Ref. No. : Ex/PG/DB/SWRE/09/2024

M.E. (Water Resources & Hydraulic Engineering) Examination, 2024

(Second Year-1st Semester)

ADVANCED HYDROLOGY

Time: Three Hours Full Marks: 100

Answer any *five*

1. (a) Define midsize catchment. What are the characteristics of a midsize catchment?

(b) Establish the co-relation between actual runoff (Q) and total rainfall (P) using Runoff Curve Number (CN) Method for midsize catchments condition.

$$Q = \frac{R[CN(P/R + 2) - 200]^2}{CN[CN(P/R - 8) + 800]}$$

Which is subject to the restriction that $P \geq R[(200/CN)-2]$ where R= 2.54, and P and Q are given in cm.

(c) Deduce an expression for range of a reservoir as developed by Hurst on the basis of average discharge data that can be expected throughout the year and draw the residual mass curve in the graph paper.

Month	Mean monthly flow (cumec)	Month	Mean monthly flow (cumec)
January	5	July	20
February	2	August	25
March	1	September	27
April	1	October	20
May	6	November	28
June	1	December	10

2+8+10=20

2. (a) Deduce an expression of time of concentration (t_c) for overland flow for a kinematic wave to travel the distance from the catchment boundary to catchment outlet (L) and rainfall excess rate (i_e)

(b) A catchment consists of an ashpalt pavement (n=0.011) that drains into a trapezoidal concrete channel (n=0.013). The ashpalt pavement has an average slope of 0.5%, and the distance from the catchment boundary to the drain is 50 m. The drainage channel is 40 m long, 30 cm wide, side slope 2 (H) : 1 (V), and has a slope of 0.7%. For an effective rainfall intensity of 75 mm/h, the flow rate in the channel is estimated to be 0.030 m^3/s. Estimate the time of concentration of the entire catchment area in minute. Consider the kinematic wave equation for the overland flow.

10+10=20

3. (a) What are the guidelines that should be considered for storm transposition?
   (b) Under what circumstances two basins can be considered meteorologically homogeneous?
   (c) Determine the PMP of catchments?

   Area of Catchment - 9685 Sq.km

Isohyetals (mm)	295	230	200	175	150	100	50
Area enclosed (sq. km.)	530	1550	2023	2994	4923	8220	10089

Measured **3** day maximum rainfall of two stations located inside the isohyet 295 mm are – 302.55 mm and 298.67 mm.

4+2+14=20

4. (a) Calculate Snyder synthetic unit hydrograph parameters for the following data: catchment area A=350 km^2; L=20 km; L_{ca}=15km; C_t=1.4; C_p=0.6; Derive a Unit hydrograph for the catchment.

   (b) A reservoir has the following elevation, discharge and storage relationships

Elevation	**Storage**	**Outflow Discharge**
m	**10^6 m^3**	**m^3/s**
100	3.35	0
100.5	3.472	10
101	3.38	26
101.5	4.383	46
102	4.882	72
102.5	5.37	100
102.75	5.527	116
103	5.856	130

Route the following flood hydrograph through the reservoir by Goodrich method.

Time (h)	0	6	12	18	24	30	36	42	48	54
Discharge (m^3/s)	10	30	85	140	125	96	75	60	46	35

The initial conditions are: when t=0, the reservoir elevation is 100.60 m

10+10=20

5. (a) Explain the basic principles involved in the development of IUH by Nash's model.

(b) Route the following flood wave using the convex method of the kinematic wave equation.

Time (min)	0	10	20	30	40	50	60	70	80	90	100
Inflow (m^3/s)	0	1	2	4	8	10	8	4	2	1	0

Assume base flow 0 m^3/s, velocity = 1 m/s, celerity = 1.5 m/s, space grid spacing = 1200 m and time grid spacing = 10 min.

8+12= 20

6. (a) What is Instantaneous Unit Hydrograph (IUH)?

(b) What are the main advantages of IUH.

(c) The ordinates of 4 hr UH of catchment is given below determine the ordinate of IUH of the catchment.

Time (hr)	Ordinates of 4 hr UH (m^3/s)
0	0
1	1.0
2	6.38
3	17.0
4	29.13
5	39.0
6	42.5
7	38.6
8	31.3
9	23.5
10	16.6
11	11.0
12	6.6
13	3.5
14	1.5
15	0.4
16	0

Or

The coordinate of IUH of a catchment are as below:

Time	0	1	2	3	4	5	6	8	10	12	14	16	18	20
Ordinates (m^3/s)	0	11	37	60	71	75	72	60	45	33	21	12	6	0

i) What is the areal extent of the catchment?

ii) Derive the three hours unit hydrograph for this catchment.

3+3+14=20

7. (a) Define term forest hydrology?

(b) Write short notes on

i) Flooding Forest ii) Stream Network

(c) A 900 ha water shed has the land use/ land cover and corresponding runoff coefficient is given below table.

Land Use/cover	Area (ha)	Runoff coefficient
Forest	500	0.10
Pasture	140	0.11
Cultivated land	260	0.30

The maximum length of travel of water in watershed is about 4000 m and the elevation difference between the highest and outlet point is 26 m. The maximum intensity duration frequency relationship of the watershed is given by.

$$\mathbf{I} = \frac{6.311\,T^{0.1523}}{(D+0.50)^{0.945}}$$

Where i= intensity in cm/h, T = return period in years and D= Duration of the rainfall in hours. Estimate the

(i) 25 years peak runoff from the watershed

(ii) The 25 years peak runoff, if the forest cover has decreased to 250 ha and the cultivated land encroached up on the pasture and forest land to have a total average of 650 ha.

2+6+12=20