

**WATER RESOURCES ENGINEERING
(CIVL 4101)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

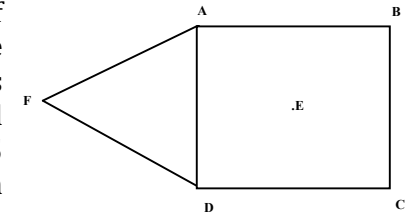
**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The double mass curve technique is adopted to
 - (a) check the consistency of raingauge records
 - (b) to find the average rainfall over a number of years
 - (c) to find the number of raingauges required
 - (d) to estimate the missing rainfall data.
 - (ii) In a small catchment, the infiltration rate was observed to be 10 cm/h at the beginning of the rain and it decreased exponentially to an equilibrium value of 1.0 cm/h at the end of 9 hours of rain. If a total of 18 cm of water infiltrated during 9 hours interval, the value of decay constant K_h in Horton's infiltration equation in (h^{-1}) unit is
 - (a) 0.1 (b) 0.5 (c) 1.0 (d) 2.0.
 - (iii) The shape of recession limb of a flood hydrograph depends on
 - (a) basin as well as storm characteristics (b) storm characteristics only
 - (c) basin characteristics only (d) base flow only.
 - (iv) The rainfall in five successive days on a catchment was 3, 5, 9, 6, and 1 cm respectively. The ϕ -index for the storm can be assumed to be 3 cm/day. The total direct runoff from the catchment due to this storm was
 - (a) 8 cm (b) 11 cm (c) 20 cm (d) 23 cm.
 - (v) A storm hydrograph was due to 3-h of effective rainfall. It contained 6 cm of direct runoff. The ordinates of direct runoff hydrograph of this storm
 - (a) when divided by 3 give the ordinates of a 6-h unit hydrograph
 - (b) when divided by 6 give the ordinates of a 3-h unit hydrograph
 - (c) when divided by 3 give the ordinates of a 3-h unit hydrograph
 - (d) when divided by 6 give the ordinates of a 6-h unit hydrograph.

- (vi) Paleo is defined as
 - (a) the ratio of the number of days the canal as actually run to the number of days of irrigation period
 - (b) the ratio of mean supply to the full supply of a canal
 - (c) the initial irrigation required by the land before sowing
 - (d) ratio of the area for which the permit has been issued to the mean supply for the base period.
- (vii) Based on the function of canal, the canal is classified as,
 - (a) permanent canal (b) alluvial canal
 - (c) main canal (d) feeder canal.
- (viii) With regard to the alignment of canal which of the given statement is incorrect
 - (a) alignment should result in the most economical way of distribution of water
 - (b) command is as high as possible
 - (c) cross drainage works are minimum
 - (d) side slope canal is preferred due to economy.
- (ix) The spacing of closed drains is independent of
 - (a) coefficient of permeability
 - (b) drain size
 - (c) height above the impervious stratum
 - (d) maximum height of the drained water table above the impervious stratum.
- (x) The waterlogging can be counteracted
 - (a) by increasing the F.S.L. of the canal
 - (b) by lowering the F.S.L. of the canal
 - (c) by using unlined canal section for irrigation
 - (d) all of the above.

Group - B

2. (a) Discuss various methods of calculating the average rainfall over a catchment area.
- (b) The area shown in figure is composed of a square plus an equilateral triangular plot of side 20 km. The annual precipitations at the rain-gauge stations located at the four corners A, B, C, D, Centre 'E' of the square plot and apex 'F' of the triangular plot are 46 cm, 65 cm, 76 cm, 80 cm, 70 cm, and 60 cm respectively. Find the mean precipitation over the area by Thiessen polygon method, and compare with the arithmetic mean.



3. (a) The infiltration capacity of a catchment is represented by Horton's equation as,
 $f_p = 0.5 + 1.2e^{-0.5t}$, where f_p is in cm/h, t is in hours.
 Assuming the infiltration to take place at capacity rates in a storm of 4 hours duration, estimate the average rate of infiltration for the duration of the storm.
- (b) The mass curve of an isolated storm in a 450 Hectare watershed is as follows:

Time from start (hour)	0	2	4	6	8	10	12	14	16	18
Cumulative rainfall (cm)	0	0.8	2.6	2.8	4.1	7.3	10.8	11.8	12.4	12.6

If the direct runoff produced by the storm is measured at the outlet of the watershed as 0.320 Mm^3 . Estimate the Φ -index of the storm and duration of rainfall excess.

6 + 6 = 12

Group - C

4. (a) The 6-hour unit hydrograph of a basin is triangular in shape with a peak of $200 \text{ m}^3/\text{s}$ occurring at 24-h from the start. The base is 72-h.
 (i) What is the area of the catchment represented by this unit hydrograph?
 (ii) Calculate the flood hydrograph due to a storm of rainfall excess of 2.0 cm during the first 6 hours and 4.0 cm during the second 6 hours interval.
 The base flow can be assumed to be $30 \text{ m}^3/\text{s}$ constant throughout.
- (b) Briefly discuss the two basic assumptions in the theory of unit-hydrograph.
5. (a) Discuss the different types of surface irrigation methods with the help of a neat sketch.
- (b) The base period, intensity of irrigation and duty of water for various crops under a canal system are given in the table below. Determine the reservoir capacity if the culturable command area is 40,000 hectares, canal losses are 20% and reservoir losses are 15%.

Crop	Base period (days)	Duty of water at the field (hectares / cumec)	Intensity of irrigation (percentage)
Wheat	120	1800	20
Sugarcane	360	1700	20
Cotton	180	1400	10
Rice	120	800	15
Vegetables	120	700	15

7 + 5 = 12

Group - D

6. (a) Discuss the following terms with reference to a channel section:
 (i) berms, (ii) borrow pits, (iii) dowel, (iv) spoil banks.
- (b) A canal has a bed width of 8 m, full supply depth of water is 1.5 m, bank width is 1.8 m. The cutting slope is 1:1 and filling slope is 1.5:1 and the free board is kept as 0.6 m. Calculate the balancing depth of the most economical section.
7. (a) "The irrigation canals can be classified in different ways on the basis of various considerations". Present a detail discussion on those various classifications.
- (b) Explain the various causes for the losses of water in an irrigation canal.

6 + 6 = 12

9 + 3 = 12

Group - E

8. Discuss in detail the effect of water logging on an agricultural land. Also discuss the causes of water logging and the various measures to be considered for its prevention.
9. (a) Discuss your understanding of closed drains and also present in detail the various layouts of the closed drain system.
- (b) There are two different areas A and B to be drained by means of closed tile drainage system. If $k_A:k_B = 2.5:1.2$; $L_A:L_B = 1:1.5$ and $(b^2 - a^2)_A : (b^2 - a^2)_B = 5.3:6.5$
 Find the ratio of the discharge per unit length of the area A to the area B. If the drain carry 1% of average annual rainfall in 24 hours in both the cases, find the ratio $P_A : P_B$.
 Let, k = coefficient of permeability, L = spacing of the drains, P = average annual rainfall, a = the height of the drains above the impervious stratum, and b = maximum height of the drained water table above the impervious stratum.
 In all the given notations the suffixes A and B represents the respective terms for the two given different areas A and B.

6 + 6 = 12