

COMBINED COMPETITIVE EXAMINATION (MAIN)**CIVIL ENGINEERING****Paper-II***Time : 3 Hours**Full Marks : 200**Note : (1) The figures in the right-hand margin indicate full marks for the questions.**(2) Attempt five questions in all.**(3) Question No. 1 is compulsory.***1. Answer any *ten* questions from the following :****4×10=40**

- (a) Define '53 grade' cement. What test will you do to certify that a cement conforms to '53 grade'?
- (b) Why is dimensional tolerance of bricks important? How are they tested?
- (c) What is the standard gauge in Indian Railways? State the disadvantages of having a multiple gauge system.
- (d) Indicate how traffic volume data are presented and the results used in traffic engineering.
- (e) What are the qualities of good building stones?
- (f) What do you understand by the terms unit operations and unit processes used in wastewater treatment systems?
- (g) What are the advantages of fiber reinforced concrete?
- (h) Describe, briefly, backwater effect on a rating curve.
- (i) Why is base flow separated from the flood hydrograph in the process of developing a unit hydrograph?
- (j) Describe, in brief, the basic requirements of a good alignment. What are the factors that control the alignment of a railway line?
- (k) In terms of trickling filter, what is recirculation ratio?
- (l) Distinguish between hyetograph and hydrograph.

2. Answer any *eight* questions from the following :

5×8=40

- (a) A summit curve is formed at the intersection of a 3% up gradient and 5% down gradient. Calculate the length of the summit curve to provide a stopping distance of 128 m.
- (b) What are the characteristics of good lime?
- (c) What are the causes of creep? How can creep be adjusted?
- (d) How do you proceed to paint on an old work?
- (e) What are the characteristics of damp proofing materials?
- (f) Explain, in brief, the working principle of flooding type infiltrometer.
- (g) A crop requires a total depth of 92 cm of water for a base period of 120 days. Find the duty of water.
- (h) Explain (i) specific capacity of well and (ii) spherical flow in well.
- (i) A single-stage filter is to treat a flow of 3.79 MLD of raw sewage with BOD of 240 mg/L. It is to be designed for a loading of 11086 kg of BOD in raw sewage per hectare meter, and the recirculation ratio is to be 1. What will be the filter volume?
- (j) The moisture content of a sludge is reduced from 95% to 80% in a sludge digestion tank. Find the percentage decrease in the volume of sludge.

3. Answer any *five* questions from the following :

8×5=40

- (a) Explain why anaerobic reactors may fail if organic loading rate (OLR) is increased suddenly. What are the early warnings of reactor failure and how can such failure be prevented?
- (b) Why is equalization necessary in a wastewater treatment plant? With appropriate diagrams describe the difference between on-line and off-line equalization.
- (c) The following data pertains to the healthy growth of a crop :
 - (i) Field capacity of soil = 30%
 - (ii) Permanent wilting point = 11%
 - (iii) Density of soil = 1300 kg/m³
 - (iv) Effective depth of root zone = 700 mm
 - (v) Daily consumptive use of water for the given crop = 12 mm

For healthy growth moisture content must not fall below 25% of water-holding capacity between the field capacity and the permanent wilting point. Determine the water intervals in days.

- (d) An ascending gradient of 1 in 100 meets a descending gradient of 1 in 120. A summit curve is to be designed for a speed of 80 km/hr so as to have an overtaking sight distance of 470 m.
- (e) Mention the objectives of signaling. How are signals classified? Mention the functions of each signal.
- (f) What is oxygen sag curve? List two important limitations of oxygen sag curve.
- (g) What is siphon spillway? Sketch a saddle siphon spillway and explain the function of its various component parts.

4. Answer any *four* questions from the following :

10×4=40

- (a) A horizontal aquifer is of 10 m thickness and infinite areal extent with its top level 25 m below ground level. Static piezometric surface is 10 m below ground level. During steady rate of pumping from the well at 5000 m³/day, the steady drawdown at the well is 12 m. Permeability of aquifer formation is 48 m/day. Assuming the radius of influence as 500 m, find the effective well diameter in metre.
- (b) A trapezoidal channel with bottom width 3.5 m and side slopes 1H : 1V on the left and 1.5H : 1V on the right with $n = 0.016$ and a bed slope of 2.6 in 10000, carries a discharge of 8 m³/sec. Determine the normal depth and the average shear stress on the channel bed.
- (c) What are various plans to be prepared after the planning surveys are carried out? Briefly describe each one of them.
- (d) Find the terminal settling velocity of a spherical particle with diameter 0.5 mm and specific gravity of 2.6 settling through water at 20°C. $\rho_w = 998.2 \text{ kg/m}^3$ and $\mu = 1.002 \times 10^{-3} \text{ N-s/m}^2$ at 20°C.
- (e) It is required to supply water to a population of 20000 at a per capita demand of 150 L/d. The disinfection used for chlorination is bleaching powder which contains 30% of available chlorine. Determine how much of bleaching powder is required annually at the waterworks, if 0.3 ppm of chlorine dose is required for disinfection.

5. Answer any *two* questions from the following :

20×2=40

- (a) Compute the steepest gradient that a train of 20 wagons and a locomotive can negotiate given the following data :
Weight of each wagon = 20 t, Weight of locomotive = 150 t, Tractive effort of locomotive = 15 t, Rolling resistance of locomotive = 3 kg/t, Rolling resistance of wagon = 2.5 kg/t, Speed of the train = 60 km/hr.
- (b) A trickling filter plant treats 1500 cum per day of sewage with a BOD of 220 mg/L and SS of 250 mg/L. Estimate the total solid production assuming that primary clarification removes 30% of BOD and 60% of influent solids. Take the solid production in the trickling filter as @ 0.5 kg/kg of applied BOD.

- (c) At an energy dissipater structure below a low spillway, the discharge is $19 \text{ m}^3/\text{s}$ and the energy loss is 1 m at hydraulic jump forming therein. Determine the depths of flow at both ends of the jump.

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

- (a) In a water treatment plant, the pH values of incoming and outgoing waters are 7.2 and 8.4 respectively. Assuming a linear variation of pH with time, determine the average pH value of water.

- (b) Test for common ions are run on a sample of water and the results are shown below:

Constituents	
$\text{Ca}^{2+} = 55 \text{ mg/L}$	$\text{HCO}_3^- = 250 \text{ mg/L}$
$\text{Mg}^{2+} = 18 \text{ mg/L}$	$\text{SO}_4^{2-} = 60 \text{ mg/L}$
$\text{Na}^+ = 98 \text{ mg/L}$	$\text{Cl}^- = 89 \text{ mg/L}$

If a 10 percent error in the balance is acceptable, should the analysis be considered complete?

- (c) Give a list of materials which are commonly used as flooring materials and give a brief description of them.
- (d) What are the factors to be considered for the design of flexible pavements? Discuss the significance of each.
- (e) How is the 'design load' arrived at for rigid pavement design, using the data of axle load distribution studies? What are the objectives of providing dowel bars in rigid pavement?

7. Answer any *two* questions from the following : 20×2=40

- (a) Determine the warping stresses at interior, edge and the corner of a 25 cm thick rigid pavement with traverse joints at 5.0 m interval and longitudinal joints at 3.6 m intervals.

☒ Modulus of elasticity of cement concrete, $E = 3.0 \times 10^5 \text{ kg/cm}^2$

☒ Thermal coefficient of concrete per $^\circ\text{C}$, $e = 10 \times 10^{-6} \text{ per } ^\circ\text{C}$

☒ Poisson's ratio of concrete, $\mu = 0.15$

☒ Modulus of subgrade reaction, $K = 6.9 \text{ kg/cm}^3$

☒ Radius of contact area, $a = 15 \text{ cm}$

(Assume maximum temperature differential during day to be 0.6°C per cm slab thickness and maximum temperature differential of 0.6°C per cm slab thickness)

- (b) Explain total reaction time of a driver and the factors on which it depends. Explain PIEV theory and the importance of it. Derive the expression for calculating the overtaking sight distance on a highway.
- (c) Two million litres of water per day is passing through a sedimentation tank which is 6 m wide, 15 m long and having a water depth of 3 m. (i) Find the detention time for the tank. (ii) What is the average flow velocity through the tank? (iii) If 60 mg/L is the concentration of suspended solids present in turbid raw water, how much dry solids will be deposited per day in the tank, assuming 70% removal in the basin, and average specific gravity of the deposit as 2? (iv) Compute the overflow rate.
8. In design of pavements what are the design aspects to be considered? Outline the principle of rigid pavement design using stress equations. Mention different types of rigid pavements. What are the steps for design of rigid pavement as per IRC guidelines? Explain the necessity of providing dowel and tie bars in rigid pavements. 40
9. Raw wastewater is entering a treatment plant and contains 250 mg/L suspended solids. If 55% of these solids are removed in sedimentation, find —
- (a) the volume of raw sludge produced per million litre of wastewater. Assume that the sludge has a moisture content of 96% and specific gravity of solids is 1.2;
- (b) the unit weight of raw sludge. 40
- If 45% of raw sludge is changed to liquid and gas in the digestion tank, find the volume of digested sludge per million litre of wastewater. Assume that the moisture content of the digested sludge is 90%.
10. Following particulars were recorded from a barrage :
- Maximum reservoir level = 212 m
 - Pond level = 211 m
 - Downstream high flood level in the river = 210 m
 - Maximum design flood discharge = 3500 m³/s
 - Crest level of the barrage = 207 m
 - Crest level of the head regulator = 208 m
 - Coefficient of discharge for barrage = 2.1 m^{1/2}/sec
 - Coefficient of discharge for head regulator = 1.5 m^{1/2}/sec
 - River bed level = 205 m
 - Design discharge of main canal = 500 m³/s

Determine the number of gates required for the barrage and the head regulator if each gate has 10 m span. Neglect (a) the end contractions due to piers and abutments and (b) velocity of approach. If the stilling basin is provided downstream of the barrage for energy dissipation, find the length and RL of the basin floor. Assume that the length of the basin is 5 times the conjugate depth required for hydraulic jump. Neglect losses due to friction. 40