2021

APPLIED HYDROLOGY

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.

1. Write short notes on any *five* of the following :
   5×4=20

   (a) Elements of hydrologic cycle relevant to water resource assessment, development and management with a schematic diagram.

   (b) Advantages of Self-Recording Rain Gauges.

   (c) Horton's formula for estimating infiltration capacity.

   (d) One and two-point methods of measuring average velocity in a stream.

   (e) Definition of Unit Hydrograph and its limitation.

   (f) Usefulness of a Rating Curve.

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(g) Rational method of estimating peak discharge.

(h) Darcy's formula for estimating ground water discharge.

2. (a) What are the points to be remembered while installing a rain gauge ? What is the time at which measurement in an Ordinary Rain Gauge (ORG) for daily rainfall is recorded in India ? Describe with a sketch an ORG as specified in IS:5225-1992.   3+2+3=8

(b) Describe with a sketch the Isohyetal method of estimating average rainfall.   6

(c) 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 monthly rainfall data are also provided in this table.

Rain gauge	A	B	C	D	E	F	G	H
Thiessen area (km^2)	720	1380	1440	1040	900	2220	500	2000
Rainfall (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
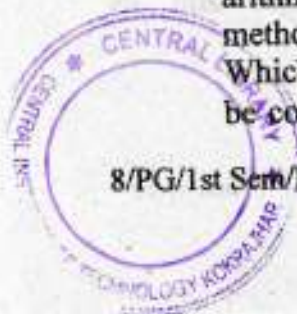
3. (a) Describe any one direct method of measuring discharge of a river by providing a suitable sketch. 6

(b) Name different indirect methods of measuring discharge of a river. Give an example of any situation or project in which any one indirect method of your choice of discharge measurement may be deployed for practical application. 6

(c) The data collected for measuring discharge by a current meter at a gauging site are provided in the following table. The rating equation of the current meter that was used for the measurement is $v = 0.51 \times Ns + 0.03$ m/sec, v being the velocity of flow, and N_s being the number of revolution/sec recorded by the current meter. Estimate the discharge. 8

| Distance from left edge (m)	0.0	1.0	3.0	5.0	7.0	9.0	11.0	12.0
Depth d (m)	0.0	1.1	2.0	2.5	2.0	1.7	1.0	0.0
Current meter revolutions at 0.6d	---	39	58	112	90	45	30	---
Duration(s)	---	100	100	150	100	100	100	---

4. (a) Show with a sketch the different components of a discharge hydrograph. Describe any one method of separating base flow from total flow to obtain Direct Runoff Hydrograph (DRH).   2+4=6

   (b) What are assumptions of Unit Hydrograph theory ? By which two methods can you derive a Unit Hydrograph of a duration different from the one available with you ?   4+2=6

   (c) 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
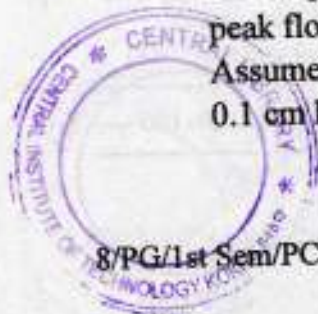
5. (a) What is a Synthetic Unit Hydrograph (SUH). What Physical Catchment Descriptors would be needed for deriving an SUH for an ungauged catchment on the Gaurang River near Kokrajhar by the method recommended by the Central Water Commission in India ?

$$4+2=6$$

(b) Write the expressions for estimating the peak discharge of a river by : $3 \times 2 = 6$

(i) Rational formula

(ii) Dicken's empirical formula

(iii) Statistical flood frequency analysis.

(c) The design discharge of a hydraulic structure on a river is 310 m³/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 m³/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. $4+4=8$

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6. (a) Describe with a sketch a Intensity Duration Frequency (IDF) curve, and state its usefulness in designing storm water drainage system of a urban area. 6

(b) What is a Flow Duration Curve (FDC). Provide a sketch of a typical FDC, and state its usefulness. 6

(c) A catchment has an area of 250 Ha. The runoff/rainfall ratio for this catchment during monsoon season is assessed as being 0.6. If a rainfall of 12 cm over the catchment results in a stream flow that lasts for 6 hours at the outlet of the catchment, compute the average stream flow during the period. 4

(d) At a station A on a river carrying 142 Cumec discharge, the stage and the water surface slope were recorded as 3.6m and 1 in 6000 respectively. If during a flood the stage at the same station was 3.6m, but the water surface slope was 1 in 3000, then estimate the discharge in Cumec that passed through the section. 4

7. (a) Describe with sketches : 6

    (i) Water table

    (ii) Piezometric surface and

    (iii) Perched water table.

(b) Define and give examples of aquifer, aquitard, aquiclude and aquifuge. 6

(c) Derive an equation for estimating steady flow into a well fully penetrating a confined aquifer. 4

(d) 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 m²/day respectively if a 25m 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 4.0m at the well, given that the radius of influence is 350m. 4