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.

Question Nos. **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.

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

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.

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.

Answers must be written in ENGLISH only.

SECTION—A

1. *(a)* Which properties of normal concrete will improve by adding polymers in a polymer concrete? What are the worthwhile applications of costly polymer concrete? 8

(b) Sketch the following brick masonry works and briefly explain their functions :

(i) Wall footing

(ii) Buttresses

(iii) Corbels

(iv) Retaining walls 8

(c) Differentiate between the following :

(i) Total float and Independent float of an activity

(ii) Optimistic time estimate and Pessimistic time estimate of an activity 8

(d) A road intersection has five legs designated as 1, 2, 3, 4 and 5. Leg 1 is in N-S direction and others are marked clockwise. The traffic volumes in terms of PCU (V_{ij}) per hour during peak period are given below :

V_{12}	37	V_{31}	466	V_{41}	182	V_{51}	45
V_{13}	303	V_{32}	122	V_{42}	54	V_{52}	132
V_{14}	64	V_{34}	47	V_{43}	18	V_{53}	62
V_{15}	52	V_{35}	657	V_{45}	116	V_{54}	15

Find the weaving ratio between the legs 1 and 2. What is the use of this value? Draw a sketch showing the traffic volumes between legs 1 and 2. 8

(e) Discuss briefly the aspects of flight planning for an aerial survey and derive an expression for the number of photographs required for a given length and width for such a survey. 8

2. *(a)* Calculate the maximum permissible train load that can be pulled by a locomotive with four pairs of driving wheels with an axle load of 28·42 t each on a straight level BG track at a speed of 90 kmph. Also, calculate the reduction in speed if the train has to run on a rising gradient of 1 in 200. What would be the further reduction in speed if the train has to negotiate a 3° curve on the rising gradient? Take the coefficient of friction to be 0·2. 15

(b) What are the general causes of pavement failures? What are the various types of failures in flexible pavement? Explain the causes. 10

(c) Briefly discuss the following techniques to repair various types of cracks in concrete surface :

(i) Routing and sealing

(ii) Stitching

(iii) Grouting 5×3=15

3. *(a)* Briefly explain the following :

(i) How do the size of the equipment and standardization affect equipment selection?

(ii) How do availability of equipment and availability of spare parts affect equipment selection?

(iii) Objects of preventive maintenance of construction equipment 5×3=15

(b) Briefly explain how fineness modulus of an aggregate is obtained. The actual masses of various materials required at the site to prepare a concrete mix are :

(i) Cement = 350 kg / m^3

(ii) Coarse aggregate = 1526 kg / m^3

(Fineness modulus = 7·6)

Determine the mass of fine aggregate (having fineness modulus as 2·8) required to make a mix of fine and coarse aggregate having designed fineness modulus as 6·4. 10

(c) The following consecutive readings were taken with a level and 3 m levelling staff on a continuously sloping ground :

0·605, 1·235, 1·860, 2·575, 0·240, 0·915,
1·935, 2·875, 0·565, 1·825, 2·720

The RL of the first point was 247·850. Rule out a page of a level field book and enter the above readings. Calculate the reduced levels of all points and apply the check. Also, find out the gradient of the line joining the first and last points spaced at a distance of 160 m. 15

4. *(a)* A construction project is planned for 15 weeks and the information about various activities of the project (as shown in Fig. 1) is given in Table–1 below. It is required to complete the project in 12 weeks. Determine *(i)* the total cost to complete the project in 12 weeks and *(ii)* the project duration for which the total project cost is the lowest :

Table–1

Project Activity	*Normal Duration* (weeks)	*Normal Cost* (₹ in lakh)	*Crash Duration* (weeks)	*Crash Cost* (₹ in lakh)
A–B	10	9	6	15
B–C	5	6	2	8·7

Assume project overhead indirect cost as ₹ 1 lakh/week.

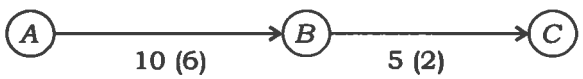

Fig. 1 15

(b) The following are the records of a tacheometric survey :

Instrument Station	*Staff Station*	*Bearing*	*Vertical Angle*	*Hair Readings*
A	*B*	N30°30′E	+10°	1·250, 1·750, 2·250
B	*C*	S40°30′E	+ 5°	0·950, 1·750, 2·550
C	*D*	S45°0′W	+ 8°	1·550, 2·150, 2·750

The instrument constants are 100 and 0. The staff is held vertically. Calculate the length and bearing of line *DA*. 15

(c) Draw a neat sketch of a right-hand turnout taking off from a straight broad gauge track, and name thereon the various component parts and important terms connected with the layout. Write briefly about any four components. 10

SECTION—B

5. (a) Consider the following flood hydrograph entering the upstream end of river reach. Apply the Muskingum routing procedure ($K = 8$ h and $x = 0{\cdot}25$) :

Time (h)	0	4	8	12	16	20	24	28
Inflow (m^3/s)	8	16	30	30	25	20	15	10

Assume that the initial outflow from the reach is 8 m^3/s. Find the peak discharge at the d/s end of river reach. 8

(b) (i) Define duty and methods of improving duty. 4

(ii) The distribution of crops under a canal system is given below. Compute the release from reservoir if the canal losses are 30% :

Crop	*Base Period* (days)	*Duty of Field* (hectares/cumec)	*Area under each Crop* (hectares)
Wheat	120	1800	4800
Cotton	200	1400	2400
Rice	120	900	3200
Vegetables	120	700	1400

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(c) (i) A well is discharging steadily at 1·5 m^3/min and producing drawdowns of 2·0 m and 1·1 m at distances of 120 m and 160 m, respectively. If the well is operating in a 20 m thick confined aquifer with full penetration, calculate (1) the transmissibility coefficient and (2) the drawdown at well (if well diameter is 30 cm). 5

(ii) Differentiate between Barrier boundary and Recharge boundary. 3

(d) Draw the population growth curve or the logistic curve and show the various growth segments on the same. Also, show the corresponding population forecasting method applicable to the particular growth segment on the logistic curve explaining the logic. Under what conditions the population growth of a place will follow the logistic curve? 8

(e) What are the dual media and multimedia filters in water treatment? How are they advantageous than the single-media filters? What media are used in these filters and why? 8

6. (a) A municipal wastewater treatment plant receives wastewater flow of 7500 m^3/d. The influent BOD is 300 mg/L. The wastewater treatment involves primary sedimentation followed by trickling filters. Determine the required filter diameters for a two-stage trickling filter unit for the following design parameters :

Desired effluent BOD = 30 mg/L

BOD removal in primary sedimentation = 35%

Depth of both the filters = 1·85 m

BOD removal efficiency for both the filters equal, $E_1 = E_2$

Recirculation ratio = 2 : 1

Wastewater temperature = 20 °C 15

(b) Treated effluent from a wastewater treatment plant is being discharged in a river. The wastewater flow rate is 12000 m^3/day with BOD_5 of 30 mg/L, dissolved oxygen concentration of 2 mg/L and a temperature of 25 °C. The river at the upstream of the wastewater discharge point is found to have a flow of 0·4 m^3/s, a BOD_5 of 3 mg/L, a dissolved oxygen concentration of 6 mg/L and a temperature of 22 °C. After almost instantaneous and complete mixing of river and wastewater, the velocity of the mixed flow is 0·2 m/s. The BOD rate constant is 0·23 per day and the reaeration constant is 0·4 per day at 20 °C. Determine the location of the most critical oxygen deficit point in the river and the value of dissolved oxygen concentration at this point. Take thermal coefficients for BOD reaction rate as 1·047 and reaeration rate as 1·016. The equilibrium concentration of oxygen at the mix temperature for freshwater is 8·7 mg/L. 15

(c) The direct runoff hydrograph of a catchment is given below :

Time (h)	0	2	4	6	8	10	12	14	16	18
Direct Runoff (m^3/s)	0	120	480	670	470	270	130	80	30	0

The runoffs are resulting from two successive 2-h duration rainfall excesses of 2·0 cm and 3·0 cm, respectively. Derive a 2-h unit hydrograph for this catchment. 10

7. *(a)* For the following data, design a vertical drop weir on Bligh's theory and check the exit gradient by Khosla's theory :

(1) Maximum flood discharge = 1800 cumecs

(2) Lacey's silt factor $f = 1$

(3) HFL before construction = 185 m

(4) FSL of canal = 184 m

(5) Downstream bed level = 178 m

(6) Permissible afflux = 1 m

(7) Creep coefficient = 12

(8) Exit gradient = 1/5

(9) Retrogression after construction = 0·5 m

(10) Head loss through regulator = 0·5 m

(11) Assume crest bottom width = 8 m

Only compute the following components of vertical drop weir :

(i) Crest level

(ii) u/s and d/s cutoff level

(iii) Length of impervious apron

(iv) Exit gradient of design floor 15

(b) *(i)* Draw the sketch of a canal head regulator and mark the important levels in the cross-section. 5

(ii) A non-alluvial soil canal is to be designed to carry discharge of 40 cumecs on a bed of 1/4000 slope. Assume Manning's $n = 0{\cdot}025$ and maximum permissible velocity as 0·8 m/s, and slide slope 1 : 1. 10

(c) *(i)* A circular sewer of 450 mm diameter, laid at a slope of 0·0018 m/m, carries a peak flow of 0·121 m^3/s when flowing full. Check whether the sewer fulfills the requirements of the minimum velocity and the maximum velocity. Assume Manning's n as 0·013. Why there is a need to check for minimum velocity and maximum velocity requirements? 5

(ii) What are the check valves and the pressure-reducing valves? Why and where are they used? 5

8. *(a)* *(i)* Explain the Swedish circle method of slope stability. 10

(ii) Write the steps for computation of hydraulic jump at the d/s of a spillway. 5

(b) (i) Compute the most probable number (MPN) of coliform organisms per 100 mL based on the following test results using the Thomas equation :

Sample Volume (mL)	100	10	1	0·1	0·01
Number Positive	5	5	4	3	1
Number Negative	0	0	1	2	4

Mention the tube combination that is to be selected for calculation giving the reason. 5

(ii) What are the primary air pollutants and the secondary air pollutants? Explain with example. What are the primary and secondary air quality standards? Which should be more stringent? What is air quality index? What are the air pollutants that are integrated in the air quality index? 10

(c) A municipal solid waste landfill is being designed to handle the solid waste generated by a city at a rate of 50000 kg/d. The waste will be delivered by trucks on a 5 d/week basis. The density as spread is 120 kg/m^3. It will be spread in 0·60 m layers and compacted to 0·20 m. Assuming three such lifts per day and a daily cover of 0·15 m, determine *(i)* the annual volume of landfill consumed in m^3 and *(ii)* the daily plan (horizontal) area covered by the solid waste. Ignore the soil volume between the stacks. 10

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