Notes by-

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Pro. 1]

St. No.	Normal Rainfall	Annual Rainfall $(P-P_i)$	$(P-P_i)^2$
1	42.4 cm	70.08-42.4=27.68	766.18
2	53.6 cm	16.48	271.59
3	67.8 cm	2.28	5.19
4	78.5 cm	-8.42	70.89
5	82.7 cm	-12.62	159.26
6	95.5 cm	-25.42	645.16

$\Sigma P = 420.5, \therefore \bar{P_i} = 70.08 \quad \Sigma(\bar{P}-P_i)^2 = 1918.27$

$\epsilon = \text{error} = 10\%$

Number of Rain Gauge stations = ?

Procedure:-

① $\Sigma P_N =$

② $\bar{P} = \dfrac{\Sigma P_N}{m}$

③ $(\bar{P}-P_i)^2$

④ $\Sigma(\bar{P}-P_i)^2$

⑤ $\sigma_{m-1} = \sqrt{\dfrac{\Sigma(\bar{P}-P_i)^2}{m-1}} = \sqrt{\dfrac{1918.27}{6-1}} = 19.59$

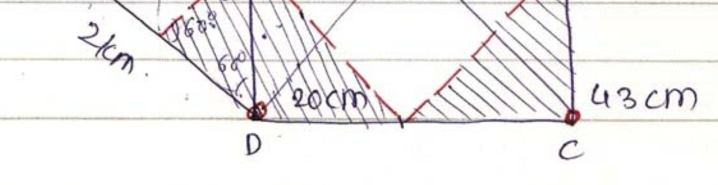
⑥ $C_v = \dfrac{100 \times \sigma_{m-1}}{\bar{P}} = \dfrac{100 \times 19.59}{70.08} = 27.95$

⑦ $N = \left[\dfrac{C_v}{\epsilon}\right]^2 = \left(\dfrac{27.95}{10}\right)^2 = 7.81 \simeq 8$ stations.

$\therefore$ 2 More stations are Reqd. ... Ans.

Pro: 2]

Thiessen Polygon method:-



Area of □ABCD = $2 \times 2 = 4\ km^2$

Area of inner □ = $2\ km^2$

① Area for statⁿ E = $2 km^2$

② Area for statⁿ B, C, = $0.5 km^2$

③ Area for statⁿ A & D = $0.577 + 0.5 = 1.077\ km^2$

Area of ADF = $\frac{1}{2} \times 2 \sin 60 \times 2$

$= 1.732\ km^2$

∴ Area of stⁿ F = $\frac{1}{3}(1.732) = \cancel{0.577}\ km$

$\frac{1}{2}(1.732) = 0.867$

$$\bar{P} = \frac{\sum P_i A_i}{\sum A}$$

∴ ~~$\bar{P} = 1.077 * 10 +$~~

Station	Pi (cm)	Ai (km²)	PiAi
A	10	1.077	10.77
B	68	0.5	34
C	43	0.5	21.5
D	20	1.077	21.54
E	38	2	76
F	15	0.577	8.655
		Σ 5.731	Σ 172.465

$$\boxed{\therefore \bar{P} = \frac{172.465}{5.731} = 30.1\ cm}$$

Pro 3] USNWS Mtd.

Stⁿ	Rainfall (P cm)	X	Y	$D^2 = X^2 + Y^2$	$W = 1/D^2$	P·W
A	102	2.0	1.0	5	0.2	20.4
B	120	2.0	2.0	8	0.125	15
C	126	3.0	1.0	10	0.1	12.6
D	108	1.5	1.0	3.25	0.3125	33.75
E	131	4.5	1.5	22.5	0.044	5.764
					ΣW = 0.7815	ΣPW = 87.5

$$PM = \frac{\sum PW}{\sum W} = \frac{87.514}{0.7815} = 111.98\ cm.$$

Pro: 4] Missing Rainfall Problem :-

Types of Pro. in Ppt. $\frac{6/12}{2}$

* Intensity Durat^n Curve
* Depth Durat^n Curves
* Frequency Analysis.

St^n	Normal annual Rainfall (N)	P
P	125	13.2
Q	102	9.2
R	76	6.8
S	113	10.2
T	137	?

$N_T = 137$

10% of N_T $= \cancel{0}1.1 \times 137 = \cancel{123}\ 150.7$
$= 0.9 \times 137 = 123.3$

All other normal value are within the range then go for arithmatic average. otherwise use,

$$P_T = \frac{13.2+9.2+6.8+10.2}{4} = 9.85$$ ... ~~Arithmatic Avg. mtd. which~~ should not used here

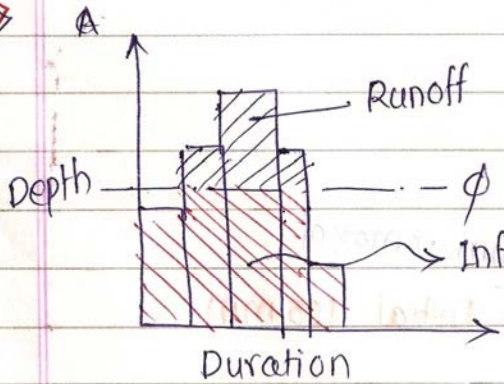
$$\therefore P_T = \frac{N_T}{m}\left[\frac{P_p}{N_p}+\frac{P_q}{N_q}+\frac{P_r}{N_r}+\frac{P_s}{N_s}\right]$$ ... "Normal Ratio Method"

$$= \frac{137}{\cancel{5}4}\left[\cancel{125}\ \frac{13.2}{125}+\frac{9.2}{102}+\frac{6.8}{76}+\frac{10.2}{113}\right]$$

$\boxed{\cancel{P_T = 10.29}}$ $\boxed{P_T = 12.86}$

Evaporation

Pro 1)



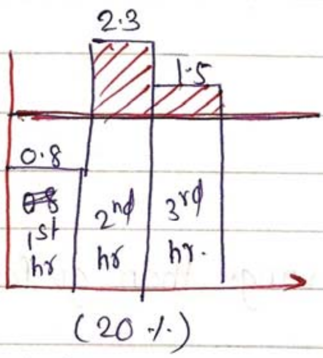
The vol. above ϕ ~~value~~ line is Runoff & below ϕ line is infilteration

$\therefore$ Runoff = Ppt - Infilterat^n.

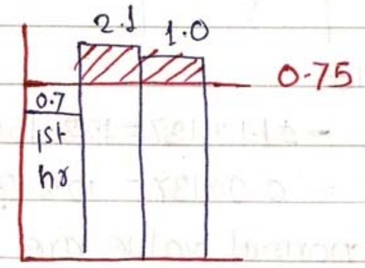
% of catment area	φ cm/hr	1^{st} (hr)	2^{nd} (hr)	3^{rd} (hr)
20	1.00	0.8 0	2.3 1.3	1.5 0.5
30	0.75	0.7 —	2.1 1.35	1.0 0.25
50	0.50	1.0 0.5	2.5 2.0	0.8 0.3

20% (0)

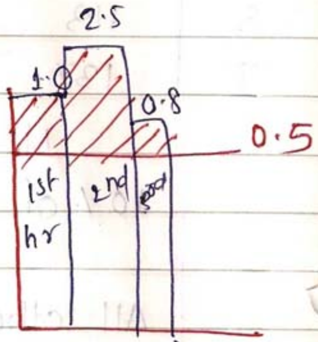
Runoff quantity i.e. 1.5 − 1.0, 1.0 − 0., 0.8 − 0



(20%)



(30%)



(50%)

~~Ist hr.~~

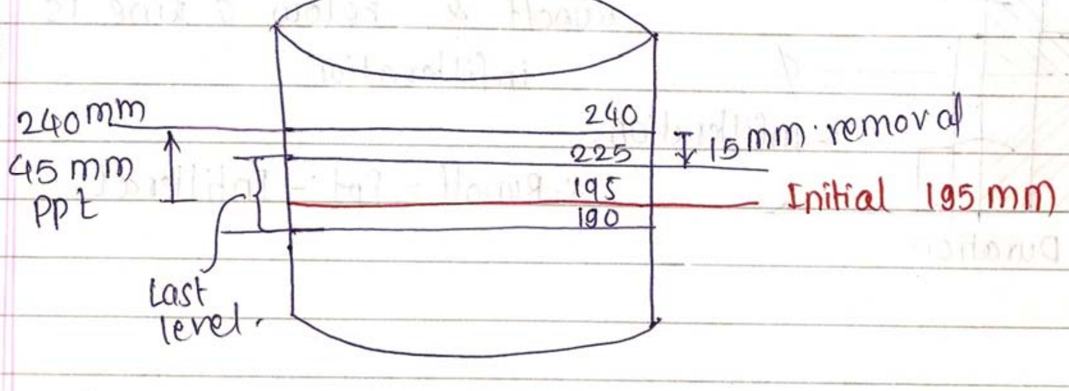
$$\therefore I^{st}\ hr = \frac{20(0)+30(0)+50(0.5)}{(20+30+50)} = 0.25$$

$$II^{nd}\ hr = \frac{20(1.3)+30(1.35)+50(2)}{20+30+50} = 1.665$$

$$III^{rd}\ hr = \frac{0.5(20)+0.25(30)+0.3(50)}{100} = 0.325$$

Total Runoff = 0.25 + 1.665 + 0.325 = **2.24 cm**.

Pro: 2]



Pan evaporation = 225 − 190 = 35 mm

Lake evaporatⁿ = Pan Eva × Cp

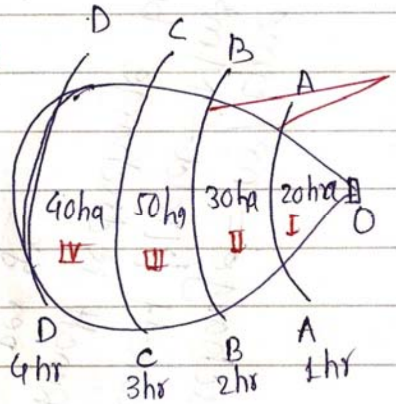
= 35 × 0.7 = 24.5 mm

* water Budget eqⁿ :-

$$\boxed{S_2 - S_1 = P - I - E - GW}$$

storage = (Mm³)

Runoff :- Pro:



Isochromes :- line having equal time of concentration.

Thus ~~line~~ water coming from A-A line takes 1 hr to reach up to 'O'.
& From B-B line 2 hrs are reqd & so on

Iˢᵗ hr : AA Donates water.
IIⁿᵈ hr : AA + BB
IIIʳᵈ : AA + BB + CC
IVᵗʰ : AA + BB + CC + DD
Vᵗʰ : BB + CC + DD ... Rainfall stops.
VIᵗʰ : CC + DD
VIIᵗʰ : DD.
VIIIᵗʰ : 0. No Runoff

Surface contributing Runoff (ha)	Time of begining of storm (hr) 1	2	3	4	5	6	7	8	Runoff coeff.
I	20 ← 1st hr.	20 → 2nd hr of this	20	20	–	–	–	–	0.5
II	~~30~~	30 → 30 ha. has 1st hour	30	30	30	–	–	–	0.6
III	~~50~~	–	50	50	50	50	–	–	0.7
IV	~~40~~	–	–	40	40	40	40	–	0.8

$Q = \cancel{CAI}$ CIA - - - Rational Formula of Runoff calculat?

C = Runoff coeff. = ~~ppt~~ $\dfrac{\text{Surface Runoff}}{\text{Precipitation}}$.

I = Avg. intensity

A = catchment area.

KPIA $\frac{1}{36}$

m/s

ha
cm/s
cm/hr

m³/hr

m³/hr	
1000	∴ $Q_1 = \overset{\text{1st hr Going}}{0.5 \times 20 \times 10^4} \times \frac{1}{100} =$
2700	$Q_2 = \overset{\text{2nd hr going}}{0.6 \times 20 \times 10^4} \times \frac{1}{100} + \overset{\text{1st hr-going}}{0.5 \times 30 \times 10^4} \times \frac{1}{100}$
5700	$Q_3 = \overset{\text{3rd hr. going}}{0.7 \times \frac{20 \times 10^4}{100}} + \overset{\text{2nd hr. going}}{0.6 \times \frac{30 \times 10^4}{100}} + \overset{\text{1st hr going}}{0.5 \times \frac{50 \times 10^4}{100}}$
8700	$Q_4 = 0.8 \times \frac{20 \times 10^4}{100} + 0.7 \times \frac{30 \times 10^4}{100} + 0.6 \times \frac{50 \times 10^4}{100} + 0.5 \times \frac{40 \times 10^4}{100}$
8300	$Q_5 = 0.8 \times \frac{30 \times 10^4}{100} + 0.7 \times \frac{50 \times 10^4}{100} + 0.6 \times \frac{40 \times 10^4}{100}$
6800	$Q_6 = 0.8 \times \frac{50 \times 10^4}{100} + 0.7 \times \frac{40 \times 10^4}{100}$
3200	$Q_7 = 0.8 \times \frac{40 \times 10^4}{100}$
0	$Q_8 = 0$
~~36400~~	

Discharge = m³/ time

Runoff / yield = Mm³ = Vol.

i.e. Runoff is discharge but expressed per yr.