(Figures in the margin indicate full marks)

First Half
Answer Q.6 and any three from the rest

1. Following are the data obtained in a stream gauging operation. A current meter was used to measure the velocity at 0.6 depth, with a calibration equation, V=(0.3N+0.01) m/s, where N=revolutions per second. Using *area-velocity* method, calculate the discharge in the stream.   (10)

Distance from left bank (m)	0	2	4	6	8	10	12	14	16	18	20
Depth (m)	0	0.5	1.10	1.95	2.25	1.85	1.75	1.55	1.20	0.75	0
No. of revolutions / second	0	60	85	125	150	120	110	100	90	75	0
Time (s)	0	120	120	120	120	120	120	120	120	120	0

2. During a high flow, water surface elevations of a small stream were observed at a section A and another station B, 500 m downstream of A. The elevations and other salient points are given below. Using *slope-area* method, estimate the discharge in the stream. (Assume Manning's n =0.025, and eddy loss coefficient K_e=0.0. Calculate up to 3rd iterations).   (10)

Section	Water surface elevation (m)	Area of cross-section (m²)	Wetted Perimeter (m)
A	104.8	86.3	40.75
B	103.3	90.2	47.35

3. a) Three points on a rating curve of a stream gauging station have the following co-ordinates: (100m³/s, 121.67m), (200 m³/s, 122.23m), and (400 m³/s, 123.04m). Compute the rating curve parameters. Also calculate the discharge for a depth of 124.5m.   (5)

   b) A 500 g/l solution of sodium dichromate was used as chemical tracer. It was dosed at a constant rate of 0.004 m³/s. There was a background concentration of 5000 parts per billion. At a downstream section sufficiently far away, the equilibrium concentration was found to be 45 ppm. Estimate the discharge in the stream.   (5)

4. a) With neat sketch, derive the expression for steady discharge from a well fully penetrated in an unconfined aquifer of saturated depth B.   (5)

   b) A 45 cm well in an unconfined aquifer of saturated thickness of 45m yields 600 lpm under a drawdown of 3.0m at the pumping well. If the diameter is changed to 30cm and the drawdown at the well is increased to 5m, what would be the resulting steady discharge? Assume a constant radius of influence of 500m in both cases.   (5)

5. a) With neat sketches, briefly discuss three methods of separating base flow from observed flood hydrograph.   (5)

   b) In order to derive correlation between observed precipitation (P) and runoff (R), following statistics are obtained from 20 years of observed annual data. Assuming a linear relation R = aP +b, estimate the coefficients a and b from these statistics. Also find the correlation coefficient and comment.   (5)

ΣP	ΣP^2	ΣR	ΣR^2	ΣPR
418	10324	110	1132	3597

6. Write a program to calculate the steady discharge Q =2×PI×K×B×(s1-s2)/ALOG(r2/r1) from a well fully penetrated in a confined aquifer of thickness B, from known values of drawdowns (s_1, s_2) at two observation wells of radii r_1 and r_2.   (5)

Second Half
Answer Q.12 and any three from the rest

7. The ordinates of a 4-h unit hydrograph of a catchment are given below. Derive a 2-h unit hydrograph for that catchment.   (10)

Time	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
UH (m3/s)	0	10	28	60	98	120	113	96	77	60	45	33	23	15	8	4	0

8. a) With neat sketch, define Unit Hydrograph.   (3)

   b) The ordinates of a 2-h unit hydrograph are given below. From these data, develop a 6-h unit hydrograph.   (7)

Time (h)	0	2	4	6	8	10	12	14	16	18	20	22
2h-UH (m³/s)	0	25	100	160	190	170	120	70	40	21	8	0

9. a) With neat sketch, define ϕ–index.   (3)

   b) The runoff from a catchment due a 8h storm was found to be 3.5cm. Given the mass curve of rainfall as below, estimate the ϕ–index.   (7)

Time from start (h)	0	1	2	3	4	5	6	7
Accumulated rainfall (cm)	0	0.5	1.65	3.55	5.65	6.8	7.75	7.8

10. Using Blaney-Criddle formula, find the consumptive use for the two crops, from the following data.   (10)

Month	July	Aug	Sept	Oct
Mean monthly temp (°C)	25.3	24.1	22.0	22.5
Monthly percent of daytime hours	8.84	8.74	8.26	8.29
Monthly consumptive use coefficients, crop1	0.90	0.85	0.75	0.55
Monthly consumptive use coefficients, crop2	0.80	0.80	0.70	0.60

11. The ordinates of a flood hydrograph due to 3cm and 2cm of ER in successive two 6-h durations are given below. Determine the ordinates of a 6-h UH and the area of the catchment.   (10)

Time (h)	0	6	12	18	24	30	36	42	48	54	60	66	72	78
Discharge (m³/s)	0	300	950	1115	845	590	410	290	205	145	95	45	10	0

12. Write a program to calculate the evaporation loss using Meyer's formula: EL = KM(ew-ea)(1+u9/16), given values of KM, u9, ew and relative humidity Rh.   (5)