M.E. (Water Resources & Hydraulic Engineering) Examination, 2019

(1ST Year-2ND Semester)

ADVANCED HYDROLOGY
PAPER-VII

Time: Three Hours | Full Marks: 100

Answer any *five questions*

1. (a) Deduce an expression of time of concentration (t_c) for overland flow from the catchment boundary to catchment outlet (L) and the rainfall excess rate (i_e) in case of 1-D approximation of surface-runoff process.

(b) An urban catchment with an asphalt surface has an average slope of 0.8%, and the distance from the catchment boundary to the outlet is 80 m. At the catchment location, the 2 year 24- hour rainfall is estimated as 85 mm. For a 20 min storm with an effective rainfall rate of 70 mm/h, estimate the time of concentration using: (a) the kinematic-wave equation, (b) the NRCS method, (c) the Kirpich equation, (d) the Izzard equation and (e) the Kerby equation. n=0.15. Assume any data if required.

10+10=20

2. a) Define Instantaneous Unit Hydrograph (IUH).

b) State advantages of IUH.

c) The IUH of a catchment is a triangle with a base of 36 hr. and a peak of 20 m^3/s at 8 hr. from the start. Derive a 2 hr. UH for this catchment.

d) The ordinates of a 4 hr UH of a catchment is given below. Determine the ordinates of the IUH of the catchment.

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

(2+3+4+11)

3. (a) Explain a procedure of deriving a D-h unit hydrograph from the IUH of the catchment.

(b) The coordinates of the IUH of a catchment are given below. Derive the 3-hour unit hydrograph for this catchment.

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

5+15=20

4. (a) What is synthetic stream flow? Establish the multi-period Markov model equation used extensively in stream seasonal or monthly flow analysis.

(b) A basin has an area of 400 km^2, and the following characteristics:

Item	Basin
L_{ca}	10 km
L	35 km
Snyder's coefficients	C_t =1.5 and C_p =0.70

Develop synthetically the 3-h synthetic unit hydrograph for this basin using Snyder's method.

7+13=20

5. (a) Establish the co-relation between actual runoff (Q) and potential runoff (P) using Runoff Curve Number (CN) Method for midsize catchments condition in SI unit.

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

Which is subject to the restriction that $P \geq (200/CN)$-2.

(b) A 6-h unit hydrograph of a catchment of 500 km^2 area can be expressed as triangle with base of 66 hours.

(i) What is the peak ordinate of this unit hydrograph?

(ii) Calculate the equilibrium discharge of the S_6 – curve of the basin.

8+12=20

6. a) Explain the terms: (i) channel routing, (ii) reservoir routing, (iii) hydrologic routing and (iv) hydraulic routing.

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

Elevation (m)	Storage (Mm^3)	Outflow discharge (cumec)
100.0	3.350	0
100.5	3.472	12
101.0	3.380	29
101.5	4.383	56
102.0	4.882	82
102.5	5.370	115
103.0	5.527	136
103.4	5.856	170

When the reservoir level was at 100.5 m, the following flood hydrograph entered the reservoir:

Time (h)	0	6	12	18	24	30	36	42	48
Discharge (cumec)	0	37	80	66	46	44	55	18	11

Route the flood and obtain (i) the outflow hydrograph and (ii) the reservoir elevation vs time curve during the passage of the flood wave.

(3+4)+13= 20

7. a) Differentiate between prism storage and wedge storage.

b) For a sub-basin in lower Rupnarayan catchment with an area of 250 km^2 the following values of Nash model coefficients were found appropriate n=3.3 and K=1.69 h. Determines the coordinates of (a) IUH of 1 h interval and (b) 1 h UH at 1 h interval.

c) Discretise the following kinematic flood wave equation to apply it in second order accurate numerical scheme of stream channel routing:

$$\frac{\partial Q}{\partial t} + \beta V \frac{\partial Q}{\partial x} = 0$$

3+14+3= 20

8. a) Using convex method route the following inflow hydrograph assuming Courant number is 2/3.

Time (h)	0	1	2	3	4	5	6	7	8	9	10
Inflow (m^3/s)	0	30	60	90	120	150	120	90	60	30	0

b) Explain the term "channel diffusivity".

c) Differentiate between storage reservoirs and detention reservoirs.

d) Explain the factors responsible for snow formation and snow accumulation.

11+2+3+4= 20