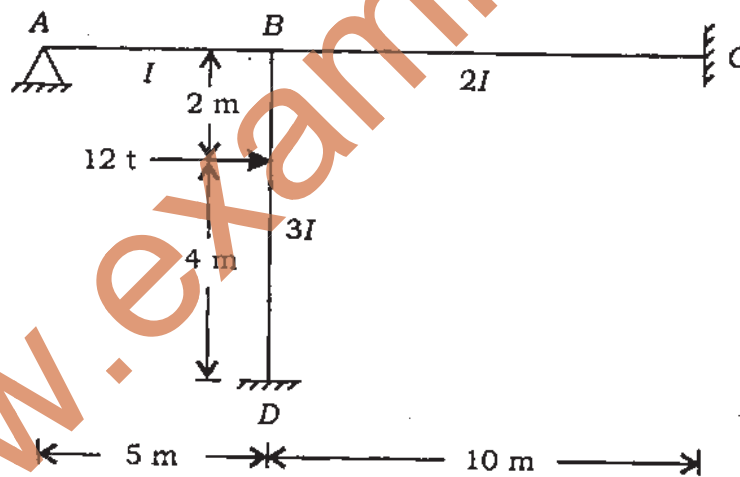
10



- (c) Find the reaction at  $B$  for the beam shown below.  $K$  is the stiffness of spring at  $B$ . Beam is of constant section. Use energy method of analysis. 10



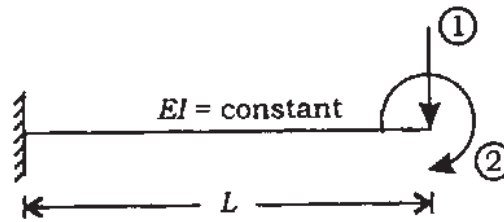
4. (a) Employing slope-deflection method, evaluate BM at salient points of the frame shown below. Draw BM diagram indicating BM values on it. 18



- (b) Define the terms 'plastic section modulus', 'shape factor' and 'load factor'. 6

Find the shape factor for a hollow tube section of external diameter  $D$  and internal diameter  $d$ . 6

- (c) Develop the flexibility matrix for the cantilever beam for the degrees of freedom shown below. 10



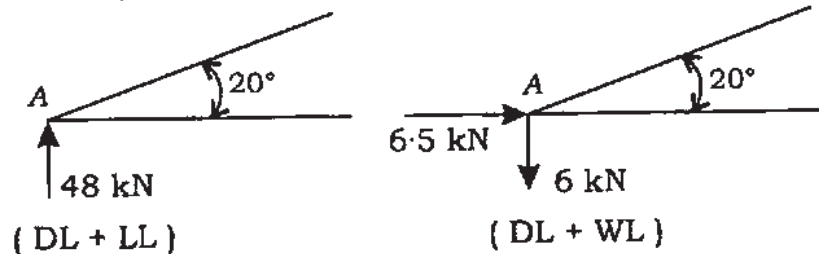
5. (a) (i) Discuss the failure of rivets. 3

- (ii) Explain why the design of compression member is done by indirect method. 5

- (iii) The joint A of a roof truss is shown below, where the main rafter and the main tie intersect. It is a hinged joint. It is subjected to end reactions as shown below : (1) Dead load + Live load and (2) Dead load + Wind load. Effective length of the main rafter is 2.83 m. Check the assumed section of the main rafter for its safety against compression.

Properties of the section assumed—  
 double-angle back-to-back, angle being 80 mm × 50 mm × 10 mm  
 having an area of 12.02 cm<sup>2</sup> each.  
 $r_{xx}$  of the double-angle section = 2.49 cm.

12



$l/r$	$f_c$ (kg/cm <sup>2</sup> )
0	1250
10	1246
20	1239
30	1224
40	1203
50	1172
60	1130
70	1075
80	1007
90	928
100	840
110	753
120	671
130	597
140	531
150	474
160	423
170	377
180	336
190	300
200	270
210	243
220	219
230	199
240	181
250	166
300	109
350	76

(b) (i) Explain the importance of welded connection in building connection. 5

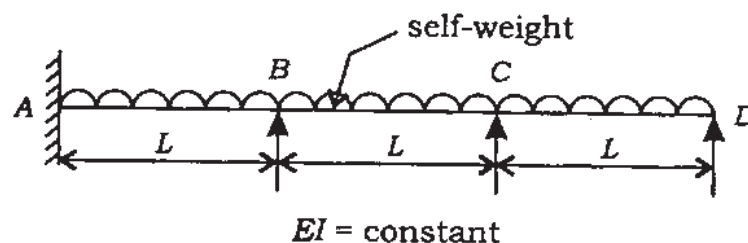
(ii) Design a single equal-angle tension member. It is 4 m long and subjected to a tensile load of 25 t. It is connected to a gusseted plate through one leg only. Assume rivet diameter of 18 mm.

$$\sigma_t = 1500 \text{ kg/cm}^2$$

Check for slenderness ratio. Given,  $\gamma_{\min} = 1.94$ . 15

6. (a) A pretensioned beam of size 250 mm × 350 mm prestressed by 12 wires of 7 mm diameter is initially stressed to 1200 N/mm<sup>2</sup> with the eccentricity located 100 mm from the soffit. Estimate the final loss of prestress due to elastic deformations, creep, shrinkage and relaxation. Given, relaxation of steel stress = 90 N/mm<sup>2</sup>,  $E_s = 210 \text{ kN/mm}^2$ ,  $E_c = 35 \text{ kN/mm}^2$ , creep coefficient ( $\phi$ ) = 1.6, residual shrinkage strain =  $3 \times 10^{-4}$ . 20

(b) (i) Sketch the elastic curve for the continuous beam as shown below. Sketch the reinforcement alignment. 5





- (ii) Design a T-beam for a commercial complex with reference to the data as stated below by working stress method : 15

Clear span of the T-beam = 10 m

Spacings of the T-beam = 2.5 m

Live load = 4 kN/m<sup>2</sup>

Thickness of the slab = 15 cm

Materials = M-20 grade concrete  
and Fe-415 HYSD bars

Effective span of the beam = 10.5 m

Assume the width of the rib  
= 300 mm

7. (a) A  $\frac{1}{2}$  cubic metre short boom dragline having ideal output of 150 m<sup>3</sup>/hr is to be used to excavate hard tough clay. The effect of the depth of cut of 5.0 m and angle of swing of 120° shall be 0.89. The operating factor shall be 50 min/hour. Determine the probable output of the dragline. 4

- (b) Indicate the performance of power shovel, backhoe, dragline and clamshell for the following conditions in terms of very good, good, fair or poor : 6

- (i) Excavation in hard soil or rock  
(ii) Excavation in wet soil or mud  
(iii) Loading efficiency

- (c) A contractor intends to bid for a small-size civil engineering project consisting of the following activities and corresponding different time limits. Work out (i) critical path and standard deviation for the whole network, (ii) Z-factor for completing the project in 42 weeks, (iii) completion time duration for which the contractor should bid considering 93% probability assuming Z-factor as 1.5 and (iv) TF, FF and IF : 15

Activity	Optimistic time (in weeks)	Most likely time (in weeks)	Pessimistic time (in weeks)
1-2	1	3	5
1-3	3	6	15
2-3	2	5	14
2-4	5	7	9
3-4	2	4	12
2-5	6	9	18
4-5	1	2	3
3-8	3	12	15
4-6	4	6	8
5-7	1	2.5	7
6-8	3	4	5
6-7	0	0	0
7-9	1	8	9
9-10	1	3	5
8-10	0	0	0
8-11	1	9	11
10-11	3	4.5	9
9-11	4	9	20

- (d) Determine the minimum cost and optimum duration for a project network. The duration and cost of each activity of the project is given in the following table. The indirect cost of the project is Rs 800 per day. Draw the time-scaled version of the network :

15

Activity	Normal duration (in days)	Normal cost (in Rs)	Crash duration (in days)	Crash cost (in Rs)
A-B	2	10,000	2	10,000
A-C	7	5,000	3	9,000
B-C	6	3,000	3	4,200
B-D	5	2,000	4	2,500
C-D	0	0	0	0
C-E	9	6,000	4	9,000
D-F	11	6,000	6	10,000
E-F	6	7,000	3	9,100

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Sl. No.

5209

A-GUG-K-DFB

**CIVIL ENGINEERING**

**Paper II**

**(Conventional)**

*Time Allowed : Three Hours*

*Maximum Marks : 200*

**INSTRUCTIONS**

*Question No. 1 is compulsory. Out of the remaining seven questions, attempt any FOUR questions.*

*Each question carries 40 marks.*

*The number of marks carried by each subdivision of a question is indicated at the end of the subdivision/question. Wherever a question is attempted, all its subdivisions must be attempted.*

*Answers must be written only in ENGLISH.*

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

*Unless indicated otherwise, notations and symbols have their usual meanings.*

*Neat sketches to be drawn, wherever required.*

(Contd.)

1. (a) (i) Following data are observed during testing of a Kaplan turbine :

Power developed = 2500 kW, Head = 60 m and speed = 350 r.p.m.

What will be the dimensionless specific speed of the turbine ? 2

- (ii) Determine the total pressure on a plane rectangular surface of 1 m wide and 3 m deep when its upper edge is horizontal and coincides with water surface and plate is held perpendicular to water surface. 2

- (iii) The velocity components in  $x$  and  $y$  directions are given as  $u = x + y$  and  $v = x - y$  respectively. Find whether these velocity components satisfy possible two dimensional incompressible flow or not ? 2

- (iv) The diameters of the impeller of a centrifugal pump at inlet and outlet are 20 cm and 40 cm respectively. Determine the minimum starting speed of the pump against a head of 25 m. 2

- (b) (i) Find the probable life of a reservoir with an initial capacity of  $4 \times 10^6 \text{ m}^3$  if the annual sediment inflow into reservoir  $4 \times 10^4 \text{ m}^3$ . The average trap efficiency 0.9 and life of a reservoir is terminated when 90 per cent of initial capacity is occupied by sediment. 2

- (ii) Find the width of elementary gravity dam whose height is 100 m. Specific gravity of dam material 2.2 and seepage co-efficient at the base  $c = 0.8$ . 2

- (iii) An aquifer of 25 m average thickness is overlain by an impervious layer of 30 m thickness. A test well 0.4 m in diameter and two observation wells at a distance of 12 m and 48 m are located in the aquifer. After pumping at a rate of  $0.2 \text{ m}^3/\text{s}$  for a long time, drawdowns in the wells were observed to be 3.5 m and 1.5 m respectively. Determine the coefficient of permeability in m/day. 2
- (iv) A conical tube of length 2 m fixed vertically with its smaller end upwards. The velocity head, pressure head at upper ends are 1.27 m and 2.50 m respectively. The velocity head and pressure head at lower ends are 0.203 m and 5.407 m respectively. Find the direction of flow. 2
- (c) (i) For a BOD test, raw sewage (3.0 ml) was diluted to 300 ml (capacity of a BOD bottle). The diluted sewage was observed for its dissolved oxygen at the beginning and end of 5 days incubation at  $20^\circ\text{C}$ . The respective values were 8.6 mg/L and 4.6 mg/L. Determine the BOD of the raw sewage. 2
- (ii) A mixed liquor with 2,000 mg/L of suspended solids has the settled volume of 200 ml from a litre of this mixed liquor. Calculate its sludge volume index. Is it safe? 2
- (iii) If the alum dose to coagulate is 10 p.p.m., find out the amount of alum (in quintals) needed to treat 10 mld of water. 2

- (iv) For a population of 2 lac having per capita daily demand of water of 150 litres, determine the water horse power to raise the water from a river of R.L. 120 m to treatment plant of R.L. 140 m through a rising main 1 m in diameter. Assume 2 m as the total head loss due to friction, etc. and pumping efficiency of 70%. 2
- (d) (i) Estimate the value of coefficient of permeability for a uniform graded sand of size  $D_{10} = 0.15$  mm, obtained from sieve analysis.  $G = 2.67$ . 2
- (ii) Calculate the active earth pressure at a depth of 3.6 m in a sandy soil with angle of internal friction as  $30^\circ$  and having a density of 1.9 gm/cc. 2
- (iii) Using Terzaghi theory find the ultimate bearing capacity for a square footing of  $2.0 \text{ m} \times 2.0 \text{ m}$  placed at depth of 1.2 m below the ground on a pure cohesive soil having density  $18 \text{ kN/m}^3$ .  $N_c = 5.7$ . Use local shear failure conditions.  $C = 40 \text{ kN/m}^2$ . 2
- (iv) A Flow net is plotted for a homogeneous earthen dam of 30.0 m height with a free board of 5.0 m. If  $K = 6 \times 10^{-4} \text{ cm/sec}$ , No. of flow channels = 4, No. of potential drops = 10, calculate the discharge per metre run of dam. 2



(c) (i) The scale of an aerial photograph is  $1 \text{ cm} = 150 \text{ m}$  and the size of the photograph is  $20 \text{ cm} \times 20 \text{ cm}$ . Determine the number of photographs in each strip to cover an area of  $15 \text{ km} \times 15 \text{ km}$  if the longitudinal overlap is 70% and side overlap 30%. 2

(ii) Using Prismoidal Rule calculate the volume of a 5 m deep pit whose top and bottom dimensions are respectively  $10 \text{ m} \times 20 \text{ m}$  and  $20 \text{ m} \times 40 \text{ m}$ . 2

(iii) In a locality where the rainfall is heavy, it is proposed to construct an ODR of WBM pavement (single lane), a two lane MDR of thin bituminous surface pavement. Taking IRC recommended camber and carriageway width, find out the height of the crown with respect to the edges. 2

(iv) A B.G. track has a sleeper density of  $n + 6$ . If the track is laid with welded rails of 26 m length, find out the number of sleepers required for constructing a railway track of 1690 m. 2

2. (a) (i) A power house has 5 impulse turbines. Each turbine has two runners. Each runner is installed with 4 nozzles. Total discharge is  $40 \text{ m}^3/\text{s}$ . Find the diameter of jet. Take coefficient of velocity as 0.985 and head as 250 m. 4

- (ii) A pipe carrying water tapers from cross-section  $0.3 \text{ m}^2$  at  $A$  to  $0.14 \text{ m}^2$  at  $B$ . The average velocity at  $A$  is  $1.8 \text{ m/sec}$  and pressure is  $441 \text{ kN/m}^2$  (gauge). If the frictional effects are negligible, determine the pressure at  $B$  which is  $5.5 \text{ m}$  above the level of  $A$ . 4
- (b) (i) In  $1 : 30$  model spillway, the velocity and discharges are  $2.0 \text{ m/sec}$  and  $2.0 \text{ m}^3/\text{sec}$  respectively. Find the corresponding velocity and discharge in the prototype. 4
- (ii) Draw surface profiles in the following cases :
- (i) Upstream and downstream of sluice gate on a mild sloped channel when critical depth line is above the gate opening.
  - (ii) A steep sloped channel ending in an abrupt drop having reservoir level on the downstream side above the critical depth line.
  - (iii) Steep sloped channel followed by a mild sloped channel.
  - (iv) Mild sloped channel followed by a steep sloped channel. 4
- (c) Explaining their qualitative differences in respect of total dissolved solids, turbidity and bacterial quality, suggest the units needed for the treatment of water drawn from (a) ground, (b) lake and (c) river. 8

- (d) What will be the gross and net safe bearing capacity of sand having  $\phi = 30^\circ$  and density  $2.1 \text{ t/m}^3$  below (a)  $1.0 \text{ m}$  wide strip footing (b)  $1.0 \text{ m} \times 1.0 \text{ m}$  square footing placed at a depth of  $1.2 \text{ m}$  below the ground. Take factor of safety as  $2.5$ . Take  $N_c = 30.14$ ,  $N_q = 18.4$ ,  $N_r = 22.4$ . 8
- (e) The observed altitude of  $\beta$ -ursac Minoris at lower and upper culminations are  $29^\circ 58' 15''$  and  $60^\circ 45' 3''$ . Find the latitude of the place of observation assuming the correction for refraction to be equal to  $57'' \times \text{tangent of apparent zenith distance}$ . 8
3. (a) (i) Show that the hydrostatic pressure remains invariant in a horizontal plane parallel to free surface. 4
- (ii) A sudden enlargement of a water pipeline from  $200 \text{ mm}$  to  $400 \text{ mm}$ . The hydraulic gradient rises by  $10 \text{ mm}$ . Estimate the discharge in the pipe. 4
- (b) (i) A metallic sphere of specific gravity  $8.0$  falls in an oil of density  $800 \text{ kg/m}^3$ . The diameter of the sphere is  $10 \text{ mm}$ . The viscosity of oil is  $7.848 \frac{\text{N-sec}}{\text{m}^2}$ . Determine the terminal velocity of metallic sphere. 4
- (ii) Show that for wide rectangular channel the bed slope ' $S_0$ ' is mild or steep according  $S_0$  being less than or greater than  $\frac{n^2 g \frac{10}{9}}{q^{\frac{2}{9}}}$ . 4

- (c) Differentiate between a slow sand filter and a rapid sand filter in respect of
- (i) Mechanisms of removal of impurities,
  - (ii) Cleaning process,
  - (iii) Effluent quality,
  - (iv) Bed size in qualitative term. 8

- (d) (i) Discuss Pore pressure parameters. 3
- (ii) In a laboratory vane shear test a vane 100 mm long and 60 mm diameter was pressed into the soft cohesive soil ( $G = 2.72$ ). A torque of 40 kN-mm was required to achieve the failure. Same soil when remoulded required 15 kN-mm to achieve failure. Calculate the cohesion in both cases and value of sensitivity. 5
- Take the void ratio of soil as 30%.

- (e) Find the difference in level between two points A and B in a reciprocal levelling with the following data :

$$R \sin 1'' = 30.876 \text{ m}, \sin 1'' = \frac{1}{206265}$$

$$\text{Horizontal distance between A and B} = 6882.38 \text{ m}$$

$$\text{Angle of elevation from A to B} = 1^\circ 50' 20''$$

$$\text{Angle of depression from B to A} = 1^\circ 51' 10''$$

$$\text{Height of signal at A} = 4.145 \text{ m}$$

$$\text{Height of signal at B} = 3.597 \text{ m}$$

$$\text{Height of instrument at A} = 1.463 \text{ m}$$

$$\text{Height of instrument at B} = 1.554 \text{ m} \quad 8$$

4. (a) (i) A five cylinders reciprocating pump raises the water level by 150 m and the theoretical discharge is  $0.20 \text{ m}^3/\text{s}$ . The velocity in the delivery pipe is  $2.0 \text{ m/s}$ . Total head loss in pipes is 20 m. What is the input power, if the efficiency of the pump is 0.87? 4
- (ii) Two pipes of lengths 2500 m each and diameters of 80 cm and 60 cm respectively, are connected in parallel. The friction factor for each pipe is  $4f = 0.024$ . Total flow is equal to 250 litres per second. Find the discharge in each pipe. 4
- (b) (i) A 5.0 m wide rectangular channel carries  $15 \text{ m}^3/\text{s}$  of water with a velocity of  $6 \text{ m/s}$ . State whether hydraulic jump is a possibility. If yes compute height of the jump and power dissipated. 4
- (ii) A trapezoidal channel with side slope 2 H : 1 V is carrying  $25 \text{ m}^3/\text{s}$ . The slope of the channel bed is 1 in 800. Take Chezy's  $C = 45$  and design the channel. 4
- (c) How much will be the settling velocity of a spherical particle A (having specific gravity of 2.65) of diameter  $10 \times 10^{-3} \text{ cm}$ . Determine the size for a floating spherical particle having a specific gravity of 0.80 (rising with the same velocity as that of particle A). Assume kinematic viscosity of water as  $1.012 \times 10^{-2} \text{ cm}^2/\text{sec}$ . 8

- (d) In a consolidation test done in laboratory a sample of 20 mm thick consolidated 50% in 15 minutes with double drainage. How much time a 5.0 m thick layer of same soil will consolidate 50% and 30%? If the soil layer has a rock below, how much time it will take to consolidate 50% and 30%? 8
- (e) The speeds of overtaking and overtaken vehicles are 80 kmph and 60 kmph respectively. If the acceleration of the overtaking vehicle is 2.5 kmph per second, calculate the safe passing sight distance for (i) single lane one way traffic (ii) three lane both way traffic. Assume perception time of driver = 2 sec. 8
5. (a) (i) A reaction turbine having inlet diameter as 1.0 m and rotational speed 400 r.p.m. has flow area  $0.25 \text{ m}^2$  at the inlet and is working under a head of 65 m. Flow is radial at the outlet. Compute the hydraulic efficiency and power developed by the wheel taking velocity of flow at inlet as 8.0 m/s and velocity of whirl at inlet as 25.0 m/s. 4
- (ii) Find the critical depth for a discharge of  $4 \text{ m}^3/\text{sec}$  for flow in right angle triangular channel. 4
- (b) (i) Two reservoirs are connected by a pipe 100 m long and 100 mm in diameter followed by another pipe 60 m long and 50 mm in diameter. The total head loss between the reservoirs is 10.3 m. Given  $f = 0.03$ . Compute discharge neglecting minor losses. 4

(ii) The velocity distribution within the

boundary layer is given by  $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{\frac{1}{n}}$ .

Obtain the ratio of displacement thickness to momentum thickness. 4

(c) Using  $n = 0.015$  in Manning's formula, design a sewer running half-full at a flow rate of 650 l/sec and laid at an invert slope of 0.0001. 8

(d) A 1.5 m layer of soil is subjected to an upward seepage head of 1.95 m. What depth of coarse sand will be required above this soil to provide a factor of safety of 1.5 against piping. Coarse sand and soil have specific gravity 2.67 and porosity as 30%. 8

(e) Calculate the design traffic in million standard axles (MSA) and commercial vehicles per day (CVD) required for design of flexible pavement as per current Indian procedure (revised IRC method) for the following data :

Annual daily commercial vehicles at last count (May 2008) = 200

Rate of traffic growth = 6%

Design life = 10 years

Vehicle damage factor = 2

The road is proposed to be completed in May 2011. 8

6. (a) (i) Find the magnitude of Froude number after the hydraulic jump given the Froude number before the jump is  $\sqrt{6}$ . 4



(ii) An oil having viscosity  $0.08 \text{ Ns/m}^2$ , specific weight  $8829 \text{ N/m}^3$ , density  $900 \text{ kg/m}^3$  flows at the rate of  $5.4 \times 10^{-3} \text{ m}^3/\text{s}$  through a horizontal circular pipe of  $0.12 \text{ m}$  diameter and length  $150 \text{ m}$ . Find

- (i) pressure difference in  $150 \text{ m}$  length in  $\text{kN/m}^2$
- (ii) wall shear stress in  $\text{N/m}^2$  and
- (iii) average and maximum velocity. 4

(b) (i) A three dimensional flow is given by

$$\vec{V} = (y^2 + z^2) \mathbf{i} + (x^2 + z^2) \mathbf{j} + (x^2 + y^2) \mathbf{k}$$

Determine the components of acceleration at a point  $(2, 3, 4)$ . 4

(ii) Show that the normal depth of flow in a triangular channel having side slope  $ZH : 1V$  is given by

$$y_n = 1.189 \left[ \frac{Q \cdot n}{\sqrt{S_0}} \right]^{\frac{3}{8}} \left( \frac{z^2 + 1}{z^5} \right)^{\frac{1}{8}} \quad 4$$

(c) The BOD rate constant ( $k$ ) for a river's BOD assimilation was determined to be  $2.0 \text{ day}^{-1}$  (base  $e$ ). The BOD of this river after leaving a heavily populated town was determined to be  $50 \text{ mg/L}$ . Determine the distance after which the river's BOD would become  $4 \text{ mg/L}$  when the average velocity of the river was  $1 \text{ m/sec}$ . What would have been the  $K$  value if this distance would have been  $300 \text{ km}$  and state what  $K$  manifests. 8



(d) A 6.0 m high retaining wall is to support a soil with unit weight  $\gamma = 17.4 \text{ kN/m}^3$ ,  $\phi = 26^\circ$  and  $c' = 14.36 \text{ kN/m}^2$ . Determine the Rankine active force per unit length of wall before the tensile crack occurs. Find the critical depth.

8

(e) A locomotive on B.G. track with four pairs of driving wheels each carrying axle load of 20 tonnes is required to haul a train at a speed of 80 kmph. The train is made to run on a level track with curvature of  $2^\circ$ . Calculate the maximum permissible load that can be pulled by the engine. Take hauling capacity  $\frac{1}{6}$  time the load on driving wheels.

8

7. (a) (i) Show that the most efficient trapezoidal channel section is half regular hexagon

given the side slope  $m = \frac{1}{\sqrt{3}}$ . 4

(ii) Design a transition using Mitra's hyperbolic transition given by

$$B_x = \frac{B_c B_f L_f}{L_f B_c - (B_c - B_f) x}$$

and compare the results using Chaturvedi's semi-cubical parabolic transition given by

$$x = \frac{L_f B_c^{3/2}}{B_c^{3/2} - B_f^{3/2}} \left( 1 - \left( \frac{B_f}{B_x} \right)^{3/2} \right)$$

Given nominal bed width = 25 m, width of flumed section = 10.0 m and total length of transition = 15.0 m. 4

- (b) (i) The shear stress  $\tau$  in open channel depends on depth of flow  $y$ , velocity  $v$ , density  $\rho$ , surface tension  $\sigma$  and acceleration due to gravity  $g$ . Using Buckingham's Pi Theorem, make out the dimensional analysis of the problem. 4
- (ii) The depth of moisture in root zone at field capacity and permanent wilting point per  $m$  depth of soil are  $0.5 \text{ m/m}$  and  $0.2 \text{ m/m}$  respectively. Compute the field capacity and permanent wilting point. Take dry weight of soil as  $13.73 \text{ kN/m}^3$ . 4
- (c) On the basis of a detention period of 24 hrs, determine the size (assuming length to width ratio of around 2 and depth of waste water about 1 m) of a Septic Tank required for a large house dwelling 100 persons. The flow into the tank may be assumed at the rate of 70 lpcd. What will be the surface loading and equivalent weir loading of the tank? 8
- (d) A  $450 \times 450 \text{ mm}$  concrete pile  $20.0 \text{ m}$  long is driven into sand deposits with  $\gamma = 17 \text{ kN/m}^3$  and  $\phi' = 30^\circ$ . Find the ultimate load ie point load  $Q_p$  by Meyerhoff's method and Janbu method.  
Meyerhoff's  $N_q' = 55$ , Atmospheric pressure =  $100 \text{ kN/m}^2$ , Janbu's  $N_q' = 18.4$ . 8
- (e) (i) From the following tidal data determine the wave height and wave velocity for a non-translatory wave  
Depth of water =  $3 \text{ m}$   
Fetch =  $800 \text{ km}$  4

- (ii) What are the considerations for determining the thickness of concrete lining in a tunnel. Find out the concrete lining thickness for a tunnel with a bore diameter of 7.6 m. 4

8. (a) (i) Flood frequency computation yields the following results :

<i>Return Period Years</i>	<i>Peak flood m<sup>3</sup>/s</i>
50.0	20,500
100.0	25,400

Using Gumbel's method, estimate the flood for a return period of 150 years. 4

- (ii) Show that if a plate 10 m × 5 m is towed through a fluid so that the boundary layer is entirely laminar, the ratio of towing speeds so that the drag force remains constant regardless of whether 10 m or 5 m side is in the flow direction is given by

$$\frac{U_{10\text{ m}}}{U_{5\text{ m}}} = 1.2598$$

If the boundary layer is entirely turbulent and Reynolds number is less than  $10^7$ ,

$$\frac{U_{10\text{ m}}}{U_{5\text{ m}}} = 1.08. \quad 4$$

- (b) (i) A rectangular channel 15 m wide has a normal depth of 0.8. The discharge carried is  $10 \text{ m}^3/\text{s}$ , what is the alternate depth? 4
- (ii) An inward flow reaction turbine is supplied water at the rate of  $0.36 \text{ m}^3/\text{s}$ . Outlet pipe of the turbine is 380 mm in diameter. Turbine operates under a head of 55 m. Radial velocity of wheel is the same as the velocity of flow in the outlet pipe. The tangential velocity of wheel at inlet is 20 m/s. Compute guide vane angle and vane tip angle at inlet. 4
- (c) Discuss the impact of air pollution on
- (i) Monuments
  - (ii) Animals
  - (iii) Plants and
  - (iv) Climate 8
- (d) A rectangular foundation  $6.0 \text{ m} \times 3.0 \text{ m}$  in size exerts a pressure of  $20 \text{ kN/m}^2$  to the soil underneath. Compute the increase of vertical stress at a point 0.5 m below the centre of foundation. Use Boussinesq equation. 8
- (e) Determine the radius of a taxiway for a supersonic aircraft to negotiate the curve at a turning speed of 50 kmph. The wheel base is 35 m and the tread of main landing gear is 7.5 m. The airport is of type A as per ICAO. Assume co-efficient of friction between tyre and pavement surface as 0.13. 8