

**WATER RESOURCES ENGINEERING  
(CIVL 4115)**

**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) Rainfall hyetograph shows the variation of  
(a) cumulative rainfall with time  
(b) rainfall intensity with time  
(c) rainfall depth over an area  
(d) rainfall intensity with the cumulative rainfall.
- (ii) Calculate the runoff (cm) from a rainfall of 3 hours. The intensity of rainfall is 2 cm/hr. The evaporation and infiltration losses 8 mm and 16 mm respectively.  
(a) 1.2                      (b) 2.8                      (c) 3.6                      (d) 6.8.
- (iii) The intensity of rainfall for successive 1 hour period of a 6-hr storm are 2, 6, 8, 9, 7 and 3 cm/hr. The runoff is 4 cm/hr. Calculate the  $\phi$  index (cm/hr).  
(a) 2.5                      (b) 3.5                      (c) 4.6                      (d) 7.67.
- (iv) An irrigation canal is 80 km long. It has an average surface width of 15 m. If the evaporation measured in a Class A pan is 5 mm/day, the volume of water evaporated in a month of 30 days is: (assume pan coefficient as 0.7)  
(a) 126000 m<sup>3</sup>              (b) 18000 m<sup>3</sup>              (c) 12600 m<sup>3</sup>              (d) 180000 m<sup>3</sup>.
- (v) Among the classification of canals based on alignment criteria, identify the canals in which the number of cross drainage works is maximum?  
(a) Detour canal                      (b) Contour canal  
(c) Ridge canal                      (d) Side slope canal.
- (vi) The discharge capacity required at the outlet to irrigate 2600 ha of sugarcane having a kor depth of 17 cm and a kor period of 30 days is  
(a) 2.3 m<sup>3</sup>/s              (b) 1.71 m<sup>3</sup>/s              (c) 14.7 m<sup>3</sup>/s              (d) 0.18 m<sup>3</sup>/s.
- (vii) The ratio of quantity of water stored in the root zone of crops to the quantity of water actually delivered in the field is known as  
(a) water use efficiency                      (b) water conveyance efficiency  
(c) water application efficiency                      (d) water storage efficiency.

- (viii) The field capacity of soil is 25%, its permanent wilting point 15% and specific dry unit weight is 1.5. If the depth of root zone of crop is 80 cm, the storage capacity of soil is \_\_\_\_\_  
 (a) 8 cm                      (b) 10 cm                      (c) 12 cm                      (d) 14 cm.
- (ix) Method of applying water directly to the root zone of the plant is called \_\_\_\_\_  
 (a) check flooding                      (b) drip method  
 (c) furrow method                      (d) sprinkler irrigation.
- (x) Calculate the water distribution efficiency, if the depths of penetration along the length of border strip at an interval of 20 m are 1.5 m, 1.8 m and 2.1 m respectively.  
 (a) 66%                      (b) 83%                      (c) 88%                      (d) 97%

**Group - B**

2. (a) A watershed has four raingauge stations P, Q, R, S. During a storm station P was inoperative, while Q, R, and S recorded rainfall of 66 mm, 48 mm and 37 mm, respectively. Estimate the missing storm of station P if the normal annual precipitation at P, Q, R, and S are 65.6 cm, 72.6 cm, 51.8 cm and 38.20 cm, respectively.

[(CO1)(Analyze/IOCQ)]

- (b) Explain the Slope-Area method used for streamflow measurement with diagram.

[(CO2)(Understand/LOCQ)]

- (c) The isohyetal map for 24 hr storm gave the areas enclosed between different isohyets as follows: Find the average depth of annual precipitation over the basin.

Isohyets (mm)	75-85	85-95	95-105	105-115	115-135	135-155
Enclosed area (km <sup>2</sup> )	580	2960	2850	1000	610	160

[(CO1)(Analyze/IOCQ)]

**5 + 3 + 4 = 12**

3. (a) A 1 day rainfall of 18 hrs at station C was found to have a return period of 50 yrs. What is the probability that a 1 day rainfall of this or larger magnitude will not occur during next 50 yrs?

[(CO3)(Analyse/IOCQ)]

- (b) Analysis of data on maximum one day rainfall depth at Bombay indicated that a depth of 300 mm had a return period of 20 years. Determine the probability of a one-day rainfall depth equal to or greater than 300 mm at Bombay occurring once in 5 successive years.

[(CO3)(Analyse/IOCQ)]

- (c) Twelve months rainfall-runoff data are available for a catchment. Develop a correlation between R and P.

Month	1	2	3	4	5	6	7	8	9	10	11	12
R	0.5	10	13.8	8.2	3.1	3.2	0.1	1.6	2.2	1.5	1	0
P	5	15	40	55	10	31	36	42	8	2	10	25

[(CO2)(Analyze/HOCQ)]

**3 + 3 + 6 = 12**

**Group - C**

4. (a) The mass curve of rainfall of 100 min duration is given below. The initial loss is 0.6 cm and  $\phi$ - index is 0.6 cm/h, calculate total surface runoff from the catchment.

Time from start of rainfall (min)	0	20	40	60	80	100
Cum rainfall (cm)	0	0.5	1.2	2.6	3.3	3.5

[(CO1)(Analyse/IOCQ)]

- (b) A water course commands an irrigated area of 1000 hectares. The intensity of irrigation of rice in this area is 70%. The transplantation of rice crop takes 15 days and during the transplantation period the total depth of water required by the crop on this field is 500 mm. During the transplantation period, the useful rain falling on the field is 120 mm. Find the duty of irrigation water for the crop on the field during transplantaion, at the head of the field and at the head of the water course assuming losses of water to be 20% in the water course. Also calculate the discharge required at the water course.

[(CO4)(Analyse/HOCQ)]

**6 + 6 = 12**

5. (a) An irrigation channel is carrying 3 cumecs of water to a CCA of 1500 ha with an intensity of irrigation 50%. If the base period of the crop is 140 days, calculate the delta of the crop.
- (b) Define Ø-index and W-index.
- (c) Water is released at the rate of 12 cumecs at the head of a canal. If the duty at the field is 1250 ha/cumecs and loss of water in transit is 25%, find the area of land to be irrigated.

[(CO4)(Understand/IOCQ)]

[(CO2)(Understand/LOCQ)]

[(CO4)(Analyse/HOCQ)]

**4 + 4 + 4 = 12**

### Group - D

6. (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.
7. (a) Discuss the following terms with reference to a channel section:  
(i) berms, (ii) borrow pits, (iii) dowel
- (b) Design an irrigation channel using Kennedy's and Lacey's theory to carry a discharge of 45 cumecs. Take  $N = 0.0225$  and  $m = 1.05$ , Bed slope = 1 in 5000,  $f = 1$ ; Side slope = 1/2:1.

[(CO5)(Remember/LOCQ)]

[(CO5)(Remember/LOCQ)]

**7 + 5 = 12**

[(CO5)(Remember/LOCQ)]

[(CO5)(Analyse/HOCQ)]

**3 + 9 = 12**

### Group - E

8. Define Water logging. How it is categorised? Explain the causes and effects of water logging in details.
9. (a) Differentiate between closed drains and open drains with figure.

[(CO6)(Remember/LOCQ)]

**(2 + 3 + 7) = 12**

[(CO6)(Remember/LOCQ)]

- (b) Find the average annual rainfall if the drains carry 1% of average annual rainfall in 24 hrs, if spacing between the drains is 50 m and height above the impervious stratum is 10 m. Maximum height of drained water level above the stratum is 10.3 m. Take  $k = 1 \times 10^{-5}$  m/sec.

[(CO5)(Analyze/HOCQ)]

6 + 6 = 12

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	41.67	26.04	32.29

### Course Outcome (CO):

After the completion of the course students will be able to

1. Understand the design of water resources systems utilizing the basic principles of the hydrologic cycle and the watershed.
2. Know about the concepts of movement of ground water beneath the earth.
3. Understand the value of probability and statistical analysis in deriving precipitation and stream flow data and hydrograph theories.
4. Impart the knowledge of irrigation techniques, efficiencies, optimal irrigation of the fields, consumptive water requirements of the crops and crop types.
5. Understand the distribution systems for canal irrigation and the basics of design of unlined and lined irrigation canals system.
6. Master the concept of water logging and drainage systems.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;  
HOCQ: Higher Order Cognitive Question