Total number of printed pages: **Programme:PG/Semester:II/Code:UCE605**

2023

Hydrology and Water Resources Engineering

Full Marks: 100

Time: Three hours

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

*Answer **any five** questions.*

1.	Write short notes on any five of the following:		5×4=20
	a)	Applications of hydrology in infrastructure planning and development	
	b)	Hydrological cycle (with a sketch), its major components and the water-budget equation relating these components	
	c)	The two methods of estimating missing annual precipitation at a station	
	d)	Assumptions and limitations of Unit Hydrograph theory	
	e)	Usefulness of Synthetic Unit Hydrograph (SUH) and a sketch showing the parameters of an SUH as per CWC's flood estimation reports for India	
	f)	Rating Curve (with a sketch) and its application	
	g)	Rational method (by giving mathematical expressions) of peak flow estimation	
2.	Briefly explain (any five) why is		5×4=20
	a)	a rain gauge provided with a funnel to catch rain?	
	b)	a Self-Recording Rain Gauge preferred over an Ordinary Rain Gauge?	
	c)	an evaporimeter provided with a wire mesh at its top?	
	d)	a ring infiltrometer a better choice than simple infiltrometer?	
	e)	a current meter accompanied with a fish weight?	
	f)	a crest staff gauge a better choice than a simple or a sectional staff gauge for recording flood flow?	
	g)	a propeller type current meter is advantageous than a cup-type current meter?	
3.	a)	Name different categories of methods, and list the names of the commonly used methods under each category for measuring (i) Evaporation, (ii) Evapotranspiration, and (iii) infiltration (method-description is not required).	3×2 = 6
	b)	Using appropriate unit-conversions and applying the water-budget equation, show that the evaporation loss from a reservoir in a month in which the following data were recorded was 23.4 cm: Average surface area of the reservoir: 20 km^2 Mean inflow into the reservoir: 10 m^3/sec Mean outflow from the reservoir: 15 m^3/sec Rainfall: 10 cm Change in storage (reduction): 16 MCM (Million Cubic Meter) Infiltration/seepage loss: 1.8 cm	6

<table>
<tr><td></td><td>c)</td><td>A catchment has 5 rain-gauge stations located inside, and three more stations outside but close to the catchment's boundary. The details of the area (km^2) under Thiessen polygon around each station and the corresponding rainfall (mm) recorded in a month are given below.
<table>
<tr><td>Stations</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td></tr>
<tr><td>Thiessen area</td><td>720</td><td>1380</td><td>1440</td><td>1040</td><td>900</td><td>2220</td><td>419</td><td>1456</td></tr>
<tr><td>Rainfall</td><td>135</td><td>143</td><td>137</td><td>128</td><td>102</td><td>115</td><td>99</td><td>101</td></tr>
</table>
Stations B, D and F are outside the catchment. Determine the average depth of rainfall on the catchment in the given month by i) arithmetic mean and ii) Thiessen mean methods. Which method would you prefer and why?</td><td>6+2 = 8</td></tr>
<tr><td>4.</td><td>a)</td><td>Draw a Intensity-Duration-Frequency curve giving the units of measurement. What is its usefulness in drainage design for urban flood control?</td><td>2+2=4</td></tr>
<tr><td></td><td>b)</td><td>(i) What do you mean by checking the internal and external consistencies of data for use in water resources project planning and design?</td><td>2+2=4</td></tr>
<tr><td></td><td></td><td>(ii) Describe with suitable sketches a single- and a double-mass curve of annual rainfall.</td><td>2+2=4</td></tr>
<tr><td></td><td></td><td>(iii) Which type of graph is produced by a self-recording rain-gauge, and how can you get the intensity of rainfall from such a graph?</td><td>2+2=4</td></tr>
<tr><td></td><td>c)</td><td>Define return period of an extreme event. Express the relation between the probability of exceedance, Return Period and the frequency of occurrence.</td><td>2+2=4</td></tr>
<tr><td>5.</td><td>a)</td><td>Categorize different techniques of measuring discharge of a river into direct and indirect methods. Describe two procedures of measuring velocity of a stream by a current meter.</td><td>4+2=6</td></tr>
<tr><td></td><td>b)</td><td>By observing the following photographs, describe the general purpose of the activities being carried out, the equipment being used, and the method to be applied for meeting the purpose.


 </td><td>4</td></tr>
<tr><td></td><td>c)</td><td>What is the usefulness of measuring the stage at a gauging site? From the following data for measuring discharge of a river at a gauging site, estimate the discharge by calculating by the mid-section method.
<table>
<tr><td>Distance from left water edge (m)</td><td>0.0</td><td>1.0</td><td>3.0</td><td>5.0</td><td>7.0</td><td>9.0</td><td>11.0</td><td>12.0</td></tr>
<tr><td>Depth of flow (m)</td><td>0.0</td><td>1.1</td><td>2.0</td><td>2.5</td><td>2.0</td><td>1.7</td><td>1.0</td><td>0.0</td></tr>
<tr><td>Velocity (m/sec)</td><td>—</td><td>0.229</td><td>0.326</td><td>0.411</td><td>0.336</td><td>0.260</td><td>0.183</td><td>—</td></tr>
</table></td><td>8+2=10</td></tr>
<tr><td>6.</td><td>a)</td><td>Show typical hydrographs of daily flow of a perennial, an ephemeral and an intermittent stream. List any eight geometrical properties (i.e., physical descriptors) of a catchment on which discharge from the catchment depends.</td><td>4+4=8</td></tr>
<tr><td></td><td>b)</td><td>Define and show a sketch of a Flow Duration Curve (FDC), and describe its usefulness in planning of a water resource project.</td><td>3+3=6</td></tr>
</table>

	c)	Estimate the minimum storage required in a reservoir to be planned if the monthly inflows and planned demands are as given in the following table. Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec Inflow (Mm^3) | 50 | 40 | 30 | 25 | 20 | 30 | 200 | 225 | 150 | 90 | 70 | 60 Demand (Mm^3) | 70 | 75 | 80 | 85 | 130 | 120 | 25 | 25 | 45 | 45 | 50 | 60	6
7.	a)	Show by drawing a dimensioned sketch the different components, i.e., the rising and receding limbs, the crest segment and the peak, the baseflow, the basin lag and the time base of a flood hydrograph.	4
	b)	Define an Effective Rainfall Hyetograph (ERH). Direct Runoff Hydrograph (DRH) and φ-index.	3×2=6
	c)	Define a Unit Hydrograph (UH). Name the methods of deriving a new UH of duration different from the duration of a UH that is already available. Describe the method when the required duration is a fraction of a known duration.	2+2+6 = 10
8.	a)	Answer the following Multiple-Choice Questions (MCQs) by choosing the correct answer: i) A 6-hr storm with uniform intensity 1.5 cm/hr produced a runoff of 72 mm. The average rate of infiltration (mm/hr) during this storm was [A] 3 | [B] 6 | [C] 9 | [D] 12 ii) If a 4-hour unit hydrograph for a catchment is approximated by a triangle with base of 48 hour and peak of 200 m^3/s, then the area of the catchment (km^2) is [A] 1728 | [B] 3456 | [C] 864 | [D] 5184	2×2=4
	b)	Write down (i) the Dicken's formula for estimating peak flow, and (ii) the formula for calculating discharge using a venturi flume.	2+2=4
	c)	Write the general equation of hydrologic frequency analysis. Describe the procedure for estimating the design flood of a specified return period for practical application using Gumbel's method. Peak floods of 50- and 100-year return periods in a river were estimated by Gumbel's Extreme Value Type-I distribution as being 40809 and 46300 m^3s^{-1} respectively. Estimate the peak flood for a 300-year return period.	2+6+4= 12