2024

Applied Hydrology

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:	$4 \times 5 = 20$
		a) Water budget equation for (i) a catchment and (ii) a lake,	
		b) Names of four mechanisms of rainfall, and the difference in	
		mechanisms between rainfall in Kokrajhar and that in Mawsynram,	
		c) Intensity-Duration-Frequency relation,	
		d) Pan evaporimeter as per Indian Standard code,	
		e) Horton's formula for estimating infiltration capacity,	
		f) Assumptions and limitations of Unit Hydrograph theory	
2		Write short notes on any four of the following:	$4 \times 5 = 20$
		a) Return period and its relation with the probability of exceedance and	
		the frequency of occurrence of an extreme event,	
		b) Stage discharge relation Flow Duration curve,	
		c) Rational method of estimating peak discharge,	
		d) General equation for hydrologic frequency analysis,	
		e) Phreatic surface and Piezometric surface,	
		f) Darcy's formula for estimating ground water discharge	
3	a)	How are 'normal rainfall' and the seasons in a water-year specified in India?	5
	b)	Describe with a sketch the Thiessen Polygon method and write the formula	5
		(in terms of Thiessen weights) for estimating average rainfall.	
	c)	Show that the average precipitation over a catchment of area 600 km ²	4
		calculated from the following data for a storm would be 7.41 cm.	
		Isohyets (cm) 15-12 12-9 9-6 6-3 3-1	
		Inter-Isohyetal area (km ²) 92 128 120 175 85	
	d)	Show that the evaporation loss from a reservoir in a month in which the	6
		following data were recorded was 23.4 cm:	-
		Average surface area of the reservoir: 20 km^2	
		Mean inflow into the reservoir: $10 \text{ m}^3/\text{sec}$	
		Mean outflow from the reservoir: $15 \text{ m}^3/\text{sec}$	
		Rainfall: 10 cm	
		Change in storage (reduction): 16 MCM (Million Cubic Meter)	
		Infiltration/seepage loss: 1.8 cm	
		(Hint: Using appropriate unit-conversions and applying the water-budget equation)	

4	a)	What are one-point and two-point methods of measuring velocity at a	4
		vertical in a river cross section by a current meter?	
	b)	Describe together with the derivation of the formula <u>any one</u> of the following	6
		methods for measuring river discharge:	
		i) Moving boat method	
		ii) Plateau gauging or continuous injection of tracer method	
		iii)Slope-Area method	
	c)	Estimate the discharge from the following data at a gauging site. The rating	8
		equation of the current meter is $v = 0.51 \times N_s + 0.03$, where v is the velocity	
		of flow in m/s, and N_s is the number of revolution/sec of the current meter.	
		Distance from left 0.0 1.0 3.0 5.0 7.0 9.0 11.0 12.0	
		edge (m)	
		Depth d (m) 0.0 1.1 2.0 2.5 2.0 1.7 1.0 0.0	
		Current meter 40 60 120 90 40 30	
		revolutions at 0.6d	
		Duration (s) 100 100 100 100 100	
	d)	The runoff/rainfall ratio for a catchment of area of 250 Ha area in a monsoon	2
		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 catchment's outlet,	
		estimate the average stream flow during the period.	
5	a)	What are the components of a typical flood hydrograph? Describe a base	2+4=6
		flow separation method.	
	b)	How is an S-curve produced? What is the use of an S-curve?	2+2=4
	c)	The observed flows from a storm of 6-hour duration at a stream gauging site	4
		having catchment area of 95 km ² are given below. Assuming base flow as	
		being zero, derive the ordinates of a 6-hour unit hydrograph.	
		Time (hr) 0 6 12 18 24 30 36 42 48 54 60 66 72	
		Flow (m ³ s ⁻¹) 0 20 50 60 30 20 14 10 7 5 3 1 0	
	4)	Choose a correct answer from the four entions given in the following two	6
	u)	Multiple-Choice Questions:	0
		i) A 6-br storm with uniform intensity 1.5 cm/br produced a runoff of 72	
		mm. The average rate of infiltration (mm/hr) during this storm was	
		mm. The average rate of infiltration (mm/hr) during this storm was[A] 3[B] 6[C] 9[D] 12	
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	b)	Write Dicken's empirical formula for estimating the peak discharge. What is	4
		the difference between the Log-Normal and Log-Pearson Type 3 methods of	
		design flood estimation.	
	c)	Design floods of return periods 100 and 50 years at a river station having 30	10
		years of data were estimated by Gumbel's method as 1200 and 1060 m^3/s	
		respectively. Show that i) the mean and standard deviation of the data are	
		385 and 223 m ³ /s respectively and ii) a flood of 500-year return period	
		would have magnitude of 1525 m^3/s . For sample size of 30, adopt reduced	
		mean=0.5362 and reduced standard deviation =1.1124.	
7	a)	Estimate the minimum storage required in a reservoir to be planned if the	6
		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 70 75 80 85 130 120 25 25 45 45 50 60	
		(Mm ³)	
	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	4
		confined aquifer.	
	d)	Assuming the radius of influence as 300 m and permeability as 45 m day ⁻¹ ,	4
		show that the steady discharge from a 30 cm diameter well fully penetrating	
		a confined aquifer 20 m deep for a drawdown of 3.0 m would be 1550 lpm.	

