Total number of printed pages:4 **PG/1st/PCEW103**

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) Hydrologic cycle

b) Optimal number of rain gauge stations in a catchment

c) Pan evaporimeter as per Indian Standard code

d) Horton;s formula for estimating infiltration capacity

e) Assumptions of Unit Hydrograph theory

f) Rating Curve

g) Rational method of estimating peak discharge

h) Darcy's formula for estimating ground water discharge

i) Methods of reducing flood runoff for flood impact mitigation.

j) Impact of climate change on surface water flow

2 a) Describe with a sketch the non-recording type raingauge as specified in IS:5225-1992 and the method of its installation and measurement of rainfall as specified in IS:4986-2002 3+3=6

b) What are the methods of estimating missing annual rainfall? Describe with a sketch the Thiessen Polygon method of estimating average rainfall. 4+4=8

c) Show that the average precipitation over a catchment of area 600 km^2 calculated from the following data for a storm would be 7.41 cm. 6

Isohyets (cm)	15-12	12-9	9-6	6-3	3-1
Inter-Isohyetal area (km^2)	92	128	120	175	85

3 a) Describe with sketches any one method of measuring discharge of a river. 6

b) Describe three simplified methods of measuring velocity of a river along a vertical using current meter 6

c) The following is a table of data collected for measuring discharge by current meter at a gauging site. The rating equation of the current meter 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. 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) What is a Hydrograph? Describe a base flow separation method. 2+4=6

b) Define a Unit Hydrograph. What are limitations of Unit Hydrograph theory? 4+2=6

c) What is an S-curve? What is the use of an S-curve? 2+2=4

d) The observed flows from a storm of 6-hour duration at a stream gauging site 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. 4

Time (hr)	0	6	12	18	24	30	36	42	48	54	60	66	72
Flow (m^3s^{-1})	0	20	50	60	30	20	14	10	7	5	3	1	0

5 a) Define 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 Dicken's empirical formula for estimating the peak discharge. 2

c) Describe the Gumbel's method for practical use for estimating flood? 4

d) The magnitudes of flood having return periods 100 and 50 years at a river station having 30 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 4+4=8

6 a) Describe with a sketch the Intensity-Duration-Frequency (IDF) and the Depth-Area-Duration curves of storms over a catchment 4+4=8

b) What do you mean by (i) Standard Project Storm (SPS) and Standard Project Flood (SPF), (ii) Probable 3×3=9

Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) and (iii) design storm of a given return period

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. 3

7 a) Define and give examples of aquifer, aquitard, aquiclude and aquifuge. 6

b) Describe with sketches i) unconfined aquifer, ii) artesian aquifer and iii) perched water table. 6

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

d) Assuming the radius of influence as 300 m and permeability as 45 m day^{-1}, 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. 4