Subject:WRE-I
Acadamic Year:2018-2019 **Section:III Year II Sem**

UNIT-I:

1. (a) Define Hydrologic cycle with a neat sketch. Discuss the various process and storages involved in the system.
(b) For a drainage basin of 500 km_2, isohyetals drawn for a storm gave the following data:

Isohyetal Interval (cm)	0-3	3-6	6-9	9-12	12-15
Area bounded between isohytes (km_2)	75	50	125	130	90

Estimate the average depth of precipitation over the catchment

2. (a) Explain the different methods of determining the average rainfall over a catchment due to a storm. Discuss the relative merits and demerits of the various methods.
(b) What is an intensity duration curve? Write down the general expression for intensity duration relationship of rainfall. Explain the necessity for frequency analysis.

3.(a).There are four rain gauge stations neighboring a gauge A, which was inoperative during a storm. The records show that the storm rainfall for the four stations is 13.7, 14.1, 14.5, and 12.6 cms and the respective normal precipitation of the stations are 140, 146, 157, and 122 cms. If the normal rainfall of station A is 131 cm, calculate storm precipitation of station A.
(b) Explain briefly the following relationships relating to the precipitation over a basin. (i) Depth- Area relationship; (ii) Depth-Area-Duration curves and (iii) Intensity-Duration frequency curves

4. (a) Differentiate between recording and Non-recording types of rain gauges.
(b) The annual rainfalls at seven rain gauge stations in a basin are 55, 95, 60, 45, 20, 80, and 65 cm respectively. What is the percentage accuracy of the existing network in the estimation of the average depth of rainfall over the basin? How many additional gauges are required if it is desired to limit the error to only 10%?

5. (a). Briefly explain the various types of rain gauges with neat sketch? Enumerates it merits and demerits.
(b). In a drainage basin of 600 km_2, isohyets drawn for a storm gave the following data:

Isohyets Interval (cm)	15-12	12-9	9-6	6-3	3-1
Inter isohyetal area(km_2)	98	128	120	175	85

Estimate the average precipitation over the drainage basin.

6. (a) Briefly explain the significant features of global water balance studies? Write a brief note on: i. Mechanism of precipitation.
ii. Different types of precipitation.
(b). A catchment has five rain-gauge stations and the annual precipitations are 900, 1100, 1750, 950, and 1250 mm respectively. Find the extra number required or not if error in estimation is limited to 10 percent.

7. (a) What factors you consider in selecting a site for a rain-gauge station? (b) In a catchment there are six rain gauge stations. The normal rainfall in the gauge stations are as follows:

Stations:	A	B	C	D	E	F
Annual Rainfall (mm)	350	650	450	781	1042	798

If the error in the estimation of catchment mean rainfall should not exceed 10%, Calculate the minimum number of additional rain gauge stations required for the Catchment.

8. (a)Briefly explain the measurement of precipitation? Also enumerate the selection rain Gauge site?
(b).In a watershed, the average precipitation for four sub basins was recorded as 100.84, 112.27, 84.84, and 73.406cm. The areas of the sub basins were : 93264.3, 71243.5, 108808.2, and 168393.8 ha. Calculate the average precipitation of the total watershed using Arithmetic mean and Thiessen polygon method.

UNIT-II

1. (a) Explain the following: (i) Evaporation (ii) Transpiration
(iii) Infiltration (iv) consumptive use
(b) Write down the most common empirical formula used to calculate evaporation.

2. (a) Explain the difference between evaporation, interception and transpiration ratio.
(b) Briefly describe any method by which you can measure the evaporation loss from a free water surface.

3.(a) What do you understand by the term infiltration? How can you measure it in the field?
(b) A storm with 10 cm precipitation produced a direct runoff of 5.8 cm. The time distribution of the storm as given below, estimate the _-index of the storm.

Time from start (hr)	1	2	3	4	5	6	7	8
Increments/ Rainfallin each hour (cm)	0.4	0.9	1.5	2.3	1.8	1.6	1.0	0.5

4.(a) Mention the factors controlling the evaporation process.
(b) A watershed of 50 km^2 produces a runoff of 2 Mm^3 from the rainfall pattern of the storm given below, Calculate _-index.

Time (hr)	0	2	4	6	8	10	12	12
Rainfall (mm)	0	1.1	2.2	6.0	5.0	3.0	1.0	0

5. (a) Discuss the use of pan measurements for the determination of evaporation from water surface.
(b) A 6 hr storm produced rainfall intensities of 7, 18, 25, 12, 10, and 3 mm/h in

successive one hour intervals over a basin of 800 km2. The resulting runoff is observed to be 2640 hectare meters. Determine _-index for the basin

6. (a). How infiltration in the field is measured? What are the different infiltration indices? Explain the each of them by sketches where necessary?
(b). The rate of rainfall for half an hour period of 3.5 hour storm are 3.5, 4.0, 12.0, 8.5, 4.5, 4.5, and 3.0 cm/hr. Assuming the _-index of 3.5 cm/hr find the net rainfall in cm, total rainfall and W - index.

7. (a) Briefly explain the factors affecting Infiltration? Explain the terms _-index, Windex and infiltration Capacity.
(b). Cumulative rainfall during a storm is:

Time (hr)	0	1	2	3	4	5	6	7	8
Rainfall(mm)	0	7	16	22	32	40	52	68	70

Assume an initial abstraction loss of 10 mm and a constant infiltration loss rate of 5.0 mm/hr. Calculate the storm runoff volume from the catchment of 122 km2.

UNIT-III

1.(a). What is runoff? Discuss the factors in details that affect the runoff process
(b) What are the elements of Unit Hydrograph? Show with a neat sketch? Enumerate the limitations and applications of Unit Hydrograph?

2. (a). Briefly explain about Synthetic Unit Hydrograph? Give itslimitations and applications.
(b). Given below are the observed flows a storm of 6 hour duration on a stream with a catchment of 600 km2.
Derive the ordinates of a 6 hour unit hydrograph. Assume the base flow as zero.

Time (hr)	0	6	12	18	24	30	36	48	54	60
Observed flow(m3/s)	0	100	200	150	90	60	30	15	5	0

3.a). Discuss the runoff cycle with neat sketch. Also explain about flow mass curve
(b) The ordinates of a2hr unit hydrograph are given below. Determine the ordinates of an 3 hr. unit hydrograph using S – Curve technique.

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22
12-h UH ordinates (m3/sec)	0	20	90	150	200	175	100	70	30	20	6	0

4. (a) What is S-curve hydrograph? How is it constructed, and what is it used for?
(b) Derive the ordinates of 1 hr unit hydrograph for the drainage basin of 1329 km2 catchment using the 3 hr unit hydrograph ordinates.

Time (hr)	0	1	2	3	4	5	6	7	8	9	10
Ordinates of 3 hr unit hydrograph	0	165	54/7	750	580	465	352	262	195	143	97

5. (a) What is meant by stream gauging? Describe the velocity area method that is used for stream gauging.
(b). The ordinates of 6-hr unit hydrograph are given as follows:

Time (hr)	0	3	6	9	12	15	18	21	24	27	30	33	36
6-hr UH ordinates	0	15	24	42	58	78	69	58	43	30	17	15	0

A storm has successive 3-hr rainfall of 3, 5, and 4 cm respectively. _- Index is 0.2 cm/hr, base flow is 53 m^3/s. Determine the resulting flow hydrograph.

6. (a). Draw the unit hydrograph and explain the salient features? Also give its assumptions and limitations.
(b).A watershed of 3130 km^2 was subjected to a storm of 4-hr duration from which the following hydrograph resulted.

Time(hr)	3	6	9	12	15	18	21	24	3	6	9	12	15	18	21
Discharge (m^3/s)	20	16	175	270	230	200	170	150	130	115	100	90	80	70	60

What is the rainfall excess for the storm? Obtain tan Unit Hydrograph for the watershed

7. (a) Explain how the following parameters affect run off
(i) Shape of basin (ii) Storage condition
(b) Explain how runoff is estimated using Khosla's method.

UNIT-IV

1. a) Describe the Muskingum method of routing an inflow hydrograph through a channel reach.
(b) What are the basic equations used for flood routing by (i) Hydrologic method and (ii)Hydraulic method.

2. (a) Enumerate the different methods of measuring discharge.
(b) Describe the Muskingum flood routing.

3.(a). What do you understand by time of concentration of a catchment? Describe briefly methods of estimation of the time concentration?
(b). Annual flood data of the river Narmada at Garudeshwar covering the period 1948 to 1979 yielded for the annual flood discharges a mean of 29,600 m^3/s and a standard deviation of 14, 860 m^3/s. For a proposed bridge on this river near this site it is decided to have an acceptable risk of 10% in its expected life of 50 years. (a). Estimate the flood discharge by Gumbel's method for use in the design of this structure (b) If the actual flood value adopted in the design is 125,000m^3/s what are the safety factor and safety margin relating to maximum flood discharge? Take $\bar{y}_n$=0.5380 and $\__n$=1.1193.

4. (a) Explain about log Pearson method?
(b). For a long record of annual peak flood of river Sankosh, a north bank tributary of the river Brahmaputra, the mean Q and standard deviation calculated by the water resource department, Govt. of Assam are 143.9 m^3/s and 56.65 m^3/s respectively. Using Gumbel's approach, obtain the return period of flood for a flood of 350 m^3/s of this river
5.(*a*) Define 'flood routing'. What are the usual assumptions made in routing a flood in a reservoir?
(*b*) Explain clearly the I.S.D. curves method of reservoir flood routing. What are the factors to be considered in choosing the routing period?

6. (a) Derive the Muskingum routing equation and the expression for the routing

coefficients C_0, C_1, C_2.
(b) A coffer dam is designed for a 25 year flood and constructed. If it takes 5 year to complete the construction of main dam, what is the risk that the coffer dam may fail before the end of the construction period? What return period in the design of coffer dam would have reduced the risk to 10%

7. (b) Between two reaches A and B of a river, the values of Muskingum coefficients determined are K = 24 h and X = 0.20. Take outflow at the beginning of routing step equal to inflow. Find the outflow hydrograph at B.

Time (h)	12	24	36	48	60	72	84	96	108	120	132	144	156	168
Inflow (m^3/sec)	14	22	36	93	141	102	86	73	61	50	38	26	20	16

UNIT-V

1. (a) What do you understand by recuperation test? Derive the equations used in the test.
(b) A 30 cm diameter well penetrates 20 m below the static water table. After 24 hours of pumping at 5000 lit/min, the water level in a test well at 100 m away is lowered by 0.5 m and in a well at away, the drawdown is 1 m. What is the transmissibility of the aquifer?

2. (a) Briefly explain the following terms: (i) specific yield (ii) aquifer and aquitard (iii) Darcy's law (iv) storage coefficient of an aquifer.
(b) A 25 cm well penetrates 50 m below the static water table. After a long period of pumping at a rate of 1000 lpm, the drawdown in the wells 20 m and 40 m from the pumped well is found to be 4 m and 2.5 m respectively. Determine the transmissibility of the aquifer. What is the drawdown in the pumped well?

3. (a) Write assumptions of Dupuit's equation. Derive the basic differential equation for steady ground water flow in a well fully penetration into a confined aquifer.
(b) During a recuperation test, the water in an open well was depressed, by pumping by 2.5 m and it recuperated 1.8 m in 80 minutes. Find (a) yield from a well of 4 m diameter under a depression head of 3 m, (ii) the diameter of the well to yield 8 lit/sec under a depression head of 2 meters

4. (a) Briefly explain the following terms: (i) Radius of influence (ii) Water table (iii) Partially penetrating well (iv) Transmissibility.
(b) Calculate the discharge in m^3/day from a tube well under the following conditions of an unconfined aquifer: Diameter of the well = 50 cm; Drawdown at the well = 10 m; length of strains = 25 m; radius of influence of the well = 250 m; coefficient of permeability = 0.01 cm/s.

5. (a). Derive an expression for unsteady flow in unconfined aquifer clearly stating the assumptions made there in?
(b). During pumping of water from a 15 cm diameter well the following information are recorded. Thickness of the aquifer is 12m, rate of pumping is 1000 lpm, drawdown at the well after 10 hr of pumping is 2.m and drawdown at the well after 20 hr of pumping is 3.0m. Determine the transmissibility, storage coefficient and coefficient of permeability of the aquifer

6.(a) In a certain alluvial basin of 120 km^2, 100 Mm^3 of ground water was pumped in a year and the ground water table dropped by 5 m during the year. Assuming no replenishment, estimate the specific yield of the aquifer. If the specific retention is 12%, what is the porosity of the soil?
(b). A 30 cm well fully penetrates an unconfined aquifer of saturated depth 25m. When a discharge of 2100lpm was being pumped for a long time, observation wells at radial distances of 30 m and 90 m indicated drawdown of 5 and 4 m respectively. Estimate the coefficient of permeability and transmissibility of the aquifer. What is the drawdown at the pumping well?

UNIT-VI

1. Explain briefly about instantaneous unit hydrograph

2. (a) Explain about clark and nash models.
   (b) Explain about kulandaiswamy model

3. (a) Explain about chow model
   (b) Explain about rainfall-runoff Modelling