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

(1st Semester)

PRINCIPLE OF WATER RESOURCES ENGINEERING

(Paper - IV)

Time: Three Hours Full Marks: 100

Answer Q. (1) and any ***four*** from the remaining

1. (a) A culvert is designed for a peak flow of Q_p on the basis of the rational formula. If a storm of the same intensity as used in the design but of duration twice larger occurs the resulting peak discharge will be

(i) Q_p (ii) $2\,Q_p$ (iii) $Q_p/2$ (iv) $(Q_p)^2$

(b) The Double mass curve technique is adopted to

(i) Check the consistency of raingauge record.
(ii) To find the average rainfall over number of years
(iii) To find the number of raingauges required
(iv) To estimate the missing rainfall data

(c) Lysimeter is used to measure.

(i) Infiltration (ii) evaporation (iii) evapotranspiration
(iv) Vapour pressure

(d) A triangle DRH due to a 6hr storm in a catchment has a time base of 100 hr and a peak flow of 40 m^3/s. The catchment area is 180 km^2. The 6 hr unit hydrograph of this catchment will have a peak flow in m^3/s of.

(i) 10 (ii) 20 (iii)30 (iv) none of these answers

(e) For a catchment with an area of 360 km^2, the equilibrium discharge of the S curve obtained by summation of 4 hr unit hydrograph is

(i) 250 m^3/s (ii) 90 m^3/s (iii) 278 m^3/s (iv) 360 m^3/s

(f) An intermittent steam

(a) has only flash flows in response to storms
(b) has flows in the stream during wet season due to contribution of groundwater.
(c) has water table above the stream bed throughout the year.
(d) does not have any contribution of groundwater at any time.

(g) At a certain point in an unconfined aquifer of 3 km^2 area, the water table was at an elevation of 102.00 m. Due to natural recharge in a wet season, the level rose to 103.20 m. A volume of 1.5 Mm^3 of water was then pumped out of the aquifer causing the water table to reach a level of 101.20 m. Assuming the water table in the entire aquifer to respond in a similar way, the specific yield of the aquifer will be

a) 0.23 b) 0.24 c) 0.25 d) 0.26

(h) A field test of permeability consists in observing the time required for a tracer to travel between two observation wells. A tracer was found to take 10 h to travel between two wells 50 m apart when the difference in the water surface elevation in them was 0.5 m. The mean particle size of the aquifer was 2 mm and the porosity of the medium 0.3. ($v = 0.01 cm^2/s$), The intrinsic permeability of the aquifer is

a) 4.15 x 10^{-5} cm^2 b) 4.25 x 10^{-5} cm^2 c) 4.35 x 10^{-5} cm^2
d) 4.45 x 10^{-5} cm^2

(i) At a certain point in an unconfined aquifer of 3 km^2 area, the water table was at an elevation of 102.00 m. Due to natural recharge in a wet season, the level rose to 103.20 m. A volume of 1.5 Mm^3 of water was then pumped out of the aquifer causing the water table to reach a level of 101.20 m. Assuming the water table in the entire aquifer to respond in a similar way, the volume of recharge during the wet season will be
a) 0.8 Mm^3 b) 0.9 Mm^3 c) 1.2 Mm^3 d) 1.3 Mm^3

(j) A field test of permeability consists in observing the time required for a tracer to travel between two observation wells. A tracer was found to take 10 h to travel between two wells 50 m apart when the difference in the water surface elevation in them was 0.5 m. The mean particle size of the aquifer was 2 mm and the porosity of the medium 0.3. (v = 0.01cm^2/s), The Reynold's number of the flow is
a) 0.834 b) 0.844 c) 0.854 d) 0.864

2. (a) Develop the equation relating the steady state discharge from a well in an unconfined aquifer and depths of piezometric surface at two known positions from the well. State clearly all the assumptions involved in your derivation.

(b) A 30 cm well completely penetrates an artesian aquifer. The length of the strainer is 25 m. Determine the discharge from the well when the drawdown at the pumping well is 4.0 m. The coefficient of permeability of the aquifer is 45 m/day/ Assume the radius of influence of the well as 350 m.

(c) The confined aquifer has the thickness B has a fully penetrating well of radius of r_0, pumping a discharge Q at a steady rate. An observation well M is located at a distance R from the pumping well. Show that the travel time for water to travel from well M to the pumping well is

$$t = \frac{\pi B \eta}{Q}(R^2 - r_0^2) \text{ where } \eta = \text{Porosity of the aquifer}$$

3. (a) What is the difference between a perennial river and an intermittent river?

(a) How much storage is required to maintain a minimum demand of 70 m^3/s from a reservoir on a stream with following monthly flows?

Months	June	Jul	Aug	Sept	Oct	Nov
River Flow (m^3/s)	20	60	200	300	200	150
Months	Dec	Jan	Feb	Mar	April	May
River Flow (m^3/s)	100	80	60	40	30	25

(3+17)

4. (a) What are the limitations of 'Frequency Studies'?

(b) The annual flood peaks at a gauging site from 1971-1985 are given below.
Determine flood magnitudes for 100 and 125 years .

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Flood(cumec)	1065	645	1005	1350	860	150	2260	650	2840	990	3210
Year	1982	1983	1984	1985							
Flood(cumec)	870	910	750	930							

(2 +18)

5. (a)Annual Rainfall data for a Station M as well as the average annual rainfall values for a group of ten neighboring stations located in a meteorologically is given below.

Year	Annual Rainfall Station M (mm)	Average Annual rainfall of group (mm)	Year	Annual Rainfall Station M (mm)	Average Annual rainfall of group (mm)
1960	677	781	1975	1244	1400
1961	579	661	1976	999	1140
1962	96	111	1977	573	650
1963	463	521	1978	596	646
1964	473	541	1979	375	350
1965	700	801	1980	635	590
1966	480	541	1981	497	490
1967	432	491	1982	386	400
1968	494	560	1983	438	390
1969	503	575	1984	568	570
1970	415	480	1985	236	377
1971	531	600	1986	685	653
1972	504	580	1987	825	787
1973	828	950	1988	426	410
1974	770	770	1989	612	588

Test the consistency of annual rainfall data of Station M and correct the record if there is any discrepancy. Estimate the mean annual precipitation in station M.

(b) The infiltration capacity in a basin represented by Horton's equation as

$$\mathbf{f_p = 3.0 + e^{-2t}}$$

Where f_p is in cm/h and t is in hour. Assuming infiltration to take place at a capacity rate in a storm of 60 minutes duration estimate the depth of infiltration in (i) the first 30 minutes and (ii)second 30 minutes of the storm.

14+6=20

6. (a) Distinguish between

(i)Depression storage and interception loss ii) infiltration capacity and infiltration rate

(b)Calculate the potential evapotranspiration from area near Delhi in the month of November by Penman's formula. The following data are available.

Latitude: 28°4' N

Elevation: 230 m above the sea level

Table: Saturation Vapour Pressure of Water

Temperature (°C)	Saturation vapour pressure e_w (mm of Hg)	A (mm/°C)
0	4.58	0.30
5.0	6.54	0.45
7.5	7.78	0.54
10.0	9.21	0.60
12.5	10.87	0.71
15.0	12.79	0.80
17.5	15.00	0.95
20.0	17.54	1.05
22.5	20.44	1.24
25.0	23.76	1.40
27.5	27.54	1.61
30.0	31.82	1.85
32.5	36.68	2.07
35.0	42.81	2.35
37.5	48.36	2.62
40.0	55.32	2.95
45.0	71.20	3.66

Table: Mean monthly solar radiation at Top of Atmosphere H_a mm Evaporable Water /day

North latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0°	14.5	15.0	15.2	14.7	13.9	13.4	13.5	14.2	14.9	15.0	14.6	14.3
10°	12.8	13.9	14.8	15.2	15.0	14.8	14.8	15.0	14.9	14.1	13.1	12.4
20°	10.8	12.3	13.9	15.2	15.7	15.8	15.7	15.3	14.4	12.9	11.2	10.3
30°	8.5	10.5	12.7	14.8	16.0	16.5	16.2	15.3	13.5	11.3	9.1	7.9
40°	6.0	8.3	11.0	13.9	15.9	16.7	16.3	14.8	12.2	9.3	6.7	5.4
50°	3.6	5.9	9.1	12.7	15.4	16.7	16.1	13.9	10.5	7.1	4.3	3.0

Table Mean monthly values of possible sunshine hours, N

North latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0°	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
10°	11.6	11.8	12.1	12.4	12.6	12.7	12.6	12.4	12.9	11.9	11.7	11.5
20°	11.1	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
30°	10.4	11.1	12.0	12.9	13.7	14.1	13.9	13.2	12.4	11.5	10.6	10.2
40°	9.6	10.7	11.9	13.2	14.4	15.0	14.7	13.8	12.5	11.2	10.0	9.4
50°	8.6	10.1	11.8	13.8	15.4	16.4	16.0	14.5	12.7	10.8	9.1	8.1

Mean Monthly temperature	19°C
Mean relative humidity	75%
Mean observed sunshine hours	9h
Wind velocity at 2 m height	85 km/day
Nature of surface cover	Close-ground green crop

4+16=20

7. (a) Define hydrograph

(b) With the help of sketches only show how catchment shape influences the hydrograph for any storm.

(c)The ordinate of a 2 hr unit hydrograph of a basin are given

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22
2 hr UH ordinates (m^3/s)	0	5	100	160	190	170	110	70	30	20	6	0

Determine the ordinate of the S curve hydrograph and using this determine the ordinates of a 4 hr unit hydrograph of the basin.

(d) State two basic assumption of unit hydrograph theory.

3+3+12+2=20