M.E. (Water Resources & Hydraulic Engineering) Examination, 2025

(2nd Semester)

ADVANCED HYDROLOGY

(Paper X)

Time : Three Hours | Full Marks : 100

Answer any ***four*** questions.

1. a) What are the different steps for determining the PMP of a river basin?
   b) What are the guidelines that should be considered for storm transposition?
   c) Determine the PMP of catchments?

   Area of Catchment - 9685 sq. km

Isohyetals (mm)	290	225	200	175	150	100	50
Area enclosed (sq. km.)	535	1650	2050	3150	5023	8200	10089

   Measured 3-day maximum rainfall of two stations located inside the isohyet 290 mm are – 303.55 mm and 299.67 mm.

   3.5+3.5+13 = 20

2. a) What is a synthetic unit hydrograph?
   b) Calculate Snyder synthetic unit hydrograph parameters for the following data: catchment area A=350 km^2; L=20 km; L_{ca}=15 km; C_t=1.4; C_p=0.6; Develop a 4-hr unit hydrograph for the catchment.

   2+18 = 20

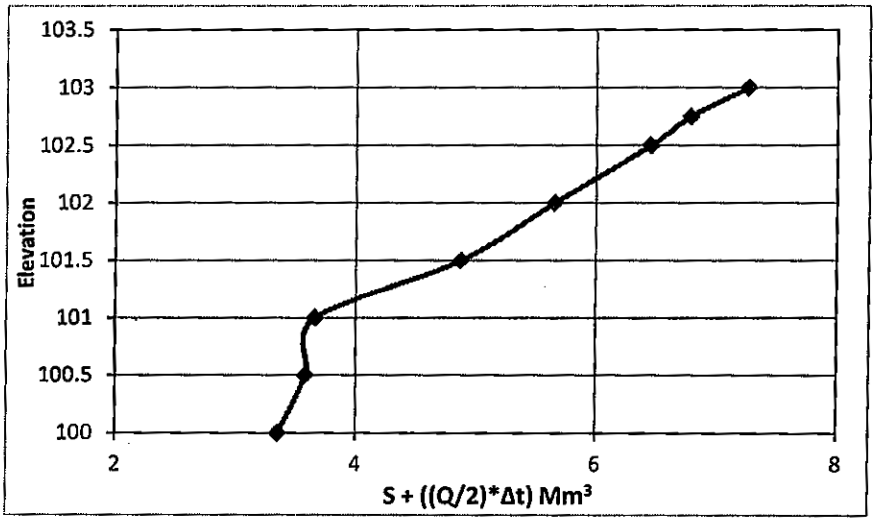
3. A reservoir has the following elevation, discharge, and storage relationships.

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

   When the reservoir level was at 100.50 m, the following flood hydrograph entered the reservoir.

Time (h)	0	6	12	18	24	30	36	42	48	54	60	66
Discharge (m^3/s)	10	20	55	80	73	58	46	36	27.5	20	15	10

Route the flood by the Modified Pulse method and obtain the outflow hydrograph.



20

4. a) Distinguish between hydrologic storage and hydrologic channel routing.

   b) Show that the reservoir routing equation for a linear reservoir is

$$\frac{dQ}{dt} + \alpha Q = \alpha I$$

   where α is a constant. Obtain the outflow from such a reservoir due to an inflow $I = I_0 + \beta t$ occurring from $t = 0$ to t_0 with the boundary condition $Q = 0$ at $t = 0$.

   c) Differentiate between prism storage and wedge storage.

   d) Derive the Muskingum routing equation for channel routing.

3+8+4+5= 20

5. a) Why are both attenuation and lag of a flood hydrograph two very important aspects of a reservoir operating under a flood control criterion?

   b) Route the following flood hydrograph through a river reach for which $k = 12$ h and $x = 0.25$. At the start of the inflow flood, the outflow discharge is 10 m^3/s.

Time (h)	0	6	12	18	24	30	36	42	48	54
Inflow (cumec)	10	20	50	60	55	45	35	27	20	15

5+15= 20

6. a) Show that in the IUH obtained by using the Nash model, the peak flow occurs at a time

$$t_p = K(n-1)$$

and the magnitude of the peak flow is

$$u(t)_p = \frac{1}{K\Gamma(n)} e^{(1-n)} (n-1)^{(n-1)}$$

b) A drainage basin has the following characteristics: Area 100 km^2, time of concentration = 18 h, storage constant = 12 h, and inter-isochrone distribution as below:

Travel Time (h)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Inter-isochrone area (km^2)	3	9	20	22	16	18	10	8	4

7+13= 20

7. a) Establish the co-relation between actual runoff (Q) and total rainfall (P) using runoff curve number (CN) method for midsize catchment in case of hydrological responses.

$$Q = \frac{[(P + 50.8)CN - 5080]^2}{CN[(P - 203.2)CN + 20320]}$$

Which is subject to the restriction that $P \geq (5080/CN)-50.8$.

All parameters are given in SI unit

b) A watershed 300 ha in size has group C soil. The land cover can be classified as 40% open forest and 60% poor quality pasture. Assuming AMC at average condition and the soil is to be black soil, estimate the direct runoff volume due to a rainfall of 82 mm in one day. Deduce the expression used for the estimation.

10+10=20

8. a) Deduce the expression of time of concentration (t_c) for overland flow using kinematic wave equation and compare with an empirical equation showing effective rainfall intensity (i_e).

b) A catchment consists of an asphalt pavement (n= 0.012) that drains into a trapezoidal concrete channel (n= 0.013). The asphalt pavement has an average slope of 0.64% and the distance from the catchment boundary to the drain is 80 m. The drainage channel is 60 m long, 60 cm wide and side slope of 2.5 H:1V and has a slope of 0.65 %. For an effective rainfall intensity of 52 mm/h, the flow rate in the channel is estimated to be 0.035 m^3/s. Estimate the time of concentration of the entire catchment area in minute. Consider kinematic wave equation for the overland flow and compare with the empirical equation.

8+12 =20

9. a) Estimate the two constants value of standard deviation (σ) and co-efficient (K) and also deduce an expression for range (R) 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	7	July	25
February	4	August	30
March	2	September	32
April	2	October	22
May	9	November	32
June	3	December	12

b) Find out the constant value of ∝ and m for a wide rectangular channel using Manning's equation in case of overland flow.

15+5=20

10. a) Define the terms forest hydrology and flooding forest.

b) What are the hydrologic characteristics of forested catchment soils?

c) A 500-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	250	0.10
Pasture	50	0.11
Cultivated Land	200	0.30

The maximum length of traveled water in the watershed is about 3000 m and the elevation difference between the highest and outlet point of the watershed is 25 m. The maximum intensity duration frequency relationship of the water shed is given by

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

Water 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 and

ii) the 25 years pick runoff if the forest cover decreases to 50 ha and the cultivated land has encroached upon the pasture and forest lands to have a total coverage of 450 ha.

4+3+13=20