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

(Evening)

(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) Interception losses

i) include evaporation, through flow and stream flow.

ii) consists of only evaporation loss

iii) include evaporation and transpiration losses.

iv)consist of only stream flow.

(c) An isohyet is a line joining point having.

(i) equal evaporation value (ii) equal barometric pressure (iii) equal height above the MSL (iv) equal rainfall depth in a given duration.

(d) The D-hour unit hydrograph of a catchment may be obtained by dividing the ordinates of single peak direct runoff hydrograph (DRH)due to the storm of D hour duration by the

(i) Total runoff volume (in cm) (ii) direct runoff volume (iii) duration of DRH (iv) total rainfall in cm

(e) A basin with an area of 756 km2 has the 6-h unit hydrograph which could be approximated as a triangle with a base of 70 hrs. The peak discharge of direct runoff hydrograph due to 5 cm of rainfall excess in 6-hrs from that basin is

i) 535 m^3/s ii) 60 m^3/s iii) 756 m^3/s iv) 300 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) $4.15 \times 10^{-5} cm^2$ b) $4.25 \times 10^{-5} cm^2$ c) $4.35 \times 10^{-5} cm^2$ d) $4.45 \times 10^{-5} cm^2$

(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. ($v = 0.01 cm^2/s$), 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 45 cm well in an unconfined aquifer of saturated thickness of 45 m yields 600 lpm under a drawdown of 3.0 m at the pumping well, (i) What will be the discharge under a drawdown of 6.0 m? (ii) What will be the discharge in a 30 cm well under a drawdown of 3.0 m? Assume the radius of influence to remain constant at 500 m in both cases.

(c) Explain the following (i) specific yield (ii) specific storage (iii) Storativity/storage coefficient. (iv) Unconfined Aquifer. 7+7+6=20

3. (a) What is the difference between direct runoff and base flow?

(b) 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

(2+18)

4. (a) Discuss the scope and limitations of flood frequency studies?

(a) The following table gives the observed annual flood values in the River Bhagirathi at Tehri. Estimate the flood peaks with return periods of 50, 100 and 1000 years by using Gumbels extreme value distribution

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Flood (m^3/s)	3210	4000	1250	3300	2480	1780	1860	4130	3110	2320	2480
Year	1974	1975									
Flood (m^3/s)	3405	1820									

(2+18)

5. (a) Annual rainfall values recorded at station M for the period 1950 to 1979 is given in below table. Represent this data as a bar diagram with time in chronological order.
   i) Identify those years in which the annual rain fall is (a) less than 20% of the mean and (b)more than the mean.
   ii) Plot three years of moving mean of annual rainfall time seies.

Year	Annual Rainfall of Station M (mm)	Average Annual Rainfall of the group (mm)	Year	Annual Rainfall of Station M (mm)	Average Annual Rainfall of the group (mm)
1950	676	780	1965	1244	1400
1951	578	660	1966	999	1140
1952	95	110	1967	573	650
1953	462	520	1968	596	646
1954	472	540	1969	375	350
1955	699	800	1970	635	590
1956	479	540	1971	497	490
1957	431	490	1972	386	400
1958	493	560	1973	438	390
1959	503	575	1974	568	570
1960	415	480	1975	356	377
1961	531	600	1976	685	653
1962	504	580	1977	825	787
1963	828	950	1978	426	410
1964	679	770	1979	612	588

(b) Explain the different procedure for checking a rainfall data for consistency

15+5=20

6. (a) Distinguish between
   i) Actual evapotranspiration and potential evapotranspiration
   ii) Field capacity and permanent wilting point

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

Latitude: 22°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) Distinguish between DRH and ERH.

   (b) State the Assumption and limitation of Unit hydrograph

   (c) Using the ordinates of a 12-hr unit hydrograph given below, compute the ordinates of a 6-hr unit hydrograph

Time (h)	Ordinates of 12-h unit hydrograph m^3/s
0	0
6	10
12	37
18	76
24	111
30	136
36	150
42	153
48	146
54	130
60	114
66	99
72	84
78	71
84	58
90	46
96	35
102	25
108	17
114	12
120	8
126	6
132	3
138	2
144	0

Note that the tail portion of the resulting 6-h UH need fairing.

3+3+14=20