Total number of printed pages–9

53 (CE 711) HYDR

2021

(Held in 2022)

HYDROLOGY

Paper : CE–711

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

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

1. Write short notes by providing sketches wherever applicable on ***any five*** from below : 4×5=20

   (i) Advantages of self-recording rain gauges

   (ii) Float method of flow measurement

   (iii) A mass curve and a double-mass curve

   (iv) Assumptions of Unit Hydrograph theory

Contd.

(v) Rating curve and its applications

(vi) Broad categories with advantages and disadvantages of flood estimation methods

(vii) Applications of flood routing

(viii) Darcy's law for estimating ground water discharge

2. (a) Amongst the rain gauge stations named in the following table, the stations B, D and F are outside the catchment. The details of the Thiessen polygons and the corresponding rainfalls recorded in a month are also provided in this table.

Rain gauge stations	A	B	C	D	E	F	G	H
Thiessen polygon area (km^2)	720	1380	1440	1040	900	2220	500	2000
Rainfall recorded (mm)	135	143	137	128	102	115	100	101

Show that the average depth of rainfall over the catchment in the given month by the arithmetic mean and the Thiessen Polygon methods is 115 and 120 *mm* respectively. Which of these two estimates would generally be considered as being superior ?

3+3+2=8

(b) How is a water-year and how are seasons in a water-year specified in India ? 4

(c) Give sketches of typical Intensity-Duration-Frequency (IDF) and Maximum Depth-Area-Duration curves (DAD) and write usefulness of these curves. 4+4=8

3. (a) Name different categories of methods and list the names of the commonly used methods in each category of measurement of : 3×2=6

(i) Evaporation

(ii) Evapotranspiration, and

(iii) Infiltration in a catchment (method- description is not needed).

(b) Explain ***any three*** of the following : 3×2=6

(i) Why is a rain gauge provided with a funnel to catch rain ?

(ii) Why is an evaporimeter provided with a wire mesh at its top ?

(iii) Why is ring infiltrometer a better choice for infiltration measurement ?

(iv) Why is a current meter provided with a fish weight ?

(c) The annual rainfall in the water-year 2018-19 over a catchment of 1256 km^2 area was estimated as being 119.4 *cm*. The average discharge during the period in the river at the catchment's outlet worked out to 31.7 m^3s^{-1}. Show that, in the water-year 2018-19,

(i) the river carried 1000 million cubic metre (*MCM*) discharge 2

(ii) 500 *MCM* water was lost by evapotranspiration and infiltration 2

(iii) the runoff coefficient of the catchment was 66.7% 2

(iv) the infiltration would be 300 *MCM* if the evapotranspiration was 15.9 *cm*. 2

4. (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 of a river by providing a suitable sketch and relevant formulae. 4+4=8

(b) State the procedure for measuring the velocity of a river by the single and the double-point method by using current meter. 4

(c) During a flood in a reach of 8.1 *km* in a small stream with its section considered as being trapezoidal having base width 12 *m* and side slope 2 horizontal : 1 vertical, the high water levels were noted as below. If the Manning's roughness coefficient is 0.03, show by applying two trials as per the slope-area method that the flood discharge in that reach was 30 m^3s^{-1}. 8

Station	Bed elevation (*m*)	Water surface elevation (*m*)
Upstream	100.2	102.7
Downstream	98.6	101.3

5. *(a)* What is Q index ? What would be the baseflow of an ephemeral river ? What do you mean by the terms ERH and DRH ? 2+2+4=8

(b) A 6-hour Unit Hydrograph simplified in the shape of a triangle having peak of 50 m^3s^{-1} at the 24th hour from the start and base of 54 hour. The mass curve of rainfall of a severe storm over the catchment had the following records :

Time (*h*)	0	6	12	18
Cumulative rainfall (*cm*)	0	4.6	11.2	13.8

Develop the design storm, and show that the peak flow from this storm would be 550 m^3s^{-1}. Assume the ϕ index and the baseflow as being 0.1 $cm\ hr^{-1}$ and 20 m^3s^{-1} respectively. 8

(c) Name the two methods by which you can derive a Unit Hydrograph (UH) of a duration different from that of a given UH. Which of these methods is more versatile ? 4

6. *(a)* Write the expressions for estimating the peak discharge of a river by : 3×2=6

(i) Rational formula

(ii) Dicken's empirical formula

(iii) Statistical flood frequency analysis.

(b) How does hydrometorological or Unit Hydrograph method differ from the above three ? 2

(c) What Physical Catchment Descriptors would be needed for deriving a Synthetic Unit Hydrograph for the Gaurang River near Kokrajhar by the method recommended by the Central Water Commission ? 2

(d) The design discharge of a hydraulic structure on a river is 310 m^3/s. If the available flood data for the river is for 20 years, and the mean and the standard deviation of the annual flood series are 119.3 and 60 m^3/s respectively, show by using Gumbels' method of flood frequency analysis that the return period of the design flood is 50 years. Adopt the values of the reduced mean and reduced standard deviation for a sample size of 20 as 0.5236 and 1.0628 respectively. 6

(e) Write down the equation for the

(i) Modified Pul's method of reservoir routing and

(ii) Muskingum method of channel routing by naming the symbols used. 2+2=4

7. (a) Describe with the help of a suitable sketch an unconfined aquifer, an artesian aquifer and perched water table. 6

(b) Define hydraulic conductivity, transmissibility and storativity of aquifers. 6

(c) Derive an expression of steady discharge into a well penetrating an unconfined aquifer. By taking care of the units of measurement, show that the hydraulic conductivity and the transmissibility of an artesian aquifer are 45 m/day and 1125 m^2/day respectively if a 25 m long strainer pipe of 30 cm diameter drawing water from the full depth of this aquifer yields a steady state discharge of 2532 lpm at a drawdown of 4.0 m at the well, given that the radius of influence is 350 m. 4+4=8

8. *(a)* List various flood control measures into two broad categories. 4

(b) Describe various engineering measures that may be adopted for reducing the 4+4=8

(i) peak flow and

(ii) peak stage for mitigating damage from flood.

(c) What are the likely impacts of climate change on occurrence of flood ? What are likely causes of urban flooding in India ? 4+4=8