CENTRAL INSTITUTE OF TECHNOLOGY KOKRAJHAR
(Deemed to be University)
KOKRAJHAR :: BTR :: ASSAM :: 783370

END – SEMESTER EXAMINATION
Post Graduate Masters programme in Water Resources & Hydraulic Engineering

Session: July-December, 2022 Semester: Ist Time: 3 Hrs. Full Marks: 100

Course Code: PCEW103 Course Title: Applied Hydrology

ANSWER ANY FIVE QUESTIONS

Answer Question No. 1 and any four from the rest. Each question carries 20 marks.

1. Describe any four of the following by providing sketches wherever applicable: (4×5 = 20)
   a) Thiessen polygon for estimating average rainfall and its advantage over other methods
   b) Rating Curve and its applications
   c) Single and double mass curves of volumes of flow at a gauging site
   d) Unit Hydrograph (UH) and its limitations
   e) S-curve and its application in deriving the UH of a duration other than that of a given UH
   f) Rational method of peak flood estimation and its usefulness

2. a) Write down the water-budget equation with reference to hydrologic cycle. What are the months of the four seasons of India according to India Meteorological Department? What are the mechanisms of predominant rainfall in India? (4+2+2 = 8)

   b) Describe any one type of Self-Recording Rain Gauge (SRRG) with a sketch. What are the advantages of an SRRG over an Ordinary Rain Gauge (ORG)? (4+2 = 6)

   c) Describe any one method for estimating the data of missing annual rainfall at a raingauge station. Write the expression for determining the optimum number of raingauge stations in a catchment for an acceptable value of percentage error in the estimates. (3+3=6)

3. a) Categorize different methods of measuring discharge of a river into direct and indirect methods. Describe the area velocity method of measuring discharge at a section in a river by providing a suitable sketch and relevant formulae. (4+6 = 10)

   b) Describe the single- & double-point method of measuring velocity by a current meter. (6)

   c) In a river carrying a discharge of 142 $m^3 s^{-1}$, the stage at a station was 3.6 m and the water surface slope was 1 in 6000. If during a flood, the stage at the same station was still 3.6 m, but the water surface slope was 1 in 3000, then, by applying the slope area method of discharge estimation, show that the flood discharge at the station was 200 $m^3 s^{-1}$. (4)

4. a) What doe you mean by the baseflow of a river. Describe with a sketch any one method of baseflow separation. What do you mean by ERH and DRH? (2+4+4 = 10)

   b) The observed flows in m^3s^{-1} from a storm of 6-hour duration at a stream gauging site having catchment area of 500 km^2 are given below. Assuming the base flow to be negligible, derive the ordinates of a 6-hour Unit Hydrograph (UH). (6)

Time (hr)	0	6	12	18	24	30	36	42	48	54	60	66	72
Flow	0	100	250	200	150	100	70	50	35	25	15	5	0

   c) Name the two methods for deriving Unit Hydrographs (UH) of different durations from a UH of a given duration. Which of these methods is versatile, and which would you use for deriving a 2-hr UH from the 6-hr UH as would be available in part (b) above. (4)

5. a) Describe the Dicken's empirical method for estimating peak discharge. Write the general equation of hydrologic frequency analysis for estimating flood. (2+2 = 4)

b) Define Return period of an extreme event. How is the return period of a flood related to its frequency of occurrence? Write down the formula for assigning plotting positions to the values in a series of annual maximum floods. (2+2+2 = 6)

c) The expressions for deriving a Synthetic Unit Hydrograph (SUH) of 1-day duration as given in the Flood Estimation Report of the Central Water Commission for the subzone 2(a) of India are reproduced below. The symbols used are those elaborated in that report as shared with you. Evaluate the parameters of the SUH at a bridge site on a river in that subzone using relevant catchment parameters provided below. Sketch the resulting SUH. If the depth of effective rainfall of a design storm of 1-day duration is 2.2 cm, what would be the peak flow of the resulting direct runoff hydrograph at the bridge site? (4+3+3=10)

SUH Parameters	Regression Equation
q_p (hour)	$2.272\ (LL_c/S)^{-0.409}$
t_p (m^3s^{-1})	$2.164\ (q_p)^{-0.940}$
W_{50} (hour)	$2.084\ (q_p)^{-1.065}$
W_{75} (hour)	$1.028\ (q_p)^{-1.071}$
W_{R50} (hour)	$0.856\ (q_p)^{-0.865}$
W_{R75} (hour)	$0.440\ (q_p)^{-0.918}$
T_B (hour)	$5.428\ (t_p)^{0.852}$
T_m (hour)	$t_p + t_r/2$
Q_p (hour)	$q_p A$

Catchment parameter	Value
Area 'A' (km^2)	120
Length of longest stream 'L' (km)	18.19
Length of the stream from CG to dam site 'L_c' (km)	10.05
Stream slope 'S' (m/km)	64.60

6. a) What do you mean by aquifer, aquiclude, aquitard and aquifuge by giving an example of each type. Explain with the help of a suitable sketch the formations of an unconfined and a confined aquifer. What is the type of the aquifer that provides water to the households in most parts of the Brahmaputra River valley of Assam? (6+4+2=12)

b) State Darcy's law for estimating ground water flow. Derive an expression for estimating steady flow into a well fully penetrating a confined aquifer. Calculate the hydraulic conductivity and transmissibility of a 10 m thick confined aquifer having a 10 cm diameter well fully penetrating the aquifer if steady state drawdowns at distances of 10 m and 40 m from the centre of the well were found to be 2.5 m and 0.05 m respectively when the well was pumped at a constant rate of 125 litre/min. (2+3+3 = 8)

7. Describe any four of the following by providing sketches wherever applicable: (4×5 = 20)
   a) Pan evaporimeter as per Indian Standard and its use in collecting evaporation data at a site.
   b) Potential evapotranspiration and the names of the methods of its estimation
   c) A model representing the process of infiltration and Hortons equation for measuring infiltration capacity
   d) Constant rate injection method of dilution technique of discharge measurement
   e) Method of assessing the storage of a reservoir using mas curve technique
   f) Procedure for estimating peak flood by applying Gumbel's flood frequency method on an annual maximum flow series of a relatively short length (say, 30 years of data).