

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.

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

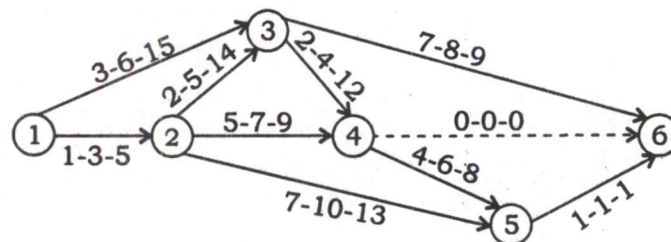
1. (a) Compare English bond and Flemish bond in brick masonry. 8
- (b) What do we understand by seasoning of timber? Why is seasoning of timber required? Discuss the methods of seasoning of timber. 8
- (c) A civil engineering project requires an investment of 100 crores. It is expected to get a return of 50 crores after 3 years and 100 crores after 6 years. If the rate of interest is 10%, is it worth to invest in the project? 8
- (d) A vehicle travelling at a speed of 50 kmph up a grade requires 58.2 m to stop after applying the brakes. Another vehicle travelling at a speed of 60 kmph down the same grade requires 79.0 m to stop. If the coefficient of friction between the tyres and the pavement is 0.4, calculate the percentage grade of the road. Assume that the reaction time is equal to 2.5 sec. 8
- (e) An open traverse having the following observations has been run from point A to E :

Side	Length (m)	Whole circle bearing
AB	300	292° 00'
BC	250	30° 00'
CD	130	0° 00'
DE	270	45° 00'

If the independent coordinates of point A is 1000 m, 1000 m, calculate the coordinates of point P, midway between A and E. 8

2. (a) For the following PERT network, calculate the—
 - (i) critical path;
 - (ii) probability of completing the work in 20 weeks;
 - (iii) completion time duration for which the probability of completion is 98%.

All time mentioned are in weeks.



Probability factor	Probability (%)
+0/-0	50.00/50.00
+0.5/-0.5	69.15/30.85
+1.0/-1.0	84.13/15.87
+1.5/-1.5	93.32/6.68
+2.0/-2.0	97.72/2.28
+2.5/-2.5	99.38/0.62
+3.0/-3.0	99.87/0.13

- (b) (i) A four-lane single carriageway road is subjected to the following traffic :

	<i>Bus</i>	<i>Truck</i>
No. of vehicles/day	500	2000
Rate of growth (%)	2%	10%
Gross wheel load (T)	16	20
Wheel configuration (Front/Rear)	Single Axle/ Dual Axle	Single Axle/ Tandem Axle

Calculate the design traffic for pavement design considering planning and construction period as 1.5 years and design life as 20 years. Assume necessary data suitably.

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- (ii) Explain, with diagram, how the surface water is collected and disposed of in urban roads.

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- (c) Plan the aerial survey for the flat terrain at mean sea level using the data given below :

Area to be covered = 50 km × 10 km

Size of the photograph = 23 cm × 23 cm

Average scale of the photograph = 1 : 5000

Longitudinal overlap = 75%

Side overlap = 30%

Focal length of the camera = 200 mm

Ground speed of aircraft = 200 km/hr

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3. (a) The following staff readings were taken with a level at a uniform common interval of 30 m :

1.350, 2.340, 3.120, 2.145, 3.400, 2.100, 2.120, 3.330, 1.240, 1.900

The instrument has been shifted after the 3rd, 6th and 8th reading. 3rd and 4th reading were taken with an inverted staff at the same point. The reduced level of the first point is 120.000 m. Calculate the RL of all other points. Apply the usual checks and also calculate the gradient of the line joining the first point with the last point.

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- (b) (i) What do you understand by concrete pump? Discuss its usage on construction site. Explain the working of concrete pump.

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- (ii) Discuss the need for low-cost housing materials. List the various options available in low-cost housing materials.

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- (c) A 2° curve on a broad gauge railway track has a maximum sanction speed of 120 kmph. Assuming the equilibrium speed of 90 kmph and the speed of slow moving trains as 50 kmph, calculate the superelevation and the maximum permissible speed on the railway track. Assume that the maximum cant deficiency is equal to 100 mm and the permissible cant excess is equal to 75 mm.

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4. (a) (i) Explain how preconstruction anti-termite treatment is carried out. 10
- (ii) Discuss the primary concept of energy-efficient building. 5
- (b) Design an isolated traffic signal with no turning movement for the right-angled crossing of two roads A and B considering the following design parameters :
- | | Road A | Road B |
|---|--------|--------|
| Width of road | 14 m | 7 m |
| Number of lanes | 4 | 2 |
| Average normal flow of traffic
(PCU per hour per lane) | 500 | 300 |
- Amber period = 2 sec
 Initial walking time for pedestrian = 7.0 sec
 Walking speed for pedestrian = 1.2 m/sec
- Assume any other necessary data suitably. 15
- (c) Discuss the usage, parts and factors affecting the efficiency of power shovel. 10

SECTION—B

5. (a) Determine the optimum number of rain gauges in a catchment area from the following data :
- (i) Number of existing rain gauges = 8
- (ii) Mean annual rainfall at the gauges = 1000 mm, 950 mm, 900 mm, 850 mm, 800 mm, 700 mm, 600 mm, 400 mm
- (iii) Permissible error = 6 percent 8
- (b) The left branch canal carrying a discharge of 20 cumecs has culturable commanded area of 20000 hectares. The intensity of Rabi crop is 80 percent and the base period is 120 days. The right branch canal carrying a discharge of 8 cumecs has culturable commanded area of 12000 hectares. The intensity of irrigation of Rabi crop is 50 percent and the base period is 120 days. Compare the efficiencies of the two canal systems. 8
- (c) A 0.4 m diameter well fully penetrates an unconfined aquifer whose bottom is 80 m below the undisturbed groundwater table. When pumped at a steady rate of $1.50 \text{ m}^3/\text{min}$, the drawdowns observed in two observation wells at radial distances of 5 m and 15 m are 4 m and 2 m respectively. Determine the drawdown in the well. 8

- (d) (i) Determine the theoretical power required to achieve an average velocity gradient value of 75 per second in a flocculator tank with a volume of 3000 cubic metre. Assume that the water temperature is 15 °C. What is the corresponding value of power required when the water temperature is 5 °C? The dynamic viscosity of water at 15 °C and 5 °C may be taken as 1.139×10^{-3} N-s/m² and 1.518×10^{-3} N-s/m². 4
- (ii) Enlist eight primary air pollutants and four secondary air pollutants. 4
- (e) The mixed liquor suspended solid concentration in an aeration tank is 3000 mg/litre and the sludge volume after 30 minutes of settling in a 1000 mL of graduated cylinder is 180 mL. Calculate the (i) sludge volume index, (ii) sludge density index, (iii) required return sludge ratio and (iv) suspended solid concentration in the recirculated sludge. 8

6. (a) The analysis of a hard water shows the following compositions :

- (i) Free carbon dioxide = 3 mg/L
- (ii) Alkalinity = 70 mg/L
- (iii) Non-carbonate hardness = 90 mg/L
- (iv) Total magnesium = 15 mg/L

Assume that it is possible to remove all but 35 mg/L of carbonate hardness with lime and that the treated water is to have a total hardness of 80 mg/L. Determine the amount of hydrated lime and soda required for treatment per million litres of raw water. 15

(b) Design a high-rate single-stage trickling filter for treating the following wastewater of a town having population of 60000 persons :

- (i) Domestic sewage @ 160 lpcd having 180 mg/L of BOD
- (ii) Industry wastewater @ 0.25 million litres per day having 600 mg/L of BOD

Assume the following :

- (1) BOD removal in primary clarifier = 35%
- (2) Permissible organic loading of filter = 8000 kg/hect-m/day (excluding recirculated sewage)
- (3) Recirculation ratio = 1.2
- (4) Permissible surface loading = 160 million litres/hect/day (including recirculated sewage)

Also, determine the efficiency of the filter and the BOD of the effluent. 15

- (c) Explain, with the help of diagram, the various components along with their functions of a diversion headwork. 10

7. (a) (i) Design the practical profile of a gravity dam of cement concrete for the given data :

RL of base of dam = 1050 m

RL of HFL = 1092 m

Specific gravity of cement concrete = 2.5

Safe compressive stress of cement concrete = 1600 kN/m^2

Height of waves = 0.90 m 10

- (ii) What do you understand by gravity dam? Enumerate the various forces acting on it, with brief description of each force. 5

- (b) (i) Design a lined canal to carry a discharge of 120 cumecs. The velocity of flow may be taken as 2 m/sec. Take the side slope as 1:1. Assume Manning's coefficient $n = 0.018$ and bed slope as 1 : 3000. 10

- (ii) Describe the various types of cross-drainage works on a canal. In what condition, each type is most suitable? 5

- (c) Explain the three distinct stages which occur in the process of sludge digestion. 10

8. (a) (i) The following is the set of observed data for successive 15 minutes period of 105 minutes storm in a catchment :

Duration (minutes)	15	30	45	60	75	90	105
Rainfall (cm/hour)	2.0	2.0	8.0	7.0	1.25	1.25	4.5

If the value of ϕ -index is 3.0 cm/hr, calculate the net runoff, the total rainfall and the value of W-index. 10

- (ii) What are the causes of waterlogging? Describe the various types of lining of irrigation channels in brief. 5

- (b) (i) What are the principles of radioactive waste management? Also, draw a flow diagram for the steps involved in it. 7

- (ii) The international 1-hour ambient air quality standards as per the World Health Organization for carbon monoxide, nitrogen dioxide and sulfur dioxide are 30 mg/m^3 , $400 \text{ microgram per cubic metre } (\mu\text{g/m}^3)$ and $350 \text{ microgram per cubic metre } (\mu\text{g/m}^3)$ respectively. Compute these concentrations in parts per million (ppm) at 25°C and 1 atm pressure (NTP). 8
- (c) Discuss the process parameters of relevance to be taken care while operating a composting unit to treat municipal solid waste with respect to their operating range/optimum range. 10

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