

**Notes by-**

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## Hydrology

- 1) In a certain river basin there are six rain-gauge stations, the normal annual rainfall depths at the stations being 42.4, 53.6, 67.8, 78.5, 82.7 and 95.5 cm, respectively. Determine the optimum number of rain-gauge stations to be established in the basin if it is desired to limit the error in the mean value of rainfall over the catchment to 10% and indicate how you distribute them. (7)

- 2) Find the mean precipitation for the area shown in Fig. 2.24 by Thiessen polygon method. The area is composed of a square plus an equilateral triangular plot of side 2 km. Rainfall readings are in cm at the various stations indicated. (32, 33 cm)

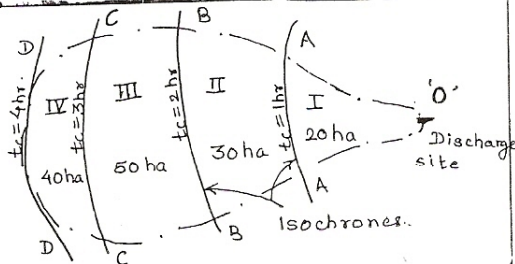
- 3) Annual rainfall at a point M is needed. At five points surrounding the point M the values of recorded rainfall together with the coordinates of these stations with respect to a set of axes at point M are given below. Estimate the annual rainfall at point M by using the USNWS method.

Station	Rainfall P (cm)	Ans: $P_m = 112.03$ cm	Coordinates of station (in units)
			X Y
A	102		2.0 1.0
B	120		2.0 2.0
C	126		3.0 1.0
D	108		1.5 1.0
E	131		4.5 1.5

- 4) The normal annual ppt. of 5 rain-gauge stations P, Q, R, S and T are respectively 125, 102, 76, 113 and 137 cm. During a particular storm the precipitations recorded by stations P, Q, R and S are 13.2, 9.2, 6.8 and 10.2 cm resp. ly. The instrument at stn T, which was inoperative is to be estimated. Ans: 12.86 cm

### Runoff

A 4-hour rain of average intensity 1 cm/hr falls over the fern leaf type catchment as shown in figure. The time of concentration from the line AA, BB, CC and DD are 1, 2, 3 and 4 hours resp. ly. to the site 'O' where the discharge measurements are to be made. The values of the runoff coeff. are 0.5, 0.6 and 0.7 for 1st, 2nd & 3rd hour of rainfall resp. ly. and attains a constant value of 0.8 after 3 hrs. Determine the discharge at site 'O'.



### Hydrograph

- 1) A flood hydrograph of a river draining a catchment of 189 km<sup>2</sup> due to a 6-hour isolated storm is in the form of a triangle with a base of 66 hours and a peak ordinate of 30 m<sup>3</sup>/s occurring at 10 hours from the start. Assuming zero base flow, develop the 6-hour unit hydrograph for this catchment.

- 2) The following are the ordinates of the hydrograph of flow from a catchment area of 770 km<sup>2</sup> due to a 6-h rainfall. Derive the ordinates of a 6-h unit hydrograph. Make suitable assumptions regarding the base flow.

Time from beginning of storm (h)	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge (m <sup>3</sup> /s)	40	65	215	360	400	350	270	205	145	100	70	50	42

- 3) The peak of a flood hydrograph due to a 6-h storm is 470 m<sup>3</sup>/s. The mean depth of rainfall is 8.0 cm. Assume an average infiltration loss of 0.25 cm/h and a constant base flow of 15 m<sup>3</sup>/s and estimate the peak discharge of a 6-h unit hydrograph for this catchment.

- 4) Ordinates of an 1-hour unit hydrograph at 1-hour intervals are 5, 8, 5, 3 and 1 m<sup>3</sup>/s. Calculate the,  
(i) watershed area represented by this unit hydrograph.  
(ii) S-curve hydrograph derived from this unit hydrograph.  
(iii) 2-hour unit hydrograph for the catchment.

- 5) The ordinates of a 6-h unit hydrograph are given.

Time (h)	0	3	6	9	12	18	24	30	36	42	48	54	60	66
6-h UH ordinate (m <sup>3</sup> /s)	0	150	250	450	600	800	700	600	450	320	200	100	50	0

A storm had three successive 6-h intervals of rainfall magnitude of 3.0, 5.0 and 4.0 cm respectively. Assuming a  $\phi$  index of 0.20 cm/h and a base flow of 30 m<sup>3</sup>/s, determine and plot the resulting hydrograph of flow.

- 6) The ordinates of a 2-h unit hydrograph are given:

Time (h)	0	2	4	6	8	10	12	14	16	18	20	22
2-h UH ordinate (m <sup>3</sup> /s)	0	25	100	160	190	170	110	70	30	20	6	0

Determine the ordinates of an S-curve hydrograph and using this determine the ordinates of a 4-h unit hydrograph.

- 7) Using the ordinates of a 12-h unit hydrograph given below, compute the ordinates of a 6-h unit hydrograph.

Time (h)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144
12-h unit hydrograph ordinate (m <sup>3</sup> /s)	0	10	37	76	111	136	150	153	146	130	114	99	84	71	58	46	35	25	17	12	8	6	3	2	0

Note that the tail portion of the resulting 6-h UH needs fairing.

### Evaporation / Infiltration

- 1) An isolated 3-h storm occurred as below

% of catchment area	$\phi$ Index (cm/h)	Rainfall (cm)		
		1st hour	2nd hour	3rd hour
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 this storm.

- 2) A class A pan was set up adjacent to a lake. The depth of water in the pan at the beginning of a certain week was 195 mm. In that week there was a rainfall of 45 mm and 15 mm water was removed from the pan to keep the water level within the specified depth range. If the depth of the water in the pan at the end of the week was 190 mm. Calculate the pan evaporation & estimate lake evaporation for coeff. of pan = 0.7. 24.5 mm, 24.5 x 0.7

