CIVIL ENGINEERING
Paper – II

Time Allowed : **Three** Hours	Maximum Marks : **200**

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions :

*There are **EIGHT** questions in all, out of which **FIVE** are to be attempted.*

*Questions no. **1** and **5** are **compulsory**. Out of the remaining **SIX** questions, **THREE** are to be attempted selecting at least **ONE** question from each of the two Sections A and B.*

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

All questions carry equal marks. The number of marks carried by a question/part is indicated against it.

*Answers must be written in **ENGLISH** only.*

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

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

Neat sketches may be drawn, wherever required.

SECTION A

Q1. (a) The images X and Y of the base and the top respectively of a tower having height 155 m are observed in a truly vertical aerial photograph of scale 1 : 10,000. Determine the position of X from the principal point given that Y is 75·0 mm from the principal point of the photograph. Focal length of the aerial camera is 125 mm. Assume the tower to be at the datum level. *8*

(b) Calculate the maximum permissible speed on a curve of a high speed broad gauge track of group A using the following data : *8*

(i) Degree of curve = 2°

(ii) Superelevation = 85 mm

(iii) Length of transition curve = 125 m

(iv) Maximum sanctioned speed = 160 km/h

(v) Cant deficiency = 100 mm

(c) Determine the safe stopping sight distance to avoid head-on collision for two cars A and B that are approaching towards each other from opposite directions. Car A is moving at a speed of 85 km/h in upward direction and car B is moving at a speed of 65 km/h in downward direction. Assume reaction time as 2·5 seconds, coefficient of friction as 0·37 and a brake efficiency as 80%. The gradient of road section is taken as 2%. *8*

(d) Briefly explain how Total float and Free float can be determined. In a network analysis, how can total float be used to determine critical path and subcritical path ? *8*

(e) Answer the following in brief : *8*

(i) What is the basic advantage of using ferro-cement in ferro-cement concrete ?

(ii) Why is carbon fiber reinforced polymer used for seismic retrofitting and repair of damaged structures ?

Q2. (a) Differentiate between the following : *15*

(i) Plastering and Pointing

(ii) Balcony and Terrace

(iii) Roof decking and Roof covering

(b) Two straights PQ and QR intersect at a chainage of 3150 m. The angle of intersection is 130°. It is required to set out a 4° simple circular curve to connect the straights. The chain used for setting out the curve is of 30 m length. The length of first subchord is 25·25 m and length of last subchord is 20·0 m. Calculate all the necessary data required for setting out the curve using the method of offsets. *15*

(c) A fixed time two-phase signal is to be designed for a four-legged intersection, for which the design hourly flow and saturation flow are given below :

Details of flow	North	South	East	West
Design hourly flow (veh/h)	570	320	550	455
Saturation flow (veh/h)	1750	1500	2210	2265

Time lost per phase due to starting delays is 2 seconds. Calculate the optimum cycle time and allocate the green time for the two phases using Webster's method. *10*

Q3. (a) What are the merits and demerits of line and staff organisation for a construction company ? *10*

(b) What are the main constituents of a concrete batching and mixing plant ? *10*

(c) An upgrade road section of gradient 1 in 130 meets a downgrade road section of gradient 1 in 130. A summit curve is required to be designed for a design speed of 65 km/h so that an overtaking sight distance of 350 m is available. Determine the length of the summit curve. *10*

(d) Design a tie-bar system for a cement concrete pavement with the following data : *10*
   (i) Thickness of slab = 18 cm
   (ii) Width of slab = 3·30 m
   (iii) Coefficient of friction = 1·5
   (iv) Unit weight of pavement = 2400 kg/m^3
   (v) Allowable working stress in steel = 1400 kg/cm^2
   (vi) Maximum permissible bond stress in concrete = 17·5 kg/cm^2
   (vii) Maximum permissible tensile stress in steel bars = 24·6 kg/cm^2

Q4. (a) A shopping centre is proposed to be developed on a valuable farmland. The farmland presently contributes ₹ 10 crores per year. It is expected that the proposed shopping centre will have a benefit of ₹ 70 crores per year. It is proposed that an amount of ₹ 500 crores is to be deposited in the bank for a period of 50 years where it will earn interest at a rate of 10% per year compounded annually. A fixed amount will be withdrawn yearly as a yearly development cost so that the amount of ₹ 500 crores will just be depleted at the end of 50 years. Analyse the desirability of the above project proposal, assuming a yearly maintenance cost of ₹ 2 crores also.

Further, assuming that the affected farmers may demand to compensate them for the cost of farmland. For this purpose, a fixed sum of money will be deposited in the bank at the end at each year such that a total amount of ₹ 120 crores will be accumulated at the end of the 10-year period to be paid to farmers. Assume interest rate as 5% per year, compounded annually. Would the revised project proposal be desirable, with this new disbenefit ? *10*

(b) What are the harmful effects of cracks in buildings ? What are the measures that can be taken to repair cracks in buildings ? *10*

(c) Assuming a linear speed density relationship, the mean free flow speed and jam density are observed as 75 km/h and 90 vehicles/km. Compute the average time headway, spacing, clearance and gap when the flow is maximum. Take average length of vehicle as 6·1 m. *10*

(d) A horizontal circular curve of radius 320 m is to be aligned on a two-lane highway, 7 m wide in an urban area having the mixed traffic condition. The design speed is 65 km/h and the wheel base of the design vehicle is of 6 m length. Superelevation is achieved by rotating the pavement about its centre line. Assume rate of introduction of superelevation as 1 in 100 for plain terrain. Determine the length of the transition curve. *10*

SECTION B

Q5. (a) What do you mean by flood routing ? Distinguish between reservoir and channel routing. What information is required for routing a flood through a reservoir. List the name of two methods generally used for reservoir routing. *8*

(b) List various types of dams based on hydraulic design and mode of resistance offered by them against external forces. Calculate stresses developed at heel and toe of the dam profile shown in Figure 1. Consider only weight of dam and water pressure.

Take unit weight of dam material = 24 kN/m³ *8*

unit weight of water = 10 kN/m³
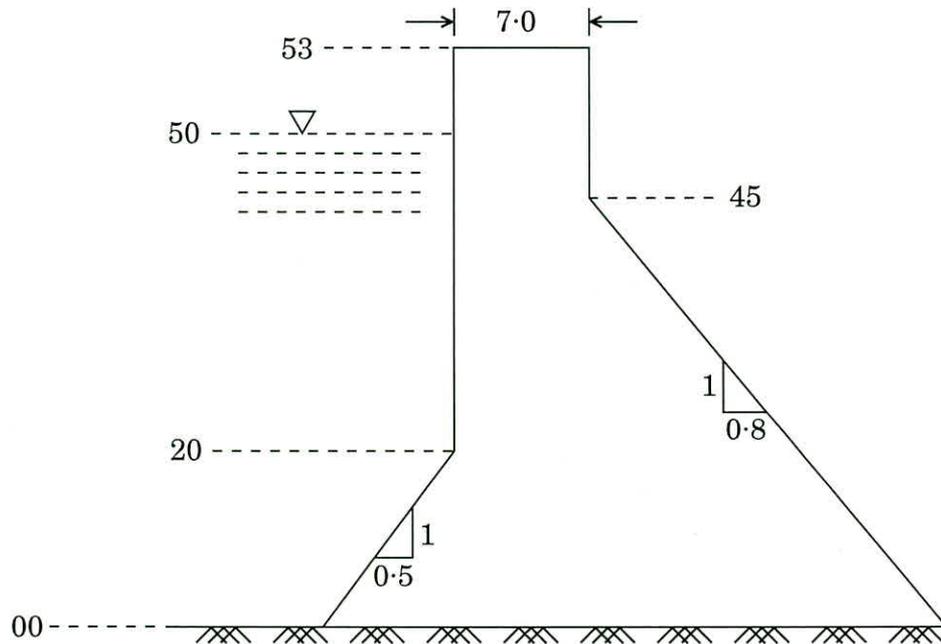
(All levels and dimensions are in metres)

Figure 1

(c) Differentiate between River training and Cross drainage works. Classify cross drainage works based on the condition of crossing. *8*

(d) River water is used as the source of water supply in a town. The major catchment of the river is agricultural fields and there is no industry existing in the catchment. What are the water quality parameters one needs to worry about ? Why ? To meet the drinking water quality, suggest the necessary treatment systems and explain why each system is needed. *8*

(e) Sedimentation tanks are used for various water and wastewater treatment facilities. Explain the design criteria for a secondary sedimentation tank of a wastewater treatment system. How is this different from the design of a primary sedimentation tank used for water treatment ? 8

Q6. (a) (i) What is the significance of break point chlorination ? Draw the titration curve representing Residual Chlorine vs Chlorine added in the following cases and explain the behaviour :
(I) Distilled water,
(II) 1000 mg/L sterilized glucose solution and
(III) Secondary treated wastewater. 5

(ii) Clean water at 20°C is passed through a bed of uniform sand at a filtering velocity of 6·0 m/h. The sand grains are 0·4 mm in diameter with a shape factor of 0·9 and a specific gravity of 2·6. The depth of the bed is 0·75 m and the porosity is 0·4. Determine the head loss through the bed. If the filter medium is to be expanded to a porosity of 0·6 by hydraulic back wash, determine the required back wash velocity and depth of expanded bed. Density of water at 20°C = 998·2 kg/m^3. Dynamic viscosity of water at 20°C, $\mu = 1·002 \times 10^{-3}$ N.s/m^2. Acceleration due to gravity, g = 9·81 m/s^2. 10

(b) (i) What do you mean by atmospheric stability ? How is it affecting the ambient air quality ? Explain. 5

(ii) A town has a population of 10,00,000 (10 lakhs). The municipality decided to construct a wastewater treatment plant using Activated Sludge Process (ASP). Show the flow diagram of the treatment system. Also calculate the volume of the aeration tank and the daily sludge wastage needed from the plant, if the BOD$_u$ of the wastewater entering the ASP is 250 mg/L and the desired effluent quality is 10 mg/L as BOD$_u$. Assume that the system is a completely mixed reactor yield coefficient, Y = 0·5; decay constant of microbes, k$_d$ is 0·05/d, MLSS concentration in aeration tank is 3000 mg/L and an underflow concentration of 10,000 mg/L is desired. The Biological Sludge Residence Time (BSRT) of the system, θ_c is 10 days. 10

(c) Explain Darcy's law of flow through porous media. A confined stratified aquifer has a total thickness of 10 m and is made up of three layers. The bottom layer has coefficient of permeability of 25 m/day and a thickness of 4·0 m. The middle and top layers have permeability of 15 m/day and 30 m/day respectively and are of equal thickness. Calculate the equivalent permeability and transmissivity of the confined aquifer, if flow is along the stratification. *10*

Q7. (a) (i) What are the salient features of Lacey's regime theory. Using Lacey's theory, design an irrigation channel for the following data : *10*

Discharge (Q) = 40 cumec

Silt factor (f) = 1

Side slopes = $\frac{1}{2}$: 1

(ii) Briefly discuss the factors affecting infiltration capacity of soil. *5*

(b) (i) What is flow mass curve ? How is it prepared ? Explain the procedure of determining the storage capacity of a reservoir by using flow mass curve. *10*

(ii) Briefly explain various purposes of providing galleries in dams. *5*

(c) (i) Explain various phases of composting and the factors affecting composting process. *5*

(ii) Draw a cross-sectional view of an engineered landfill and show various components. Also, explain the purpose of each component. *5*

Q8. (a) (i) Given below are the ordinates of 2-hour (h) Unit Hydrograph (UH) for a catchment.

Time (h)	0	2	4	6	8	10	12	14	16
Ordinates of 2-h UH, m^3/s	0	8	25	30	22	16	8	5	0

A storm of 4-hour duration and having Excess Rainfall (ER) of 3·0 cm occurred on the same catchment. Calculate the ordinates of resulting flood hydrograph. Assume a constant base flow of 5 m^3/s. *10*

(ii) List various components of a barrage. Explain the role of pocket or approach channel in controlling the sediment flow into the canal. *5*

(b) (i) Differentiate between the following : 6

        I.   Design of Water distribution system and Sewer system

        II.   Specific yield and Storage coefficient

        III.   Hydraulic conductivity and Transmissivity

(ii) What are the air pollutants emitted from a thermal power plant ? To control these pollutants, what are the pollution control devices one can use ? Show the order in which these units need to be placed and why so ? 9

(c) (i) What do you mean by sustainable development ? How can the sustainability approach be used for waste management ? 4

(ii) Determine the 3-day BOD and ultimate first stage BOD for a wastewater whose 5-day 20°C BOD is 250 mg/L. The reaction constant k (base e) is 0·23/d. What would have been the 5-day and 3-day BOD, if the test had been conducted at 28°C ? 6