M.E. Water Resources and Hydraulic Engg.(Six- Semester)

First Year - First Semester

PRINCIPLE OF WATER RESOPURCES ENGINEERING

(Program Core 1)

Time: Three Hours Full Marks :100

Answer all questions from Question 1 and any four from Questions no 2 to 7.

1. (i) A soil has a coefficient of permeability of 0.51 cm/s. If the kinematic viscosity of water is 0.009 cm^2/s, the intrinsic permeability in Darcy's is about)

(a) $5.3*10^4$ (b) 474 (c) $4.7*10^7$ (d) 4000

(ii) Two observation wells penetrating a confined aquifer are located 1.5 km apart in the direction of flow. Heads of 45 m and 20 m are indicated at these two observation wells. If the coefficient of permeability of the aquifer is 30 m/day and the porosity is 0.25, the time of travel of an inert tracer from one well to another is about

(a) 417 days (b) 500 days (c) 750 days (d) 3000 days

(iii) A sand sample was found to have a porosity of 40%. For an aquifer of this material, the specific yield is

(a) = 40% (b) > 40% (c) <40% (d) dependent on the clay fraction

(iv) An unconfined aquifer of porosity 35%, permeability 35 m/day and specific yield of 0.15 has an area of 100 km^2. The water table falls by 0.20 m during a drought. The volume of water lost from storage in Mm^3.

(a) 7.0 (b) 3.0 (c) 4.0 (d) 18.0

(v) The coefficient of permeability of a sample of aquifer material is found to be 5 m/day in a laboratory test conducted with water at 10°C. If the kinematic viscosity of water at various temperatures is as below:

Temp in °C	10	20	30
ν (m^2/s)	$1.30*10^6$	$1.00*10^6$	$0.80*10^6$

The standard value of the coefficient of permeability of the material, in m/day is about

(a) 4.0 (b) 5.0 (c) 6.5 (d) 9.0

(vi) Rational formula is used to arrive at designed peak flow of Qp. If a storm intensity is doubled and duration is increased three times ,the resulting peak discharge is

(a) Q_p (b) $2Q_p$ (c) $3Q_p$ (d) $Q_p/2$

(vi) The Double mass curve technique is adopted to

a) Check the consistency of raingauge record.
b) To find the average rainfall over number of years
c) To find the number of raingauges required
d) To estimate the missing rainfall data

(vii) Lysimeter is used to measure.

a) Infiltration (b) evaporation (c) evapotranspiration (d) Vapour pressure

(viii) 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.

a) 10 (b) 20 (c)30 (d) none of these answers

(ix) 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

a) 250 m^3/s (b) 90 m^3/s (c) 278 m^3/s (d) 360 m^3/s

(x) 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.

2. (a) Deduce the equilibrium equation for the steady flow in a confined aquifer.

(b) A 30 cm diameter well completely penetrates a confined aquifer of permeability 45m/day. The length of the strainer is 20m. Under the steady state of pumping, the drawdown at the well was found to be 3.0 m, and the radius of influence was 300m. Calculate the discharge.

10+10= 20

3. (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

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

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

4. (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

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

(b) Verify whether Gumbel extreme–value distribution fit the following flood series and estimate flood discharge with recurrence interval of 120 years

Year	1972	1973	1974	1975	1976	1977	1978	1979
Annual Flood(m^3/s)	2520	1850	750	1100	1380	1910	3170	1200
Year	1980	1981	1982	1983	1984	1985	1986	1987
Annual Flood(m^3/s)	820	690	1240	1730	1950	2160	3320	1480

Standard Deviation = 795 m^3/s

2+18=20

6. (a) Under what condition, S Curve is mandatory for Hydrographic analysis.

(b)The ordinate of 2-h unit hydrograph of basin are given

Time (h)	0	2	4	6	8	10	12	14	16	18	20	22
2-h UH ordinate (m^3/s)	0	25	100	160	190	170	110	70	30	20	6	0

Determine the ordinate of the S-2 hour curve hydrograph and using this S-2 hour curve, determine the ordinate of the 4-h unit hydrograph of the basin.

3+17=20

7. a) What is baseflow separation, and why is it important in hydrological analysis

b) Rainfall of magnitude 3.8 cm and 2.8 cm occurring on two consecutive 4-h duration on a catchment of area 27 km^2 produced the following hydrograph of flow at the outlet of the catchment. Estimate the rainfall excess and ϕ index

Time from start of rainfall (h)	–6	0	6	12	18	24	30	36	42	48	54	60	66
Observed flow (m^3/s)	6	5	13	26	21	16	12	9	7	5	5	4.5	4.5

3+17=20