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* from the following :   4×10=40

    (a) List and describe the properties of brick which affect its performance during its service life.

    (b) What are the precautions to be taken for the storage of cement?

    (c) Write brief specifications of various components of track structure recommended for BG system of Indian Railways.

    (d) Discuss the suitability of concrete sleeper for heavy axle loads, high speed traffic and electric-traction on railways.

    (e) What is bulking of sand and how is it determined in the field? Explain its importance in preparation of concrete.

    (f) A 25 mL sample of treated waste water requires 175 mL of distilled water to reduce the odor to a level that is just perceptible. What is the threshold odor number?

    (g) Give a detail method to determine the percentage mixing ratio of a number of aggregate batches to achieve a specific gradation.

    (h) Explain briefly the ϕ-index and the W-index.

(i) A channel carrying 2·25 cubic meter of water per second is able to command 1620 hectares of culturable land. Intensity of irrigation is 50%. Base period for crop is 140 days. In another system a distribution is carrying 0·56 cubic meter of water per second and is capable of irrigating 243 hectares of land. Base period of crop in this case is also 140 days. Compare the duties of two systems and state which system is using water more economically.

(j) Consider a 1-hour traffic volume of 120 vehicles; obtain the distribution of 1-minute volume counts.

(k) List and explain four important design consideration for aerobic composting processes.

(l) Distinguish between inundation canal and perennial canal.

2. Answer any *eight* from the following : 5×8=40

(a) In which specific ways are milestone charts superior to bar charts? How is a network superior to a milestone chart?

(b) Describe the qualities of first class building bricks and indicate how they are influenced by the *(i)* nature of clay used, *(ii)* process of manufacture and *(iii)* manner of firing.

(c) What is ready mix concrete? What are its advantages? How is the quantity of concrete to be ordered calculated?

(d) Describe briefly the two general types of paint. Compare the performance of good quality of oil-based paint and latex paints.

(e) What is the difference between water proofing and damp proofing? Why is it essential to differentiate between the two?

(f) Describe briefly the unsteady flow effect on a rating curve.

(g) Differentiate between *(i)* weir and dam, and *(ii)* barrage and weir.

(h) Explain Theis's solution to unsteady flow in unconfined aquifer. What further assumption he made over and above those made by Dupit and Theim?

(i) What is an indicator organism? Discuss the characteristics of the ideal pathogen indicator and indicate which organisms most nearly exhibit these characteristics.

(j) A sample of water from a surface stream is analyzed for the common ions with the following results :

$$Ca^{2+} = 98 \text{ mg/L}$$
$$Cl^- = 89 \text{ mg/L}$$
$$HCO_3^- = 317 \text{ mg/L}$$
$$Mg^{2+} = 22 \text{ mg/L}$$
$$Na^+ = 71 \text{ mg/L}$$
$$SO_4^{2-} = 125 \text{ mg/L}$$

(i) What is the percent error in the cation anion balance?

(ii) Draw a bar diagram for the water.

3. Answer any *five* from the following :   8×5=40

(a) An analysis for BOD_5 is to be run on a sample of wastewater. The BOD is expected to range from 50 to 350, and the dilution is prepared accordingly. In each case, a standard 300 mL BOD bottle is used. The data are recorded below :

Bottle No.	Wastewater (mL)	DO_i	DO_5
1	20	8·9	1·5
2	10	9·1	2·5
3	5	9·2	5·8
4	2	9·2	7·5

(i) Determine the BOD_5 of the wastewater.

(ii) If you know that oxygen utilization rate is 0·21 per day at 20 °C, what will be the BOD_3 if the test is run at 30 °C?

(b) Write short notes on Rapid sand filter, dual media filter and mixed media filter.

(c) An unconfined aquifer made up of fine sand and gravel of 20 m thickness is underlain by a clay bed. The groundwater level was observed 2·5 m below the surface. A pumping test was conducted in a fully penetrating well at steady state condition. The discharge obtained was 4 litres per second. Two observation wells were monitored during the test. The wells are located at 25 m from the pumped well and the drawdown observed was 1·5 m and 0·5 m respectively. Calculate the coefficient of permeability of the aquifer.

(d) Explain with the aid of neat sketches the various types of chairs for BH rails and DH rails.

(e) Specify the details of geometric design and standards of hill road including hairpin bends.

(f) A 200 mL sample of water has an initial pH of 10. 30 mL of 0·02 N H_2SO_4 is required to titrate the sample to pH 4·5. What is the total alkalinity of the water in milligrams per liter as $CaCO_3$?

(g) What is a guide bank or Bell's bund? Draw a good sketch of a guide bank and explain its different parts.

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

(a) The peak of flood hydrograph due to a 3 h duration isolated storm in a catchment is 270 m³/s the total depth of rainfall is 5·9 cm. Assuming an average infiltration loss of 0·3 cm/h and a constant base flow of 20 m³/s estimate the peak of the 3 h unit hydrograph of this catchment. If the area of the catchment is 567 km², determine the base width of the 3 h hydrograph by assuming it to be triangular in shape.

(b) Design an irrigation channel using Lacey's theory when following data is given :

    Mean diameter of silt particles = 0·33 mm
    Longitudinal slope of channel = 1 in 6000
    Side slopes of the section = ½ : 1

Assume that for the given slope maximum discharge the canal has to carry under regime condition.

(c) Explain how the master plan is prepared and the road development programme is phased.

10

68

(d) A filterable residue analysis is run on a sample of water as follows. Prior to filtering, the crucible and filter pad is kept overnight in the drying oven, cooled and the dry mass (tare mass) of the pair determined to be 54·352 g. Two hundred and fifty mililiters of the sample is drawn through a filter pad contained in the porous bottom crucible. The crucible and filter pad are then placed in a drying oven at 104 °C and dried until a constant mass of 54·389 g is reached. Determine the suspended solids concentration of the sample.

(e) Explain the basic concept of activated sludge process and indicate the advantages and disadvantages of the two major kinds of activated sludge reactors.

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

(a) Give a simplified flowchart of recovery and refining of petroleum asphalt. Give a report on the requirements for Paving Bitumen as per IS specification.

(b) Calculate the diameter required for a single-stage trickling filter which yield an effluent BOD of 20 mg/L when treating settled domestic sewage with a BOD of 120 mg/L. The wastewater flow is 2200 m^3/day and recirculation is constant at 4000 m^3/day. The filter depth is ·1·5 m.

(c) What are the causes of waterlogging? Why soil is rendered unproductive and infertile when it is water logged? List four anti-water logging measure.

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

(a) A main combined sewer was designed to serve an area of 60 sq km with an average population of 185 persons/hectare. The average rate of sewage flow is 350 liters/capita/day.
The maximum flow is 50% in excess of the average together with the rainfall equivalent of 12 mm in 24 hours, all of which are run off. What should be the capacity of the sewer in cu. m/sec?

Find the minimum velocity and gradient required to transport coarse sand through a sewer of 40 cm dia with sand particles of 1 mm dia and specific gravity 2·65. Assume k for sand = 0·04. The Manning's roughness coefficient (n) for the sewer material may be assumed as 0·012. Use the formula

$$V_s = \frac{1}{n} r^{1/6} \sqrt{[kd'(G-1)]}$$

for evaluating the minimum velocity. Assume the sewer will be designed to be running full.

(b) Explain with the help of a vector diagram and proper explanation, how the concept of partial removal of lighter particles in horizontally flowing rectangular tank has evolved.

(c) What are the tests which are generally carried out for determining the suitability of brick for construction? Describe any two tests in detail.

(d) List the different types of wearing course, surface course, base course and subbase course of flexible pavement. Discuss the methods of construction of these courses as per MoRTH specification.

(e) The maintenance project of a building consists of ten jobs. The predecessor relationships are identified by their node numbers as indicated below. Draw the network diagram of the project :

Sl. No.	Job	Identification	Sl. No.	Job	Identification
1	A	(1, 2)	6	F	(4, 5)
2	B	(2, 3)	7	G	(4, 7)
3	C	(2, 4)	8	H	(5, 8)
4	D	(3, 6)	9	I	(6, 8)
5	E	(3, 5)	10	J	(7, 8)

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

(a) Explain the design of rigid pavement, dowel bar and tie bar as per IRC specifications.

(b) Discuss the concept of ESWL and ESAL. Explain the various design parameters needed for design of rigid pavement and flexible pavement as per IRC specification.

(c) Design the aeration tank for an activated sludge process using the following information :

No. of tank = 2

Flow rate = 1·5 MLD

Total BOD entering = 295 mg/L

BOD left in the effluent = 20 mg/L

MLSS = 3000 mg/L

F/M ratio = 0·12

Adopt an aeration tank of liquid depth 3·5 m and 9 m width

Sludge volume index = 100 mL/gm

$\alpha_y = 1\cdot 0$

$K_e = 0\cdot 06 d^{-1}$

The designed unit has to be verified by the following checks :

Check for aeration period (should be within 10 to 25 h)

Check for volumetric loading (should be within 0·2 to 0·4 kg/m^3)

Check for return sludge ratio (should be within 0·5 to 1·0)

Check for SRT (should be within 10 to 25 days)

8. Derive the formulae of a turnout using three different methods. Also write down the important features of all these methods. 40

9. A town with a population of 30000 has to design a sewage treatment plant to handle industrial as well as domestic wastewater of the town. A sanitary survey revealed the following :

Dairy wastes of 3 million litres per day with BOD of 1100 mg/L and sugar mill waste of 2·4 million litres per day with BOD of 1500 mg/L are produced. In addition, domestic sewage is produced at the rate of 24 liters per capita per day. The per capita BOD of domestic sewage being 72 gm/day. An overall expansion factor 10 percent to be provided. The sewage effluents are to be discharged to a river stream with a minimum dry weather flow of 4500 litres per second and a saturation dissolved oxygen content of 9 mg/L. It is necessary to maintain a dissolved oxygen content of 4 mg/L in the stream.

Determine the degree of treatment required to be given to the sewage. Assume the following :

(i) Values of coefficient of deoxygenation and reoxygenation at mix temperature as 0·1 and 0·3 respectively.

(ii) Dissolved oxygen of wastewater as zero.

Also determine what should be the dilution ratio if no treatment was required and thus determine the river discharge for such a condition. 40

10. Describe design criteria for distributary head regulator and cross regulator. Describe the functions served by a distributary head regulator. How do they differ from the functions of the canal cross regulator. Determine the discharge passing through a distributary head regulator with the following data : 40

   u/s FSL = 115·50 m
   Distributary FSL = 115·00 m
   Crest of regulator = 114·00 m
   Clear water way = 9·00 m
   Cd_1 = 0·6
   Cd_2 = 0·8

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