

Group – D

6. (a) Explain the terms:
 (i) Counter berm
 (ii) Free board in canals
 (iii) Temporary land width.
- (b) A canal has a bed width of 8 m, full supply depth 1.6 m, bank width 2.5 m, cutting slope 1:1, filling slope 1.5:1 and free board 0.4 m. Calculate balancing depth.

6 + 6 = 12

7. (a) Design a concrete lined channel to carry a discharge of 150 cumec at a slope of 1 in 10000. The side slopes of the channel are 1.5:1 and Manning's N may be taken as 0.013. Assume limiting water depth of the channel as 4.0 m.
- (b) Discuss the various types of linings.

7 + 5 = 12**Group – E**

8. Discuss in detail the various types of drains, their design and maintenance with the help of neat sketches.
9. (a) What is canal lining? Discuss the advantages and disadvantages of canal lining?
- (b) Find the spacing between drains for the following data:
 (i) Annual rainfall = 1000 mm
 (ii) Height of drains above impervious stratum = 4.5 m
 (iii) Maximum height of the drained water table above the impervious stratum = 5.0m
 (iv) Coefficient of permeability $k = 10^{-6}$ m/s.

6 + 6 = 12**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) Calculate the rainfall at A if the average depth of rainfall for the basin is 5 cm. The rainfalls recorded at B, C and D are 5 cm, 4 cm and 5 cm respectively. The Thiessen weights of 4 raingauges A, B, C and D covering a catchment of a river are 0.15, 0.25, 0.30 and 0.30 respectively.
 (a) 5 cm (b) 6 cm (c) 7 cm (d) 8 cm.
- (ii) In the single point method of finding mean velocity across a vertical, the velocity is measured above the stream bed at
 (a) 0.4 d (b) 0.6 d (c) 0.7 d (d) 0.8 d.
- (iii) The rating curve of a stream gauging station gives the variation of discharge in the stream with the
 (a) area of flow (b) stage
 (c) depth of flow (d) velocity of flow.
- (iv) What is the average daily evaporation loss from a reservoir with an average water spread area of 15 km² in a month having lake evaporation of 20 cm.
 (a) 200000 m³ (b) 300000 m³
 (c) 100000 m³ (d) 150000 m³.
- (v) 1h triangular unit hydrograph of a watershed has the peak discharge of 60 m³/s at 10 h and time base of 30 h. The ϕ index is 0.4 cm/h and base flow is 15 m³/s. The catchment area of the watershed is
 (a) 3.24 km² (b) 32.4 km²
 (c) 324 km² (d) 3240 km².

- (vi) An agricultural land of 437 hectare is to be irrigated for a particular crop. The base period of the crop is 90 days and the total depth of water required by the crop is 105 cm. If a rainfall of 15 cm occurs during the base period, the duty of irrigation water is
 (a) 437 hectare/cumec (b) 486 hectare/cumec
 (c) 741 hectare/cumec (d) 864 hectare/cumec.
- (vii) A watershed 600 ha in area experienced a rainfall of uniform intensity 2.0 cm/h for duration of 8 hours. If the resulting surface runoff is measured as 0.6 Mm³, the average infiltration capacity during the storm is
 (a) 1.5 cm/h (b) 0.75 cm/h (c) 1.0 cm/h (d) 2.0 cm/h.
- (viii) The shape of the recession limb of a hydrograph depends on
 (a) basin as well as storm characteristics (b) storm characteristics only
 (c) basin characteristics only (d) baseflow only.
- (ix) A 6 h storm with hourly intensities of 7, 18, 25, 12, 10, and 3 mm/h produced a runoff of 33 mm. Then the ϕ -index is
 (a) 7 mm/h (b) 3 mm/h (c) 10 mm/h (d) 8 mm/h.
- (x) Closed drains are provided to drain
 (a) only surface water
 (b) only ground water
 (c) both surface water and ground water
 (d) neither surface water nor ground water.

Group - B

- 2. (a) List out the advantages and disadvantages of tipping bucket type and weighing bucket type recording raingauges.
- (b) The coordinate distances in km of 5 raingauge station X, A, B, C and D are (0, 0), (4, 5), (-6, 8), (-9, -6) and (5, -7) respectively. During July 2005 station X was in operative and the other four stations A, B, C and D recorded rainfalls of 8.3, 10.1, 7.7 and 12.4 cm respectively. Calculate the missing July rainfall at X.
- (c) The average annual rainfall of 5 raingauges in a basin are 89, 54, 45, 41 and 55 cm. If the error in the estimation of basin mean rainfall should not exceed 10%, how many additional gauges should be installed in the basin?
4 + 4 + 4 = 12

- 3. (a) The ordinates of a 2 hr unit hydrograph for a catchment are given as

Time h	0	1	2	3	4
Ordinate (m ³ /sec)	0	5	12	25	41

Calculate the ordinates of a 4 hr unit hydrograph for this catchment.

- (b) The Horton's infiltration equation for a basin is given by $f = 10 + 30e^{-0.8t}$, where f is in mm/h and t is in hours. What are the values of f_0 , f_c , and k? If a storm occurs on this basin with an intensity of more than 40 mm/h, determine the depth of infiltration for the first one hour and the average infiltration rate for the first two hours.

5 + 7 = 12

Group - C

- 4. (a) An 8 hr storm during a dry weather produced hourly rainfall intensities of 6, 9, 20, 16, 4, 14, 12 and 2 mm/h. What is the runoff volume from a basin area of 600 km² if the initial abstractions are 10 mm and the ϕ -index for the basin is 10 mm/h. With the help of a neat sketch show the runoff depth and the ϕ -index for the basin.
- (b) An isolated 3-h storm occurred over a basin in the following manner:

% of catchment area	ϕ -index (cm/h)	Rainfall (cm)		
		1 st hr	2 nd hr	3 rd hr
20	1.00	0.8	2.3	1.5
30	0.75	0.7	2.1	1.0
50	0.50	1.0	2.5	0.8

Estimate the runoff from the catchment due to the storm.

6 + 6 = 12

- 5. (a) Compute the field capacity of a 1200 m² cropped area (root zone depth 0.8 m) on which 400 m³ of water was applied. The moisture content of soil before irrigation was 8%. Dry density of the soil = 1800kg/m³. Assume evaporation and seepage losses as 12%.
- (b) Calculate the maximum demand for a particular season from the table below which gives the necessary details of the crop, base period and area under each crop commanded by a canal taking off from a reservoir.

Crop	Base period (days)	Area (hectares)	Duty of water at the head of the canal (hectares/cumec)
Wheat (Rabi)	120	750	1600
Sugarcane	320	900	580
Overlap for sugarcane in hot weather	90	150	580
Bajra (Kharif)	120	600	2000
Vegetables (Hot weather)	120	320	600

6 + 6 = 12