Total number of printed pages: 3

PG/Semester-I/PCEW103

2023

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	Explain why is		5×4 = 20
	a)	a current meter provided with a fish weight?	
	b)	an evaporimeter provided with a wire mesh at its top?	
	c)	a ring infiltrometer a better choice than simple infiltrometer for measuring infiltration?	
	d)	a rain gauge provided with a funnel to catch rain?	
	e)	A crest staff gauge is a preferred mode of measuring stage during the passing of a high flood at a site where continuous recording arrangement is not available.	
2	a)	Write down the differences between an Ordinary Rain Gauge (ORG) and a Self-Recording Rain Gauges (SRRG). Draw the sketch of an ORG as specified in IS:5225-1992, and the sketch of any one type of SRRG.	4+6=10
	b)	Describe with a sketch the Thiessen Polygon method of estimating average rainfall.	4
	c)	Describe with sketches the (i) maximum Intensity-Duration-Frequency (IDF) curves, and (ii) Maximum Depth-Area-Duration (DAD) curves of a catchment.	6
3	a)	Describe any one direct method of measuring discharge of a river by providing a suitable sketch and the mathematical expression.	6
	b)	Name different indirect methods of measuring discharge of a river.	4
	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 $v = 0.51 \times N_s + 0.03$ 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.	10

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
Revolutions at $0.6d$	---	39	58	112	90	45	30	---
Duration (s)	---	100	100	150	100	100	100	---

<table>
<tr><td>4</td><td>a)</td><td>What is a hydrograph? 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).</td><td>2+2+4=8</td></tr>
<tr><td></td><td>b)</td><td>Define a Unit Hydrograph. What are its assumptions? Name the methods by which you can derive a Unit Hydrograph of a duration different from the one available with you. Which of these two methods is versatile?</td><td>2+2+2+2=8</td></tr>
<tr><td></td><td>c)</td><td>What would be the rainfall excess of a 1-day storm over a catchment of 600 km^2 area that produced surface runoff as given in the following table
<table>
<tr><td>Time (day)</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>Runoff (m^3s^{-1})</td><td>20</td><td>63</td><td>151</td><td>133</td><td>90</td><td>63</td><td>44</td><td>29</td><td>20</td><td>20</td></tr>
<tr><td>Baseflow (m^3s^{-1})</td><td>20</td><td>22</td><td>25</td><td>28</td><td>28</td><td>26</td><td>23</td><td>21</td><td>20</td><td>20</td></tr>
</table></td><td>4</td></tr>
<tr><td>5</td><td>a)</td><td>In what situation is a Synthetic Unit Hydrograph (SUH) used? What Physical Catchment Descriptors would you look for in deriving an SUH at a site on the Gaurang River in your Institute's new campus by the method recommended by the Central Water Commission (CWC) in India? What values of (i) factor for estimation of aerial rainfall from point rainfall (ii) design loss rate from design storm increments and (iii) baseflow would you consider in deriving a design flood at that site by the CWC's method?</td><td>3+2+3=8</td></tr>
<tr><td></td><td>b)</td><td>Write the expressions for estimating the peak discharge of a river by:(3×2 = 6)
i) Rational formula
ii) Dicken's empirical formula
iii) general equation of statistical flood frequency analysis.</td><td>3×2 = 6</td></tr>
<tr><td></td><td>c)</td><td>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.</td><td>6</td></tr>
<tr><td>6</td><td>a)</td><td>Define with sketch a rating curve at a gauging site? What are its uses? Describe the procedure of deriving a rating curve at a site.</td><td>4+2+6=12</td></tr>
<tr><td></td><td>b)</td><td>Define with sketch a Flow Duration Curve (FDC). What are its uses? Give the expression of a plotting position formula that you would use in deriving an FDC from observed flow data, and the relation between a plotting position and the corresponding return period?</td><td>4+2+2=8</td></tr>
<tr><td>7</td><td>a)</td><td>Define i) a water table, ii) a piezometric surface, iii) a perched water table (iv) a leaky aquifer and (v) an artesian well by showing these either on a single or on separate sketches of an unconfined and a confined aquifer.</td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Define and give examples of aquifer, aquitard, aquiclude and aquifuge.</td><td>6</td></tr>
</table>

	c)	Derive an equation for estimating steady flow into a well fully penetrating a confined aquifer	4
8	Answer any four of the following:		4×5=20
	a)	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.	
	b)	A 500 gm/lit solution of sodium dichromate was applied at a constant rate of 4 lit/sec to a river's flow. If the equilibrium concentration at a downstream location was measured as 4 ppm (parts per million) then show that 500 m^3s^{-1} was the discharge of the river.	
	c)	If a 80 mm storm occurring over six hours produces a peak flood of 470 m^3s^{-1}, then show by assuming an average infiltration loss of 0.25 cm/hr and a constant base flow of 15 m^3s^{-1} that 70 m^3s^{-1} would be the peak of a 6-hour Unit Hydrograph for this catchment.	
	d)	At a station A on a river carrying 142 m^3s^{-1} discharge, the stage and the water surface slope were recorded as 3.6 m and 1 in 6000 respectively. If during a flood the stage at the same station was 3.6 m, but the water surface slope was 1 in 3000, then estimate the discharge in m^3s^{-1} that passed through the section.	
	e)	A confined aquifer is made up of three layers. The pair of values of the coefficient of permeability in metre/day and the thickness in metre of these layers are (30, 5), (20, 3.5) and (45, 3.5). Show that the transmissivity of the aquifer for a ground water flow along the stratification would be 377.5 $metre^2$/day.	
	f)	A 45 cm diameter well completely penetrates an unconfined aquifer having permeability of 20 m/day and a saturated thickness of 30 m. Show that the discharge under a steady pumping rate over a long time would be 2558 lpm if the drawdown at two observation wells 15 m and 30 m from the well were 5.0 and 4.2 m respectively.	