L-3/T-2/WRE Date: 13/01/2021

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

L-3/T-2 B.Sc. Engineering Examinations January 2020

Sub: **WRE-303** (Hydrology)

Full Marks: 180 Time: 2 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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## SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

**1.** (a) Differentiate between Infiltration and Percolation in a Hydrologic Cycle (8)

(b) The design precipitation intensity for a storm with a T-year return period with slope of 0.005 and maximum length of travel of water of 1000 m for the catchment is 3.8 in/hr. Estimate the **design return period** (T). Also estimate the **design precipitation volume** ($m^3$). Find out the **design peak discharge** (in $m^3/s$) using rational method for the catchment. The area of the catchment is 2 $km^2$ and runoff coefficient is 0.5. Use the IDF curves (Fig. 1) and Kirpich formula for your estimation. (22)

**2.** (a) Show in figures the positions of Ground Water Table (GWT) during Rainy and Dry seasons for Perennial and Intermittent streams. (8)

(b) The average rainfall values over a catchment in three successive 6-h intervals are known to be 5.5, 1.5 and 3.5 cm. The φ-index for the catchment is estimated to be 0.25 cm/hr. At the beginning the base flow is 10 $m^3/s$ and it increases by 1 $m^3/s$ every 12 hr till the end of direct runoff. Estimate the resulting flood hydrograph. Use the 6-hr unit hydrograph (UH) ordinates from the table below. (22)

| Time (hr) | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ordinate of UH ($m^3/s$) | 0 | 20 | 80 | 130 | 150 | 130 | 90 | 52 | 27 | 15 | 5 | 0 |

3. (a) Explain in brief the use of Plotting Position formula in computing certain hydrological parameter with Graphical Method. (8)

(b) Route the following hydrograph through a river reach for which K = 10 hr and x = 0.15. The outflow discharge is 5 $m^3/s$ in the beginning. (22)

| Time (hr) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Inflow ($m^3/s$) | 5 | 10 | 10 | 50 | 45 | 35 | 20 | 15 | 10 | 8 |

4. (a) Explain in brief the three methods for base flow separation. (8)

(b) Ordinates of 4-hr UH for a catchment are given below. Derive the 3-hr UH for the same catchment. (22)

| Time (hr) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ordinate of UH ($m^3/s$) | 0 | 20 | 80 | 120 | 160 | 130 | 90 | 50 | 30 | 15 | 5 | 0 |

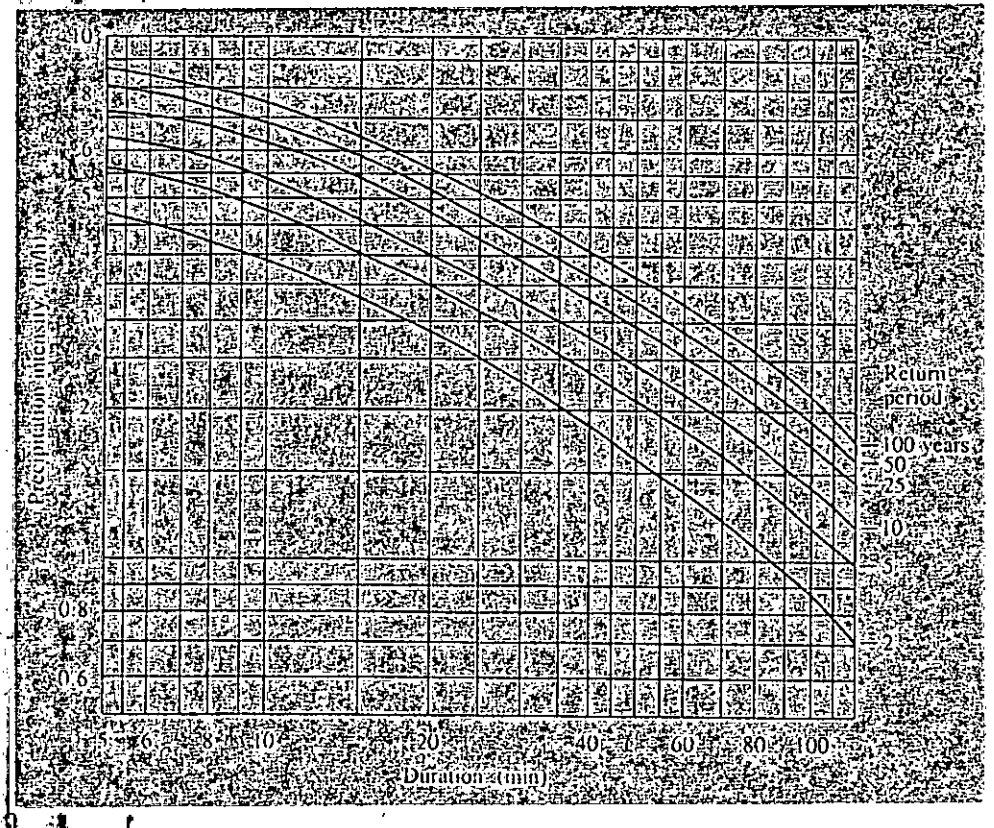


**Fig. 1: Intensity-Duration-Frequency (IDF) curves**

# SECTION – B

## Question no. 5 is compulsory and answer any two from the rest

5.(a) The mass curve of rainfall in a storm of total duration 90 minutes is given below. Plot the maximum intensity-duration curve for this storm. Assume x to be the last digit of your student ID. (15)

| Time (minutes) | 0 | 15 | 30 | 45 | 60 | 75 | 90 |
|---|---|---|---|---|---|---|---|
| Cumulative depth (mm) | 0 | 2+x | 6+x | 10+x | 20+x | 28+x | 32+x |

(b) Test the consistency of the following data of the annual precipitation measured at station A and correct the record if there is any discrepancy. Rainfall data for station A as well as the average annual rainfall measured at a group of eight neighbouring stations located in a meteorologically homogeneous region are given as follows. (22)

| Year | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|
| Rainfall of station A (mm) | 320 | 306 | 280 | 250 | 343 | 245 | 200 |
| Average rainfall of the group (mm) | 136 | 130 | 143 | 132 | 146 | 147 | 180 |
| Year | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 |
| Rainfall of station A (mm) | 246 | 182 | 140 | 180 | 232 | 187 | 230 |
| Average rainfall of the group (mm) | 155 | 152 | 117 | 128 | 193 | 156 | 160 |

(c) Describe a weather system briefly that commonly causes precipitation in the Sylhet division of Bangladesh. (3)

6.(a) Assume, you need to measure the discharge of Surma river for a water resources engineering project. Which method of velocity measurement would you employ for this purpose? Write down the relative advantages of your chosen method over the other existing methods to support your answer. (3)

(b) During velocity measurement using moving boat method, the magnitude ($V_R$) and direction ($\theta$) of the resultant velocity relative to the moving boat are measured. The depth of the stream was also simultaneously recorded. Estimate the discharge in the river from the following data. Assume mean velocity in a vertical to be 0.95 times the surface velocity measured by the instrument. The sections are (40+x) m apart. Assume, the distance between two consecutive sections and the direction ($\theta$) vary as a function x where x is the last digit of your student ID. (22)

| Section | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_R$ $(m/s)$ | - | 1.85 | 1.90 | 2.00 | 2.20 | 2.50 | 2.00 | 1.80 | 1.70 | - |
| $\theta$ (deg) | - | 55+x | 57+x | 58+x | 59+x | 60+x | 59+x | 57+x | 54+x | - |
| Depth (m) | - | 1.7 | 2.0 | 3.0 | 3.5 | 3.8 | 3.2 | 2.5 | 2.0 | - |
| Remark | Right Bank | | | | | | | | | Left bank |

7.(a) A storm in an area near the Dhaka city with 15.5 cm precipitation produces a direct runoff of (6+0.1y) cm. Given the time distribution of the storm as below, estimate the infiltration loss index ( ϕ- Index) of the storm? Assume y to be the last two digits of your student ID. (18)

| Time from start (hr) | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 |
|---|---|---|---|---|---|---|
| Cumulative rain (cm) | 1.5 | 5.5 | 10.5 | 13.0 | 14.5 | 15.5 |

(b) (200+x) g/l solution of common salt was discharged into a stream at a constant rate of (25+x) l/s. The background concentration of the salt in the stream water was found to be 10 ppm. At a downstream section where the solution was believed to have been completely mixed, the salt concentration was found to reach an equilibrium value of (40+x) ppm. Estimate the discharge in the stream. Assume x to be the last digit of your student ID. (7)

8. A catchment of 70 hectares is located on 32°4' North and 230 m (above the sea level). On a certain day of July, the temperature was (25+0.1y)° C, wind velocity at 2 m above ground was 80 km/day, observed sunshine hour was about 10 hours and possible sunshine hour was 13.7 hours. Other data are as follows (25)

Mean Monthly solar radiation at top of the atmosphere, $H_a$= 16.15 mm of water/day
Psychrometric constant= 0.49 mm of Hg
Stefan-Boltzman constant, s = $2.01 \times 10^{-9}$mm/day.
Nature of surface cover: Close-ground green crop
air pressure= 101 kPa
dew point temperature= 15° C.

Compute the following:

i) Saturation vapour pressure, actual vapour pressure
ii) weekly evapotranspiration from the catchment.

Assume y to be the last two digits of your student ID. See appendix for additional information.

**Appendix**

Table: Saturation Vapour Pressure of Water

| Temperature (°C) | Saturation vapour pressure $e_w$ (mm of $Hg$) | $\Delta$ (mm/°C) |
|---|---|---|
| 0 | 4.58 | 0.30 |
| 5.0 | 6.54 | 0.45 |
| 7.5 | 7.78 | 0.54 |
| 10.0 | 9.21 | 0.60 |
| 12.5 | 10.87 | 0.71 |
| 15.0 | 12.79 | 0.80 |
| 17.5 | 15.00 | 0.95 |
| 20.0 | 17.54 | 1.05 |
| 22.5 | 20.44 | 1.24 |
| 25.0 | 23.76 | 1.40 |
| 27.5 | 27.54 | 1.61 |
| 30.0 | 31.82 | 1.85 |
| 32.5 | 36.68 | 2.07 |
| 35.0 | 42.81 | 2.35 |
| 37.5 | 48.36 | 2.62 |
| 40.0 | 55.32 | 2.95 |
| 45.0 | 71.20 | 3.66 |

$$H_n = H_a(1-r)\left(a + b\frac{n}{N}\right) - \sigma\, T_a^4 (0.56 - 0.092\sqrt{e_a})\left(0.10 + 0.90\frac{n}{N}\right)$$