

1(CCE.M)3

Civil Engineering–II

(06)

Time : Three Hours]

[Maximum Marks : 300

**INSTRUCTIONS**

- (i) Answers must be written in English.
- (ii) The number of marks carried by each question is indicated at the end of the question.
- (iii) The answer to each question or part thereof should begin on a fresh page.
- (iv) Your answer should be precise and coherent.
- (v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.
- (vi) Candidates should attempt question no. **1** which is compulsory and any **three** more questions from any **two** Parts.
- (vii) If you encounter any typographical error, please read it as it appears in the text-book.
- (viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.
- (ix) No continuation sheets shall be provided to any candidate under any circumstances.

**Fig. 3**

5. (a) (i) The speeds of overtaking and overtaken vehicles are 90 KMPH and 50 KMPH respectively on a two way traffic road. If the acceleration of overtaking vehicle is  $1\text{m/s}^2$ .
- (1) Calculate safe overtaking sight distance
  - (2) Mention the minimum length of overtaking zone and
  - (3) Draw a neat labelled sketch of the overtaking zone and show the positions of the sign posts (overtaking zone ahead and end of overtaking zone ahead). Assume reaction time of driver as 2 seconds. 15
- (ii) What would be the permissible speed on the curve on  $8^\circ$  broad gauge track ? The average speed of the different trains is 65 KMPH and the allowable cant deficiency is half that of maximum deficiency. Assume suitable data as per Railway Board, if required. 10
- (b) (i) Write step by step procedure of measuring mid-ordinates or versines for starting lining the curves. 10

Consider the design speed as 90 KMPH and length of wheel base of largest truck as 6.0 m.

- (i) Super-elevation
- (ii) Extra widening of pavement
- (iii) Length of transition curve

Also suggest the most suitable shape of the curve. 20

(ii) What is the intended purpose of rail ? List any ten requirements to serve the intended purpose of a rail.

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(b) A vertical summit curve is to be designed when two grades +1/60 and -1/70 meet on a highway. The stopping sight distance and overtaking sight distance required are 200 m and 650 m respectively. But due to site conditions, the length of the vertical curve is to be restricted to a maximum of 500 m if possible. Calculate the length of summit curve needed to fulfill the requirements of :

- (i) Stopping site distance
- (ii) Overtaking sight distance or at least intermediate sight distance and discuss the results. 25

(c) A cement concrete (CC) pavement slab of thickness 200 mm is constructed over a granular sub-base having modulus of reaction 20kg/cm<sup>2</sup>. The maximum temperature difference between the top and bottom of the slab during summer days and night is found to be 20°. The spacing between the transverse contraction joints is 4.5 m and that between longitudinal joints is 3.5 m. The design wheel load is 5000 kg, radius of contact area is 15 cm. E-value of CC is  $3 \times 10^5$  kg/cm<sup>2</sup>, Poisson ratio

(ii) What is the difference between CPM and PERT in a network analysis ? 10

(d) A trapezoidal irrigation canal with side slope of 1.5H to 1V is proposed to be lined with bricks to reduce seepage losses. It is required to carry a discharge of 18m<sup>3</sup>/sec of water. Find the wetted perimeter for minimum amount of lining and required bed slope. The value of Manning's constant 'N' is given as 0.015 and it is stipulated that the average velocity cannot exceed 1.2 m/sec. 25

**PART-A**

2. (a) (i) The data for planning a certain Civil Engineering project by CPM-Network analysis is given below. Draw the network and establish the critical path. Also, prepare a CPM schedule and calculate total float, free float, independent float and project duration. 15

Activity	Duration in weeks	Activity immediately	
		Preceding	Following
A	03	-	E
B	04	-	D,F,G
C	14	-	H
D	03	B	H
E	05	A	-
F	06	B	-
G	04	B	I
H	01	C,D	I
I	01	GH	-

- (ii) For an activity of casting a raft foundation of high rise building, three engineers A, B and C have given the time estimates as follows. State, which is more certain about the time of completion of job ? Also, calculate expected time of completion of each engineer. 10

Engineer	Time in Weeks		
	Optimistic	Most Likely	Pessimistic
A	05	07	09
B	04	06	07
C	05	05	08

- (b) (i) Mention the different bonds used in brick masonry and discuss in detail any two of them with figures. 10
- (ii) The following Table gives the data for the duration and cost for each activity in a CPM network. The indirect cost of the project is Rs. 90 per day. Determine the optimum cost and corresponding duration of the project. Note that only the indicated durations are permissible and no intermediate durations are permissible. 15

Activity	Normal Duration (Days)	Normal Cost (Rs.)	Crash Cost (Days)	Crash Cost (Rs.)
1-2	5	60	4	90
1-3	7	150	5	250
1-5	9	115	7	175
2-3	3	30	2	60
2-4	3	100	3	100
3-5	6	150	4	250
4-5	4	100	2	240

- (c) (i) Briefly illustrate the details of lean-to-roof, coupled roof and collar roof. 15
- (ii) Briefly discuss the Fulkerson rule of numbering events in a network. 10
3. (a) (i) What are the chief constituents of an oil paint ? Explain the functions of each. 10
- (ii) What are the objects of plastering ? Discuss the method of plastering in two coats. 15
- (b) (i) What are the guiding factors that should be kept in mind while deciding the structural and architectural requirements of fire-resistive structure ? Describe the fire-resistive properties of asbestos, concrete and steel. 15
- (ii) How would you render a steel column fire-resistant ? Describe with suitable sketches. 10
- (c) (i) What is the purpose of proving cavity walls ? At what levels the cavity should be started and terminated in a cavity wall construction ? What adverse effect can take place if the cavity wall is started or terminated at random ? 15
- (ii) What do you mean by damp proof course ? Where is it placed in building and why ? Write short specification on damp proof course lying to brick masonry walls both in foundation and plinth and in superstructure. 10

**PART-B**

4. (a) (i) A 4-lane National Highway is passing through a built-up area. Design the following geometric features for a horizontal circular curve of radius 350 m for this highway.

- (x) Candidates shall put a cross (x) on blank pages of Answer Script.
- (xi) No blank page be left in between answer to various questions.
- (xii) No programmable Calculator is allowed.
- (xiii) No stencil (with different markings) is allowed.

1. Answer any **three** of the following subdivisions, including (d), which is compulsory.

- (a) (i) Draw a neat labeled sketch with dimensions showing the cross-section of a broad gauge track for double line with electric traction. 15
- (ii) Define sleep density. Find number of sleepers required for constructing a B.G. railway track of 20 km length. Take sleeper density as  $n+7$  and length of each rail 12.8 m. 10
- (b) (i) How is the dissolved oxygen sag curve interpreted to indicate the critical point or the point of maximum dissolved oxygen ? 15
- (ii) What do you mean by hydraulically equivalent section of a sewer ? What are the parameters on which the cross-section of sewer would depend upon ? 10
- (c) (i) Two straights meet at an angle of  $137^\circ$ . Due to the position of a building, a curve is to be so chosen that it may pass near a point 'F', 50 m on the bisector of the angle of intersection. Find degree of the curve and calculate how near it passes to point F. 15

is 0.15 and the coefficient of thermal expansion of cement concrete is  $10 \times 10^{-6}$  and friction coefficient is 1.5. Using edge and corner load stress charts given by IRC and the chart for warping stress coefficient, find the worst load combination of stresses at the edges. The charts are provided in Fig. 1 to 3.

25

**Fig. 1**

**Fig. 2**

- (b) (i) Discuss the phenomenon of self-purification of streams. How can it be evaluated and represented ? What are the factors that significantly affect the self purifying abilities of a stream ? 15
- (ii) Mention the permissible limit for Fluoride, Nitrate, Chloride and Arsenic for the potable water. What is the significance of the following substances when they exceed the permissible limit ? 10
- (c) (i) Design a plain sedimentation tank to treat 4 million litres water per day. The detention period may be assumed as 6 hours and the depth may be assumed as 3.5 m. Assume velocity of flow as 10 cm/minute. 15
- (ii) What is the concept of 'Groundwater Budgeting' and its importance in the determination of the safe yield from the basin ? 10

- (ii) Design and sketch the tie bars for a cement concrete pavement for a longitudinal joint using following data :  
 Slab Thickness = 30 cm  
 Lane width = 3.5 m  
 Coefficient of friction = 0.15  
 Density of concrete = 2400kg/m<sup>3</sup>  
 Allowable tensile stress in plain bars = 1250 kg/cm<sup>2</sup>  
 Allowable tensile stress in deformed bars = 2000 kg/cm<sup>2</sup>  
 Allowable bond stress for plain bars = 17.5 kg/cm<sup>2</sup>  
 Allowable bond stress for deformed bars = 24.6 kg/cm<sup>2</sup> 15

- (c) (i) Plate bearing tests were conducted with a 0.75 m diameter plate on soil sub-grade and a granular base. The stress noticed was 0.07 MN/m<sup>2</sup>, when the deflection was 0.25 cm on the sub-grade soil. On the base course, the same plate yielded 0.25 cm deflection under a stress of 0.14 MN/m<sup>2</sup>. Design the pavement for an allowable deflection of 0.50 cm, under a wheel load of 40 kN and a tyre pressure of 0.5 MN/m<sup>2</sup>. Use Figure-4 for design. 15

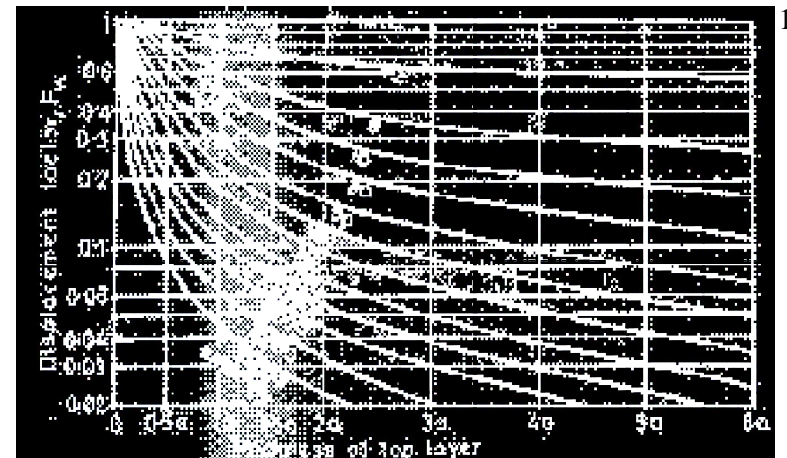


Fig. 4

Find the optimum number of non-recording and recording rain gauges for this watershed assuming an error of 8% in the estimation of mean rainfall.

- (ii) The working life of dam built to store irrigation requirement is expected to be 100 years. The spillway capacity is designed to accommodate the peak flood having a return period of 500 years. Calculate the risk of failure of the dam. 10

**PART-D**

8. (a) (i) Design a septic tank for a colony of 200 persons with daily sewage flow of 135 liters per person per day. Assume a detention period of 24 hours. Draw a neat sketch of the septic tank so designed. 15
- (ii) Explain the term BOD. Derive the expression for BOD reaction. 10
- (b) (i) Determine the BOD loading of an oxidation pond used for treating the domestic sewage of 20,000 persons when the water supply demand is 100 liters per capita per day. Assume a detention period of 7 days and BOD of sewage as 280 mg/litre. The pond is 1.5 m deep. 15
- (ii) A small town with a population of 1000 persons is to be supplied water at 100 LPED. The demand of water during different periods is given as follows :

- (b) (i) An overflow spillway is 48 m high. At the design, the energy head is 2.4 m over the spillway. Find the sequent depth and energy loss in hydraulic jump formed on a horizontal apron at the toe of the spillway. Neglect energy loss due to flow over the spillway face. Assume coefficient of discharge as 0.732 and velocity at the toe, before the jump can be approximated as  $v = [2 g (\text{total head})^{1/2}]$ , where g is acceleration due to gravity. 10

- (ii) A homogeneous earth dam 42 m high is built to store water for irrigation water requirement with a freeboard of 2.0 m. A horizontal filter of 30 m length is provided at its downstream end. The coefficient of permeability of the material of the dam is given as  $2.2 \times 10^{-3}$  cm/sec. A flow net was constructed through the body of the dam and the following results were obtained :

Number of potential drops = 25

Number of flow channels = 04

Calculate seepage flow/m length of the dam in liters/sec. 15

- (c) Determine using the 'rational formula' with runoff coefficient equal to 0.80, the peak storm runoff to be carried out by the underground drainage pipeline AB for the drainage basin area of 0.2 hectares as shown in Figure-5. Take the length of pipeline as 100 m and the level difference between A and B as 0.6 m. Assume initially a pipe diameter of 250 mm. Consider Darcy-Weisbach friction factor of 0.015. The rainfall duration and rainfall intensity is furnished in tabular form below. Consider

time entry at end A as 2 min. Check whether the pipe size is adequate or not. 25

Duration (Mins)	Rainfall Intensity (mm/hr)
2.0	122
2.5	108
3.0	97
3.5	89
4.0	82
4.5	77

**Fig. 5**

7. (a) (i) What are different types of cross drainage works that are required when a canal crosses a natural drainage ? Draw a plan view of an aqueduct showing all details. 15
- (ii) What are the various functional elements of a solid waste management system ? Describe briefly the significance of each functional element. 10

- (b) (i) The ratio between a prototype and a model of a spillway is 1:20. The velocity and discharge in the model are 1.5 m/sec and 2.0 m<sup>3</sup>/sec respectively. Find the corresponding velocity and discharge in the prototype. 10
- (ii) A rectangular channel and a triangular channel of apex angle 90° have the same material and bed slope. If the rectangular channel has the depth of flow equal to the width of the channel and flow area in both the channels are the same, find the ratio of discharges in the rectangular and triangular channels respectively. Use Manning's roughness equation for estimation of velocity. 15
- (c) (i) Four non-recording rain gauges have been installed in a watershed to record rainfall data. The annual rainfall for one of the years is given below : 15

Location site of rain gauge station	Recorded annual rainfall in mm
P	900
Q	1100
R	1300
S	700

- (ii) Differentiate between junction and terminal station and gravity and hump yard. 10

**PART-C**

6. (a) (i) The flood record for a period of 25 years of a small tributary of a main river has been analyzed based on the assumption that the distribution is log-normal. The mean ‘ $\mu$ ’ and standard deviation  $\sigma$  of the distribution have been found to be 2.4 m<sup>3</sup>/s and 1.1 m<sup>3</sup>/s. Find the magnitude of 100 and 1000 year return period flood. 10
- (ii) Various types of crop are irrigated from the water of a reservoir by means of the canal system. The data about these crops are provided in the Table given below :

Type of crop	Crop period in days	Area under crop in Hectares	Duty of water in the field in hectares/cumec
Cotton	240	3000	1430
Sugarcane	365	2000	860
Wheat	120	4000	2150
Rice	120	2000	860

Assume 25% losses of water in the entire canal system and 10% losses in the reservoir. Find the live storage of the reservoir in hectares/m. 15

Time (Hours)	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24
Total Demand (Litres)	9000	10000	12000	18000	14000	12000	10000	11000

Determine the balancing capacity of a service reservoir, if pumping is done in blocks of 24 hours, the delivery rate being constant. 10

- (c) (i) Draw a neat sketch of service pipe connection explaining the functioning and requirements of the various parts in the connection. 10
- (ii) Enumerate and discuss various factors that play a role in estimating per capita demand of water supply. Also explain the implications if heavy metals are present in concentrations above their permissible levels. 15
9. (a) (i) Estimate the population equivalent for the two cases firstly
- (a) Combined system for 2000 persons having 100 gm per capita daily BOD on the assumption that the contribution of BOD is 75 gm per capita per day and secondly for
- (b) 80,000 litres daily contribution of individual wastes containing 1000 mg/litre of suspended solids on the assumption that the contribution of suspended solids is 50 gm per capita per day. State clearly any other assumptions needed to be invoked. 15
- (ii) Explain what you mean by river training in the context of river pollution control at river banks through a typical Indian City. 10