

SEAL

I/LM/R-EXAM
2020

200115

CIVIL ENGINEERING

Time : 3 hours]

[Full Marks : 100

- Notes :** (i) Answer the questions as directed.
(ii) The figures in the right-hand margin indicate full marks for the questions.
(iii) Group—A is compulsory. Attempt *any four* questions from Group—B.
(iv) Answer all parts of a question together.

GROUP—A

(Compulsory Group)

1. Attempt *any ten* from the following :

2×10=20

- (a) State moment area theorems to find slope and deflection of the determinate beam.
- (b) State the uses of splicing in steel structures.
- (c) Explain, on what condition, bulk unit weight is equal to the dry unit weight of the soil.
- (d) List the factors affecting per capita demand for water consumption.
- (e) Explain, with figure(s), the modes of bearing capacity failure of soil.
- (f) Explain the detention period of a settling tank.
- (g) Calculate the mid-ordinate of a simple curve of radius R and deflection angle Δ .
- (h) Explain the factors affecting the calculation of length of a transition curve on a highway.
- (i) List the assumption(s) made in deriving the governing equation(s) of a gradually varied flow in a prismatic channel.

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- (j) What is the capacity of a single-lane highway section, if the free flow speed is 80 km/hr and jam density is 145 veh/km?
- (k) The discharge is maximum at a bridge site of a rectangular channel-type river for a given upstream specific energy of 4.05 m. Determine the unit discharge.
- (l) Elucidate the working techniques of the 'Remote Elevation Measurement' (REM) function in the electronics-based survey instrument 'Total Stations'.

GROUP—B

2. Attempt *any four* from the following :

5×4=20

- (a) List the assumptions made in the limit state method of reinforced cement concrete (RCC) design.
- (b) What is hydraulic jump? Calculate the loss of mechanical energy in a hydraulic jump. (Neglect slope of the channel.)
- (c) Differentiate piles according to the method of installation and briefly discuss them.
- (d) Illustrate the disinfection of water with ozone treatment (ozonation). Also, write its advantages and disadvantages.
- (e) A tension member is formed by connecting two wooden scantlings each 100 mm × 200 mm with glue (adhesive) at their ends. The connecting ends are cut at an angle of 60° with the horizontal and the members are connected through their respective cutting faces. Calculate the safe value of pull, the member can sustain, if the permissible normal stress is 2 N/mm² and shear stress is 1 N/mm².

3. Attempt *any four* from the following :

5×4=20

- (a) A vehicle is moving at a speed of 80 km/hr on a highway at a descending gradient of 2%. What is the minimum distance required by the driver to apply the brakes to avoid collision with a stationary object ahead of the vehicle? Consider the reaction time of the driver and coefficient of friction as 2.5 seconds and 0.35 respectively.
- (b) Derive the relationship between 'duty' and 'delta' of a crop. Find the delta for a crop when its duty is 864 hectares/cumec on the field, the base period of this crop is 120 days.

- (c) A saturated specimen of cohesionless sand was tested under the drained condition in a triaxial compression test apparatus. The sample failed at deviator stress of 482 kN/m^2 and the plane of the failure made an angle of 60° with the horizontal. Find the magnitude of the principal stresses. What would be the magnitude of the deviator stress and the major principal stress at failure for another identical specimen of sand, if it is tested under a cell pressure of 200 kN/m^2 ?
- (d) Concisely write the process of testing the quality of sewage.
- (e) Briefly describe any two methods of tachometry to measure horizontal distance.

4. Attempt *any four* from the following :

5×4=20

- (a) Illustrate the components and types of railway crossing.
- (b) Discuss different flood forecasting techniques.
- (c) The mass of moist soil is 20 kg and its volume is 0.011 m^3 . After drying in an oven, the mass reduces to 16.50 kg. Determine the water content, density of moist soil, dry density, porosity and degree of saturation. Take the specific gravity of soil as 2.65.
- (d) Derive the expression to find the maximum force experienced by any rivets of riveted joints subjected to moment (M) acting in the plane of the joint in addition to the direct load (W).
- (e) The sewage of a town is to be discharged into a river stream. The quantity of sewage produced per day is 8 million liters and its BOD is 250 mg/l. If the discharge in the river is 200 l/s and its BOD is 6 mg/l, find out the BOD of the diluted water. What should be the river discharge, if it is desired to reduce the BOD of the diluted water to 20 mg/l?

5. Attempt *any four* from the following :

5×4=20

- (a) The peak of flood hydrograph due to a 3-hr duration isolated storm in a catchment is $270 \text{ m}^3/\text{s}$. The total depth of the rainfall is 5.90 cm. Assuming an average infiltration loss of 0.30 cm/hr and constant base flow of $20 \text{ m}^3/\text{s}$, estimate the peak of the 3-hr unit hydrograph (UH) of this catchment. If the area of the catchment is 567 km^2 , determine the base width of the 3-hr unit hydrograph (UH) by assuming it to be triangular in shape.
- (b) What are the different methods of contouring? Explain any two indirect methods of contouring.

- (c) A constant head permeability test was carried out for a cylindrical sample of sand of 35 cm^2 cross-sectional area and 20 cm long. Under a head of 60 cm, the discharge was 120 ml in 6 min. The dry weight of sand was 1120 g and specific gravity was 2.68. Determine the hydraulic conductivity, discharge velocity and seepage velocity.
- (d) What are the different sight distance situations considered in highway geometric design and why? Write the objective(s) of providing superelevation on horizontal curves of highways.
- (e) Write itemize, the comparison between the slow sand and rapid sand filter of gravity type.
6. Use the working stress method to analyze a rectangular beam section of 300 mm width and 500 mm effective depth to determine the allowable moment of resistance and stresses induced in extreme compression fibre of concrete, compression steel and tension steel. The beam is reinforced with 4 numbers of 16 mm dia. tension steel and 4 numbers of 14 mm dia. compression steel at an effective cover of 50 mm. Consider concrete of grade M-20 ($\sigma_{cbc} = 7 \text{ MPa}$) and steel of grade Fe-415 ($\sigma_{st} = 230 \text{ MPa}$). 20
7. A beam ABC is simply supported at A and B. The length of AB and overhanging portion BC are 9 m and 3 m, respectively. The beam carries a uniformly distributed downward load of 6 kN/m over a length of 6 m from the mid-point of AC to the free end C, a concentrated downward load of 20 kN at a distance of 3 m from the left support A (towards support B), and an anti-clockwise couple of 15 kN-m at the mid-point of AC. Draw the shear force and bending moment diagram of the beam, and show the values at every 3 m interval. Also, find the position of the point of contra-flexure. 20
8. (a) What are the temporary and permanent adjustments of theodolite? Explain with their correct order. 10
- (b) The speed of overtaking and overtaken vehicles are 70 km/hr and 40 km/hr, respectively on a two-way, two-lane traffic road. The acceleration of the overtaking vehicle is 1 m/s^2 . Adopt reaction time of driver as 2 seconds. Calculate the safe overtaking sight distance and minimum length of overtaking zone. Draw a neat sketch of the overtaking zone and show the positions of sign posts. 10