USN | | | | | | | | | |

CMRIT — CMR Institute of Technology, Bengaluru. Celebrating 25 Years. Accredited with A+ Grade by NAAC

Internal Assessment Test II – June 2021

Sub:	*Hydrology and Irrigation Engineering*					*Sub Code:*	*18CV63*	*Branch:*	*CIVIL*
Date:	23/06/2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	A&B		OBE

Answer FIVE FULL Questions

Q		Question	MARKS	CO	RBT
1	(a)	Define Evaporation. With a neat sketch, explain the measurement of evaporation using ISI standard class A pan.	[05]	CO1	L2
	(b)	What are the various methods of measurement of the rate of infiltration?. Also, explain the determination of constants in Horton's equation	[05]	CO1	L2
2		The rate of rainfall for successive 30 minutes period of a 4 hour storm are as follows: 3.5, 6.5, 8.5, 7.8, 6.4, 4.0, 4.0, 6.0 cm/hr. Taking the value of φ index as 4.5 cm/hr. Compute i) Total Rainfall ii) Total rainfall excess and iii) W- Index.	[08]	CO1	L2
3	(a)	Define Hydrograph. Explain various components of the flood hydrograph.	[06]	CO1	L2
	(b)	Given the ordinates of 4hr. unit hydrograph, derive the ordinates of 12 hr unit hydrograph for the same catchment	[08]	CO1	L2

Time (hr)	0	4	8	12	16	20	24	28	32	36	40
Ordinates of 4hr	0	20	80	130	150	130	90	52	27	15	5

Q		Question	MARKS	CO	RBT
4	(a)	Define unit hydrograph. Explain the assumptions made in deriving the unit hydrograph.	[08]	CO1	L2
		OR			
	(b)	Explain with neat diagram of a (a) Simple infiltrometers b) Double ring infiltrometers.	[08]		
5	(a)	Rainfall of magnitude 3.8cm and 2.8cm occurring on two consecutive 4-hr durations on a catchment of area 27km^2 produced the following hydrograph of flow at the outlet of the catchment estimate the rainfall excess and Φ-index.	[05]	CO1	L2

Time from start of rainfall (h)	-6	0	6	12	18	24	30	36	42	48	54	60	66
observed flow(m3/s)	6	5	13	26	21	16	12	9	7	5	5	4.5	4.5

Q		Question	MARKS	CO	RBT
	(b)	A Strom over a catchment of area 5km^2 had duration of 14 hrs. The mass curve of rainfall of the storm is as follows:	[05]	CO1	L2

Time from start of storm (h)	0	2	4	6	8	10	12	14
accumulated rainfall(cm)	0	0.6	2.8	5.2	6.6	7.5	9.2	9.6

If the Φ-index for the catchment is 0.4 cm/h. determine the effective rainfall hyetograph & the volume of direct runoff from the catchment due to the storm

[10] CO1 L2

CI CCI

IAT-02

Hydrology and irrigation Engineering

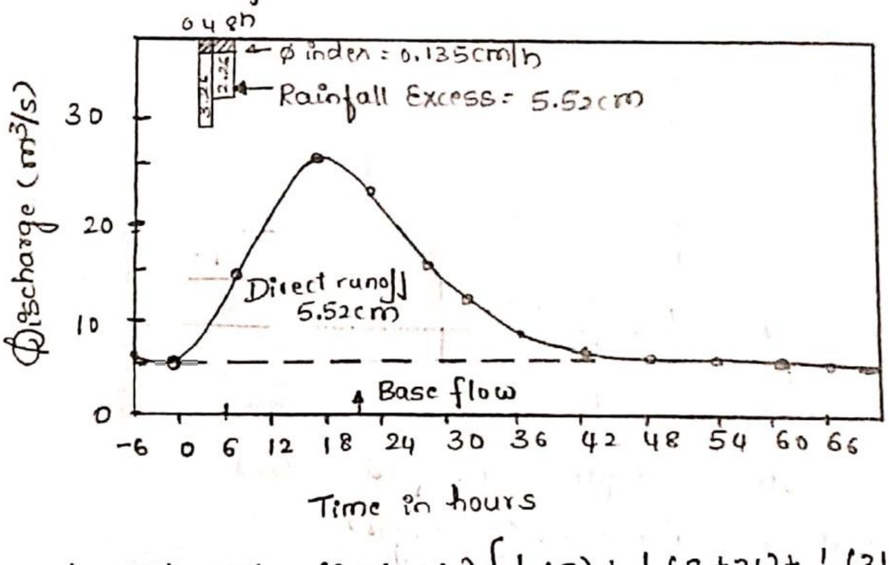
05 (a) Rainfall of magnitude 3.8cm and 2.8cm occuring on two consecutive 4-hr durations on a catchment of area 27 km^2 produced the following hydrograph of flow at the Outlet of the catchment of area 27 km^2 produced the following hydrograph of flow at the Outlet of the catchment Estimate the rainfall Excess and ϕ index

Time from Start to rainfall h	-6	0	6	12	18	24	30	36	42	48	54	60	66
Observed flow (m^3/s)	6	5	13	26	21	16	12	9	7	5	5	4.5	4.5

Solution

$N = 0.83 \times (27)^{0.2} = 1.6 \text{ days} = 38.5 h$

by interpection, DRH Starts at t=0, has the peak at t=12h and Ends at t=48h As N=36h appears to be more Staisfary than N=38.5h in the present case DRH is assumed to Exist from t=0 to 48h.



$$\text{Area of DRH} = (6 \times 60 \times 60)\left[\frac{1}{2}(8) + \frac{1}{2}(8+21) + \frac{1}{2}(21+16) + \frac{1}{6}(16+11) + 1/2(11+7) + 1/2(7+4) + 1/2(4+2) + 1/2(2)\right]$$

$$= 3600 \times 6 \times (8+21+16+11+7+4+2)$$

$$= 1.4904 \times 10^6 m^3$$

= Total direct runoff due to Storm

Runoff depth = $\frac{\text{Runoff volume}}{\text{Catchment area}} = \frac{1.4904 \times 10^6}{27 \times 10^6} = 0.0552\,m$

$= 5.52\,cm$ = rainfall Excess

Total rainfall = $3.8 + 2.8 = 6.6\,cm$

Duration = 8h

ϕ index $= \frac{6.6 - 5.52}{8} = 0.135\,cm/h$

(05)

(06) A Strom over a catchment of area $5\,km^2$ had duration of 14hrs the mass curve of rainfall of the Storm is as follows

if the ϕ index for the catchment is 0.4cm/h determine the effective rainfall hydrograph & the volume of direct runoff from the catchment due to Storm

1	2	3	4	5	6	7
0	–	0	–	–	–	–
2	2	0.6	0.6	0.8	0	0
4	2	2.8	2.2	0.8	1.4	0.7
6	2	5.2	2.4	0.8	1.6	0.8
8	2	6.7	1.5	0.8	0.7	0.35
10	2	7.5	0.8	0.8	0	0
12	2	9.2	1.7	0.8	0.9	0.45
14	2	9.6	0.4	0.8	0	0

ER = (actual depth rain fall − $\phi \Delta t$)

ER = 0 (wichever is larger)

ER = $(0.7 + 0.8 + 0.35 + 0.45) \times 2 = 4.6$

Volume of direct runoff

$= \frac{4.6}{1000} \times 50 \times (1000)^2$

$= 23000\,m^3$

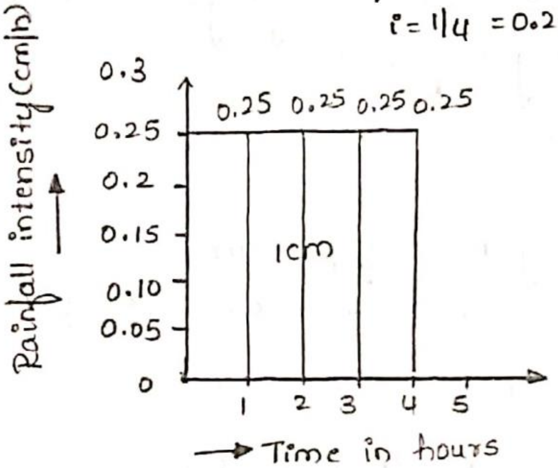
Scanned with CamScanner

04. Define Unit hydrograph. Explain the assumption made in deriving the Unit hydrograph

Assumption-1 The Effective rainfall (1cm depth) is Uniformly distributed within is duration (D-hrs)

1cm Excess Rainfall Uniformly distributed over 4-hrs

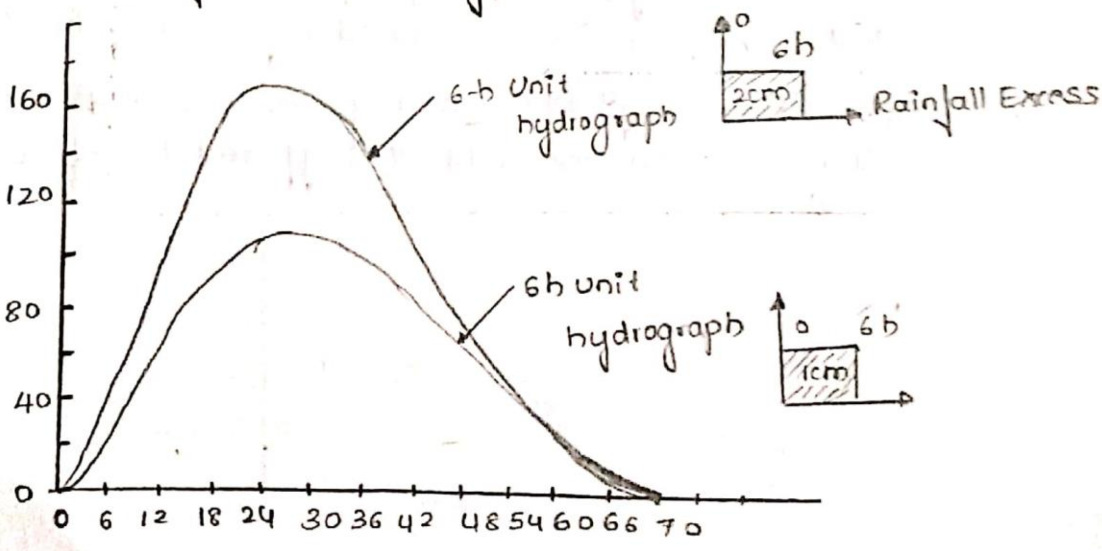
$i = 1/4 = 0.25$ cm/hr



Assumption-02: The Effective Rainfall is Uniformly distributed throughout the catchment

Assumption-03:

The base periods of direct runoff hydrograph remains same for constant duration Effective rainfall (Even if the intensity (varies)



Assumption-04

The direct runoff response to the rainfall Excess is assumed to be linear this know as Principle of Linearity

Assumption 05 :- The Shape of Direct hydrograph for a Given Excess of rainfall remains Same irrespective of time of commencement of rainfall this is known as principle of time invariance

Derivation of Unit hydrograph

The Unit hydrograph can be derived from a total Stream flow hydrograph at a Given Stream gauge location along with the following information.

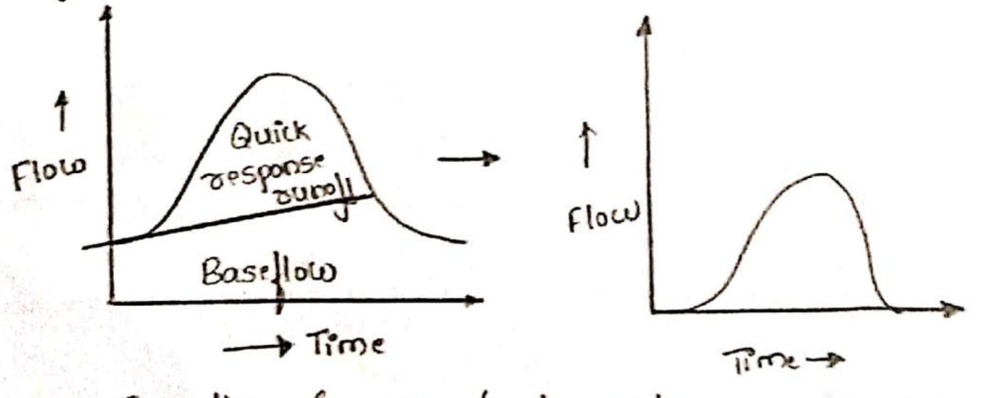
01) Storm hydrograph
02) The Basin Area
03) The Basin - averaged rainfall depth
04) The duration Over which the Excess precipitation occurred

Step-01 - Select Appropriate precipitation Event

The rainfall records of the drainage basin are Scanned to find a Single isolated Storm of desired duration (D-hrs) which is Uniformly distributed Over the Basin and at a Uniform rate Over the duration

Step 02 - Remove Base flow contribution

- Corresponding runoff hydrograph is plotted on a Graph and Baseflow is Separated by any of the methods.
- Then Ordinate of DRH at any time is obtained as different b/w the total runoff and Baseflow at the time

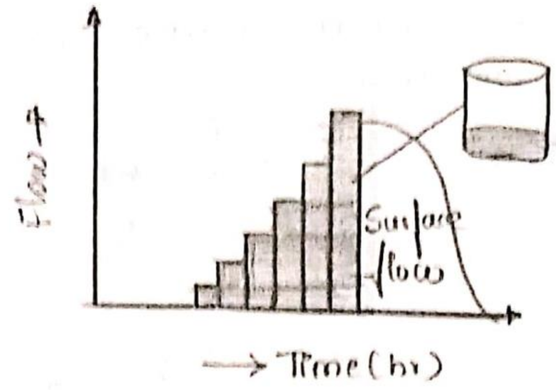


Removing Baseflow from the hydrograph

Step-03 - Calculation Quick - Response Volume

→ The total Volume of runoff is computed by calculating the area of direct runoff hydrograph

i.e Volume of runoff = Area of DRH



calculate the Volume of Quick-Response Runoff

Step-04 - Determine Excess Rainfall / Runoff from Basin

The depth of direct runoff / Excess rainfall is computed by dividing the volume of direct runoff by the area of basin

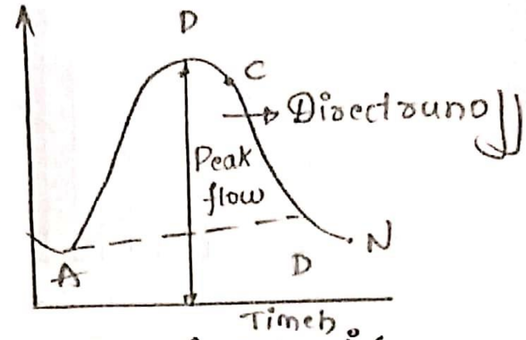
Step-05 - Determine Ordinate of Unit hydrograph

Ordinates of DRH are divide by depth of direct runoff to Yield ordinates of Unit hydrograph

$$\text{Ordinates of Unit hydrograph} = \frac{\text{Ordinates of DRH}}{\text{Excess rainfall}}$$

03) Define Hydrograph. Expalin various components of the flood hydrograph

A hydrograph is a Graph or plot that Shown the rate of water flow in relation to time Given a Specific point or cross Section



components of Hydrograph.

1) Rising limb:

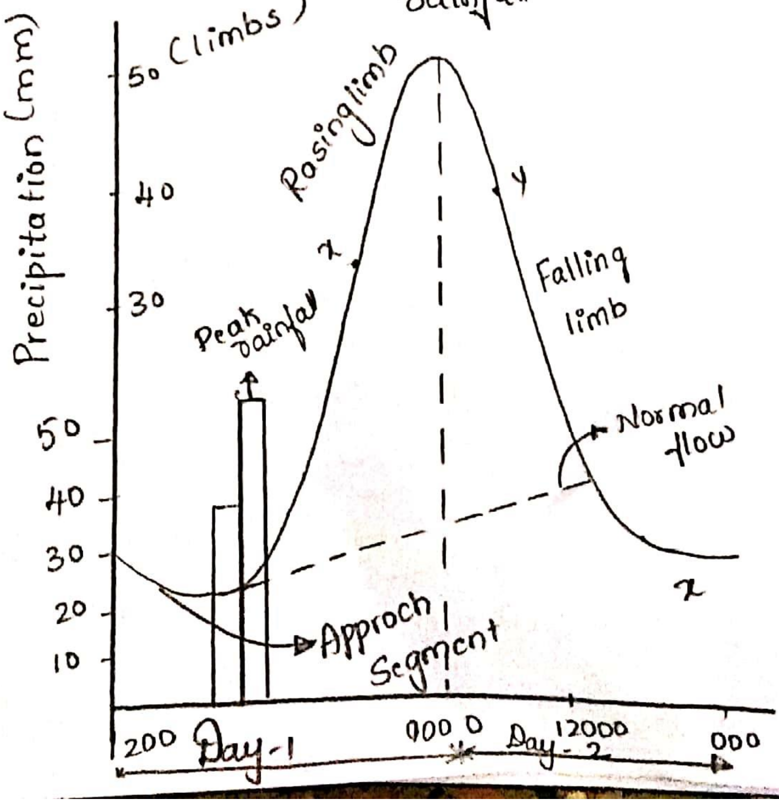
→ it is alsknown as concentration Curve, is the ascending portion of hydrograph itsslop Steepness depends on the rise of discharge due to Gradual buildings

02) Crest Segement:

This Segment is one of the very impartant parts of hydroGraph. as it containes the peak flow it is Extended from the point of inflection.

03) Falling limb or Recession limb (CD)

- it is the descending position of the hydrograph
- it is depends on Basic characteris and impartant of rainfall



Peak discharge :- The highest points on the hydrograph where rate of discharg is Greatest

Lag time :- the time interval from the centre of mass of rainfall Excess

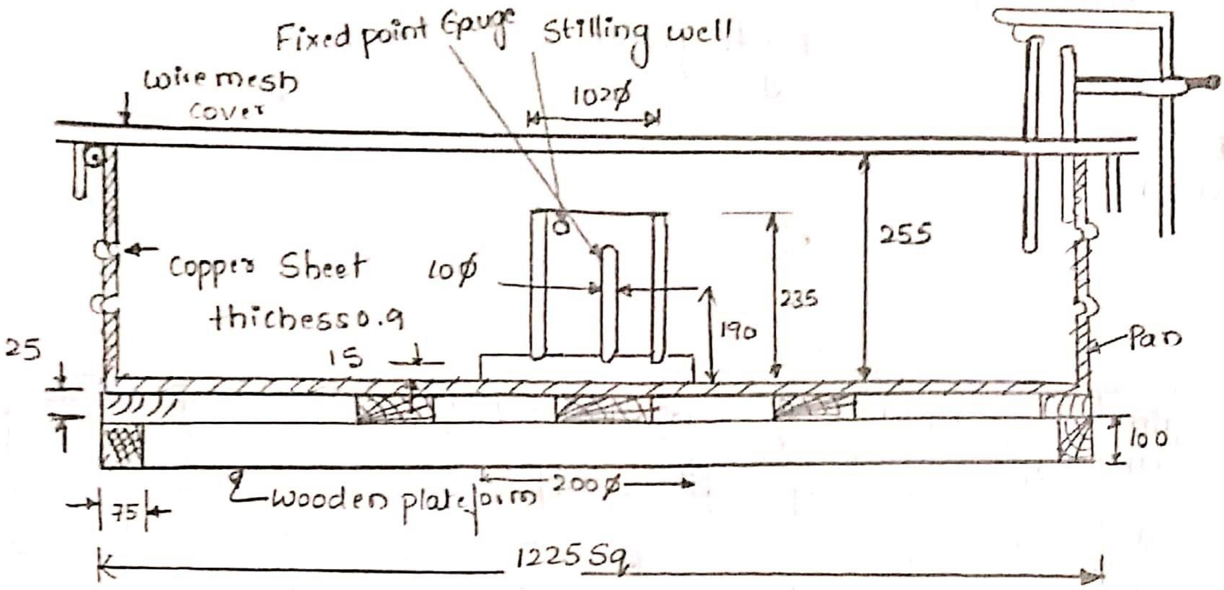
Time to peak :- Time interval from the start of the resulting hydrograph

03(b)

Time (h)	Ordinates of 4-h UH (m³/s)			DRH of 3cm in 12h (m³/s) (2+3+4)	Ordinate of 12-h-UH (m³/s)
	A	B lagged by 4-h	C lagged by 8-h		
0	0	–	–	0	0
4	20	0	–	20	6.7
8	80	20	0	100	33.3
12	130	80	20	230	76.7
16	150	130	80	360	120
20	130	150	130	410	136.7
24	90	130	150	370	123.3
28	52	90	130	272	90.7
32	27	52	90	169	56.3
36	15	27	52	94	31.5
40	5	15	27	47	15.7
44	0	5	15	20	6.7
48		0	5	5	1.7
52			0	0	0

01) Define Evaporation with a Neat Sketch Explain the measurement of Evaporation Using ISI Standard class A pan

it is the process by which a liquid changes to Gaseous State at the free Surface through tranfer of heat Energy



→ This Evaporation pan should conform to IS-5973 : 1976

- it consists of a circular copper vessel of 1220mm Effective diameter, 255mm Effective depth and a wall thickness of 0.9mm
- The thermometer is assembled to record the Various in temperature
- The A wire mesh cover with hexagonal openings is provided at the top prevent Entery of foreign matter

1(b) :-

Measurement of infiltration

infiltration rates are required in many hydrogical problem such as runoff Exitmation Soil moisture studies in agriculutial &t the different methods of determination of infitration are

- i) Use of infiltration - meter
- ii) Hydrograph analysis method.

- infiltro - meter are two types
  - a) Flooding type infiltro meter
  - b) Rainfall Simulation

- Horton's Equation

$$f_p = f_c + (f_o - f_c)\, e^{-K_h t}$$

f_p = infiltration capacity (inches/hours)

f_c - minimum infiltration capacity

t = time since the start of rainfall

K - constant depending upon soil types and vegetable cover

Question 2.

Time (hr)	Intensity (cm/hr)	Depth of rainfall (cm)	$\phi \Delta t$ (cm)	ER (cm)
0.5	3.5	7	2.25	~~15.75~~ 4.75
1	6.5	13	2.25	~~29.25~~ 10.75
1.5	8.5	17	2.25	~~38.25~~ 14.75
2	7.8	15.6	2.25	~~35.1~~ 13.35
2.5	6.4	12.8	2.25	~~28.8~~ 10.55
3	4.0	8	2.25	~~18~~ 5.75
3.5	4.0	8	2.25	~~18~~ 5.75
4	6.0	12	2.25	~~27~~ 9.75

Total rainfall

$= 7 + 13 + 17 + 15.6 + 12.8 + 8 + 8 + 12$

$= 96.4 \text{ cm}$

Total effective rainfall:

$= 4.75 + 10.75 + 14.75 + 13.35 + 10.55 + 5.75 + 5.75 + 9.75$

$= \underline{75.4 \text{ cm}}$

W-index:

$= (P - Q)/T_r$ — P = rainfall depth, Q = runoff depth.

$= (96.4 - 75.4)/4$

$= 5.25 \text{ cm/hr}$