CC/M/EXAM.
2020

CIVIL ENGINEERING

PAPER—II

Time : 3 hours] [Full Marks : 250

Note : Question Nos. **1** and **5** are compulsory and out of the remaining, any **three** are to be attempted choosing at least ONE question from each Section. The number of marks carried by a question/part is indicated against it.

SECTION—A

1. Answer *any* **five** of the following questions : 10×5=50

(a) Discuss the various operations involved in the manufacturing of bricks.

(b) List the defects formed in the plastering work. Mention the remedies to avoid such defects.

(c) Define dummy in network analysis. Discuss the various rules for providing dummies in a network.

(d) Explain the various methods for solving the three-point problem in plane table surveying.

(e) Derive the formulae for a simple turnout, assuming that the curve starts from the heel of switch rail and there exists a straight arm of crossing.

(f) Describe the moving car method. Derive the expression for traffic flow and density across a section of road by moving car method considering two-way road.

(g) Describe the various design parameters necessary for design of flexible pavement as per IRC specifications.

2. Answer the following questions :

(a) With the aid of sketches, describe the calcination of limestones. 20

(b) What is seasoning of timber? Explain the various methods of seasoning along with their merits and demerits. 15

(c) What are the rules to be observed to get a good bond in brickwork? Using neat sketches, explain various types of bond in brickwork. 15

3. Answer the following questions :

(a) *(i)* The following staff readings were obtained when running a line of levels between two benchmarks *A* and *B* :

1·085 (*A*), 2·036, 2·231, 3·014, change point, 0·613, 2·003, 2·335, change point, 1·622, 1·283, 0·543, change point, 1·426, 1·795, 0·911 (*B*).

Enter and reduce the readings in an accepted form of field book. The reduced levels of the benchmarks at *A* and *B* were known to be 43·650 m and 41·672 m respectively.

It is found after readings have been taken with the staff supposedly vertical as indicated by a level on the staff that the level is 5° in error in the plane of the staff and instrument. Is the collimation error of the instrument elevated or depressed? What is its value in seconds if the backsights and foresights averaged 30 m and 60 m respectively? 20

(ii) A 30 m steel tape measured 30·0150 m when standardized fully supported under a 70 N pull at a temperature of 20 °C. The tape weighed 0·90 kg (9N) and had a cross-sectional area of 0·028 cm^2. What is the true length of the recorded distance *AB* for the following condition? $E = 2{\cdot}1 \times 10^7$ N/cm^2. (Assume all full tape lengths except in the last one).

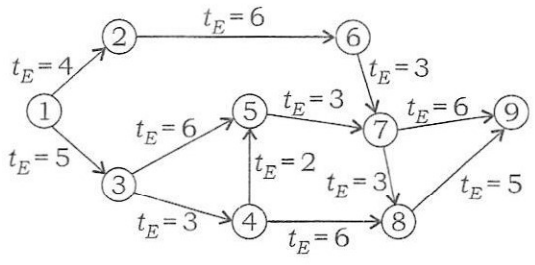
Recorded distance AB	*Average temperature*	*Means of support*	*Tension*	*Elevation difference per* 100 m
114·095 m	12°	Suspended	100 N	2·5 m

(b) The mean observed internal angles and measured sides of a closed traverse *ABCDA* (in anticlockwise order) are as follows :

Angle	*Observed value*	*Side*	*Measured length* (m)
DAB	97°41′	*AB*	22·11
ABC	99°53′	*BC*	58·34
BCD	72°23′	*CD*	39·97
CDA	89°59′	*DA*	52·10

Adjust the angles, compute the latitude and departures assuming that *D* is due N of *A*, adjust the traverse and give the coordinates of *B*, *C* and *D* relative to *A*. Assess the accuracy of the observations and draw the traverse. 15

(c) For a construction project, the expected time of completion (in days) for each activity of a network is shown in the below figure. Determine the critical path. It is given that the scheduled completion time is 21 days. 15



4. Answer the following questions :

(a) Work out the complete data needed for setting out both the circular and transition portions of a 3° curve for a BG track. The deflection angle is 20°-30°. Cant gradient should be taken as 1 in 720. Maximum speed is 100 km/h. Write down the process of laying out the curve on ground with the data that have been worked out. 20

(b) Write down the advantages and disadvantages of concrete sleeper. Describe the various types of concrete sleeper with neat sketches. 15

(c) Traffic flow in an urban section at the intersection of two highways in the design year is given below :

Approach	*Left turning*			*Straight ahead*			*Right turning*		
	Car	*Bus*	*Bike*	*Car*	*Bus*	*Bike*	*Car*	*Bus*	*Bike*
N	200	50	100	250	100	150	150	50	80
E	180	60	80	220	50	120	200	40	120
S	250	80	100	150	50	90	160	70	90
W	220	50	120	180	60	100	250	60	100

The highways at present intersect at right angles and have a carriageway width of 15 m. Design a rotary intersection making suitable assumptions. 15

SECTION—B

5. Answer *any* **five** of the following questions : 10×5=50

(a) A catchment has seven rain gauge stations. In a year, the annual rainfalls recorded by the gauges are as follows :

Station	*P*	*Q*	*R*	*S*	*T*	*U*	*V*
Rainfall (cm)	130	142·1	118·2	108·5	165·2	102·1	146·9

For a 5% error in the estimation of the mean rainfall, calculate the optimum number of additional stations required to be established in the catchment.

(b) Explain briefly :

(i) ϕ - index

(ii) W - index

(c) A 30 cm diameter well completely penetrates a confined aquifer of permeability 42 m/day. The length of the strainer is 20 m. Under steady state of pumping the drawdown at the well was found to be 3·0 m and the radius of influence was 300 m. Calculate the discharge.

(d) Design the section of an unlined canal in a loamy soil to carry a discharge of 50 m^3/s, with a permissible velocity of 1 m/s. Assume side slopes 2 : 1 and B/D ratio as 6. Using Manning formula, calculate bed slope of the canal. Take $N = 0{\cdot}0225$.

(e) Effluent from a wastewater treatment plant is discharged to a surface stream. The characteristics of the effluent and stream are as follows :

Effluent	*Stream*
Flow = 8640 m^3/d	Flow = 1·2 m^3/d
BOD_5 = 25 mg/L	BOD_5 = 2·1 mg/L
Ammonia = 7 mg/L	Ammonia = 0 mg/L
Nitrate = 10 mg/L	Nitrate = 3·0 mg/L
Chloride = 15 mg/L	Chloride = 5·0 mg/L

Determine the stream characteristics, after mixing with waste has occurred.

(f) The BOD_5 of wastewater is determined to be 150 mg/L at 20 °C. The k value is 0·23 per day. What would the BOD_8 be if the test was run at 15 °C?

(g) The present population of a community is 28000 with an average water consumption of 4200 m^3/d. The existing water treatment plant has a design capacity of 6000 m^3/d. It is expected that the population will increase to 44000 during the next 20 years. Assuming an arithmetic rate of population growth, what will be the number of years from now when the plant will reach its design capacity?

6. Answer the following questions :

(a) An activated sludge system is to be used for secondary treatment of 10000 m^3/d of municipal wastewater. After primary clarification, the BOD is 150 mg/L and it is desired to have not more than 5 mg/L of soluble BOD in the effluent. A completely mixed reactor is to be used and pilot plant analysis has established the following kinetic values : $Y = 0{\cdot}5$ kg/kg, $k_d = 0{\cdot}05\ d^{-1}$. Assuming MLSS concentration of 3000 mg/L and an underflow concentration of 10000 mg/L from the secondary clarifier, determine—

(i) the volume of the reactor;

(ii) the mass and volume of solids that must be wasted each day;

(iii) the recycle ratio. 20

(b) A 350 mm dia sewer is to flow at 0·35 depth on a grade ensuring a degree of self-cleansing equivalent to that obtained at full depth at a velocity of 0·8 m/s. Find—

(i) the required grade;

(ii) associated velocity;

(iii) the rate of discharge at this depth.

Given :

Manning's rugosity coefficient = 0·014
Proportionate area = 0·315
Proportionate wetted perimeter = 0·472
Proportionate HMD = 0·7705 15

(c) A canal takes off a reservoir to irrigate the areas shown in the table. 40% of the water required for irrigation is assumed to be available directly from precipitation. Channel conveyance losses are 15%. Reservoir losses are 10%. What would be the capacity of the reservoir needed? The reservoirs need to be filled only once a year. 15

Crop	*Base Period* (days)	*Duty at field* (hec/cumec)	*Area under the crop* (hec)
Wheat	120	1800	500
Sugarcane	320	800	600
Rice	120	900	300
Cotton	200	1400	1200
Bajra	100	1200	500

7. Answer the following questions :

(a) A round crested spillway passes a design discharge of 1 m^3/sec per meter length. The coefficient of discharge may be taken as C_d = 0·7. If height of the crest above the downstream stilling basin floor level is 10 m, design the (i) depth and (ii) length of the stilling basin. Depth of flow in the stream on the downstream of spillway is 1 m at the design discharge of 1 m^3/sec. Enquire if the bed of the stilling basin has to be depressed. 20

(b) A weir has a solid horizontal floor length of 50 m with two lines of cut-off of 8 m depth, below the river bed at its two ends. The floor thickness is 1 m at the upstream end and 2 m at the downstream end, with its upper level being in flush with the river bed. For an effective head of 5 m over the weir, calculate the uplift pressure at the two inside corner points (junction of bottom of floor with the cut-off) and also exit gradient. 15

(c) The amounts of water flowing from a certain catchment area at the proposed dam site are tabulated below. Determine—

(i) the minimum capacity of the reservoir if water is to be used to feed the turbines of hydropower plant at a uniform rate and now water is to be spilled over;

(ii) the initial storage required to maintain the uniform demand as above. 15

Month	*Inflow* ($\times 10^5$ m^3)	*Month*	*Inflow* ($\times 10^5$ m^3)
January	2·83	July	19·81
February	4·25	August	8·49
March	5·66	September	7·10
April	18·40	October	7·10
May	22·64	November	5·66
June	22·64	December	5·66

8. Answer the following questions :

(a) A rapid sand filter is to be provided in a water treatment plant to process water for a town with a population of 275000. Water demand is 200 L/capita/day. Rate of filtration is 15 $m^3/m^2/hr$. Allow 5% of filtered water for storage to meet backwash requirement. Each backwashing period is 30 min. Determine the number of filters required allowing one as standby unit. Allowable surface area configuration of filter unit is 10 m × 4 m. Also compute the up-flow velocity and head loss to expand the bed to 0·66 m from its original undisturbed depth of 0·6 m. Porosity of bed is 0·5, specific gravity is 2·5. The average size of particle is 0·6 mm. Drag coefficient is 5·02. Assume transitional flow $\rho_w = 1000$ kg/m^3. 20

(b) Estimate the size of a septic tank (length to width ratio 2·25, liquid depth 2 m with 300 mm freeboard), desludging intervals in years and the total trench area (m^2) of the percolation field, for a small colony of 300 people. Assume water supply of 100 litres per capita per day, wastewater flow at 80% of water consumption, sludge production of 0·04 cubic meters per capita per year and the retention time of 3 days at start up. Desludging is done when the tank is one-third full of sludge. A percolation test indicated an allowable hydraulic loading of 100 L per square metre per day. 15

(c) Find out the volume of an anaerobic digestion tank of 5 MLD of domestic wastewater treatment plant having 60% suspended solid removal efficiency of primary clarifier and 250 mg/L suspended solids in wastewater based on sludge volume reduction in digestor. Moisture content of influent sludge is 90%; initial volatile solids content in the sludge is 70%; volatile solids destroyed is 65%; digested sludge solid concentration is 8%; specific gravity of primary sludge is 1·03; specific gravity of digested sludges is 1·04; density of water is 1000 kg/m^3; mean cell residence time is 15 days. 15

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