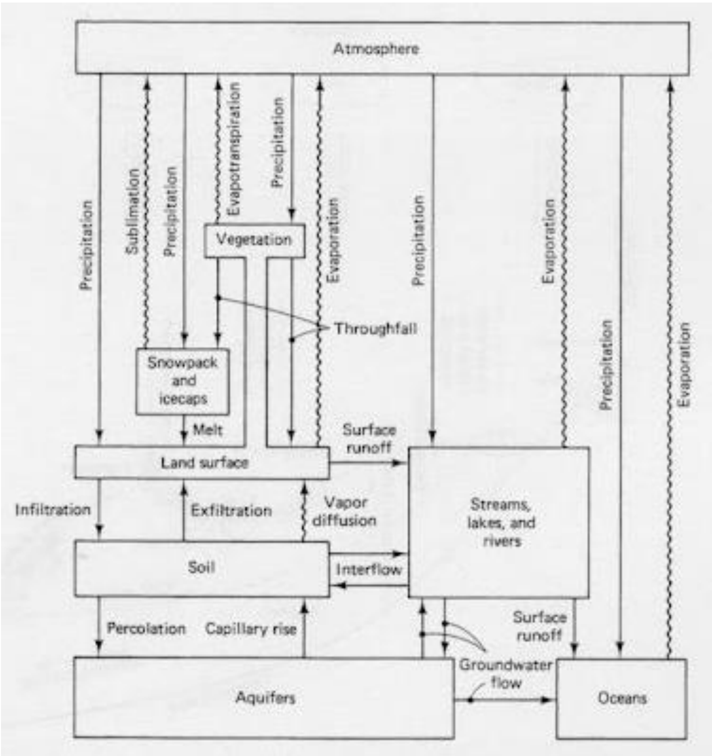
Internal Assessment Test 1
Scheme of Evaluation

Sub:	HYDROLOGY AND IRRIGATION ENGIEERING	Sub Code:	17CV73	Branch	CIVIL
					OBE
			Marks	CO	RBT
1	Explain Horton's Engineering representation of hydrological cycle, with neat sketch.		[08]	CO1	L2



3M

Figure 1.1 is a schematic representation of the hydrologic cycle. A convenient starting point to describe the cycle is in the oceans. Water in the oceans evaporate due to the heat energy provided by solar radiation. The water vapour moves upwards and forms clouds. While much of the clouds condense and fall back to the oceans as rain, a part of the clouds is driven to the land areas by winds. There they condense and *precipitate* onto the land mass as rain, snow, hail, sleet, etc. A part of the precipitation

may *evaporate* back to the atmosphere even while falling. Another part may be *intercepted* by vegetation, structures and other such surface modifications from which it may be either evaporated back to atmosphere or move down to the ground surface.

A portion of the water that reaches the ground enters the earth's surface through *infiltration,* enhance the moisture content of the soil and reach the groundwater body. Vegetation sends a portion of the water from under the ground surface back to the atmosphere through the process of *transpiration.* The precipitation reaching the ground surface after meeting the needs of infiltration and evaporation moves down the natural slope over the surface and through a network of gullies, streams and rivers to reach the ocean. The groundwater may come to the surface through springs and other outlets after spending a considerably longer time than the surface flow. The portion of the precipitation which by a variety of paths above and below the surface of the earth reaches the stream channel is called *runoff.* Once it enters a stream channel, runoff becomes *stream flow.*

5M

2	Define Precipitation. Explain different types precipitation	[08]	CO1	L2

The term *precipitation* denotes all forms of water that reach the earth from the atmosphere. The usual forms are rainfall, snowfall, hail, frost and dew. Of all these, only the first two contribute significant amounts of water. Rainfall being the predominant form

2M

Precipitation is classified according to the factors responsible for lifting and subsequent cooling. Types of precipitation are:

1) Cyclonic precipitation:

A cyclone is a large low pressure region with circular wind motion. It is caused by the lifting of an air mass due to the pressure difference. If low pressure occurs in an area, air will flow horizontally from the surrounding area, causing the air in the low pressure area to lift. The precipitation that results, is called the non-frontal cyclonic precipitation. If one air mass lifts over another air mass, the precipitation is called the frontal cyclonic precipitation.

2M

2) Convective precipitation:

In this type of precipitation the which is warmer than the surrounding due to localised heating rises because lesser density. Air from cooler surroundi to take up its place thus setting up a c cell. The warm air continues to rise, underg cooling & results in precipitation. Dependi the moisture, thermal & other conditions l showers to thunderstorms can be excepted i -ve precipitation.

2M

3) Orographic Precipitation

Orographic precipitation is caused by air masses which strike some natural topographic barriers like mountains, and cannot move forward & hence, rise up. causing condensation & precipitation. Thus in mountain ranges, the windward slopes have heavy precipitation and the leeward slopes light rainfall.

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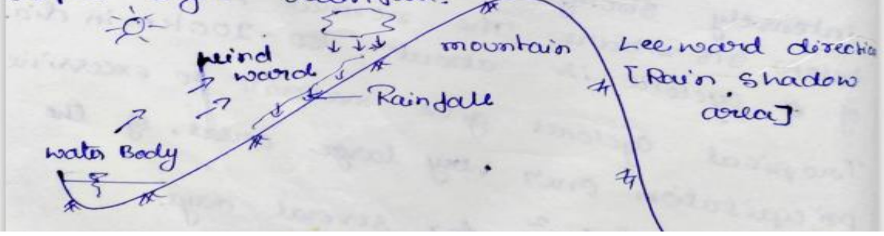

3	The normal annual rainfall of stations A, B, C and D in a catchment are 809.7, 675.9, 762.8, 920.1 mm respectively. In the year 2016, the station D was inoperative when station A, B, C recorded annual rainfall of 911.1, 722.3, and 798.9 mm respectively. Estimate the missing rainfall at D in the year 2016 by normal ratio method.	[08]	CO1	L3

Solution :

Stations	NA_RF
A	809.7 mm = N_A
B	675.9 mm = N_B
C	762.8 mm = N_C
D	920.1 mm = N_D

M = 3

1M

$P_{A(2016)}$ = 911.1mm

$P_{B(2016)}$ = 722.3mm

$P_{C(2016)}$ = 798.9 mm

$P_{D(2016)}$ = ?

1M

$$P_D = \frac{1}{M}\left[\frac{N_D}{N_A}P_A + \frac{N_D}{N_B}P_B + \frac{N_D}{N_C}P_C\right]$$

3M

$$= \frac{1}{3}\left[\frac{920.1}{809.7}\,911.1 + \frac{920.1}{675.9}\,722.3 + \frac{920.1}{762.8}\,798.9\right]$$

P_D = 994.8 mm for the year 2016.

3M

4	Describe Double mass curve technique used to check consistency of rainfall data and adjust rainfall records.	[08]	CO1	L2

The checking for inconsistency of a record is done by the *double-mass curve technique*. This technique is based on the principle that when each recorded data comes from the same parent population, they are consistent.

A group of 5 to 10 base stations in the neighbourhood of the problem station X is selected. The data of the annual (or monthly or seasonal mean) rainfall of the station X and also the average rainfall of the group of base stations covering a long period is arranged in the reverse chronological order (i.e. the latest record as the first entry and the oldest record as the last entry in the list). The accumulated precipitation of the station X (i.e. ΣP_x) and the accumulated values of the average of the group of base stations (i.e. ΣP_{av}) are calculated starting from the latest record. Values of ΣP_x are plotted against ΣP_{av} for various consecutive time periods (Fig. 2.7). A decided break in the slope of the resulting plot indicates a change in the precipitation regime of station X. The precipitation values at station X beyond the period of change of regime (point 63 in Fig. 2.7) is corrected by using the relation

$$P_{cx} = P_x \frac{M_c}{M_a} \quad (2.6)$$

where P_{cx} = corrected precipitation at any time period t_1 at station X
P_x = original recorded precipitation at time period t_1 at station X

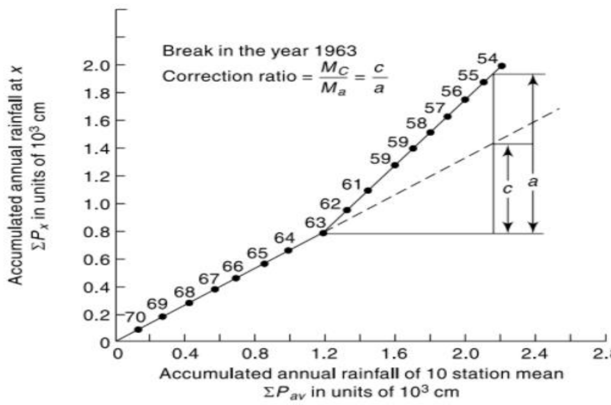

Fig. 2.7 Double-mass Curve

8M

M_c = corrected slope of the double-mass curve
M_a = original slope of the double-mass curve
In this way the older records are brought to the new regime of the station.

5	Name various practical application of hydrology. What are the different forms of Precipitation?	[06]	CO1	L1

Hydrology finds its greatest application in the design and operation of water-resources engineering projects, such as those for (i) irrigation, (ii) water supply, (iii) flood control, (iv) water power, and (v) navigation. In all these projects hydrological investigations for the proper assessment of the following factors are necessary: **4M**

1. The capacity of storage structures such as reservoirs.
2. The magnitude of flood flows to enable safe disposal of the excess flow.
3. The minimum flow and quantity of flow available at various seasons.
4. The interaction of the flood wave and hydraulic structures, such as levees, reservoirs, barrages and bridges.

The hydrological study of a project should necessarily precede structural and other detailed design studies. It involves the collection of relevant data and analysis of the data by applying the principles and theories of hydrology to seek solutions to practical problems.

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Forms of precipitation: Rainfall, Snow, Drizzle, Glaze, Sleet, Hail

6	The average annual rainfall of 8 rain gauge stations in a basin are 1000, 950, 900, 850, 800, 700, 600 and 400 mm. If the permissible error is 6%. Determine the optimum number of rain gauges required in the basin.	[06]	CO1	L3

ution:-

$m = 8$

$\epsilon = 6\%$

$$N = \left[\frac{C_v}{\epsilon}\right]^2 \qquad C_v = 100 \times \frac{\sigma_{m-1}}{\bar{P}}$$

2M

Avg. PcP → $\bar{P} = \frac{1000+950+900+850+800+700+600+400}{8}$

$\boxed{\bar{P} = 775\,mm}$

$$\sigma_{m-1} = \sqrt{\frac{\sum(P_i - \bar{P})^2}{m-1}} = \sqrt{\frac{225^2 + 175^2 + 125^2 + 75^2 + 25^2 + (-75)^2 + (-175^2) + (-375)^2}{8-1}}$$

4M

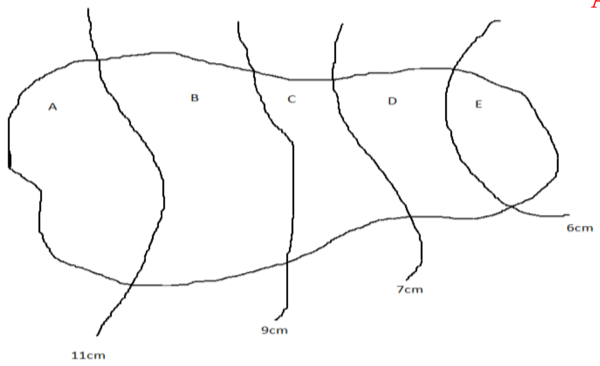
$\boxed{\sigma_{m-1} = 200}$

$$C_v = 100 \times \frac{200}{775} = 25.806\,\%$$

$$\therefore N = \left[\frac{25.806}{6}\right]^2 = 18.49 \simeq 19$$ Rain gauges required. (Optimal No of RG)

∴ Additional 11 no of Raingauge stations are required.

7	Calculate the Mean areal rainfall using Isohyetal method using the necessary data.	[06]	CO1	L3



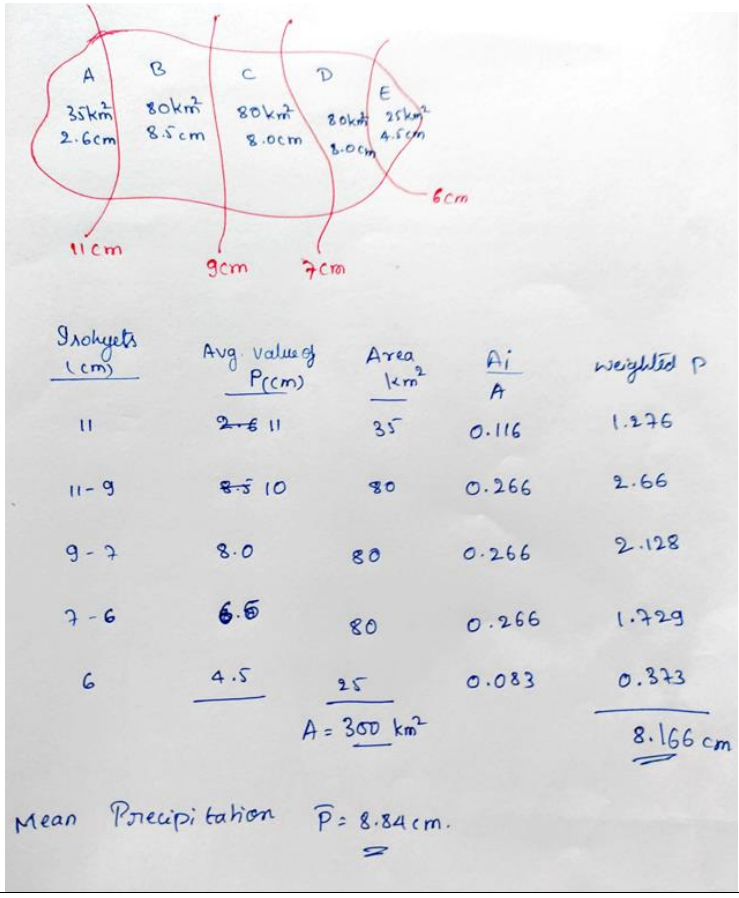
A = $35km^2$
2.6cm

B = $80km^2$
8.5cm

C = $80km^2$
8.0cm

D = $80km^2$
8.0cm

E = $25km^2$
4.5cm



Isohyets (cm)	Avg. value of P(cm)	Area km^2	$\frac{A_i}{A}$	weighted P
11	~~2.6~~ 11	35	0.116	1.276
11 - 9	~~8.5~~ 10	80	0.266	2.66
9 - 7	8.0	80	0.266	2.128
7 - 6	6.5	80	0.266	1.729
6	4.5	25	0.083	0.373
		A = 300 km^2		8.166 cm

Mean Precipitation $\bar{P}$ = 8.84 cm.

6M

P. T.O

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