(16)

08 December 2023
1:30 P.M to 04:30 P.M

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination | **Winter Semester: 2022 - 2023**
Course No.: CEE 4563 | **Full Marks: 150**
Course Title: Engineering Hydrology | **Time: 3 Hours**

There are **6 (Six)** questions. Answer all **6 (Six)** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable data/values for any missing data/info.

1. **(a)** Explain why there is little variation in regional evaporation but wide variation in seasonal evaporation in Bangladesh. (CO1:PO1:4)

(b) What is ADCP and how does it work explain with figure? (CO1:PO1:4)

(c) How do you measure rainfall? Discuss the different errors of rainfall measurement. (CO1:PO1:4)

(d) What is a catchment? Write the different characteristics of a catchment. (CO1:PO1:5)

(e) What are the limitations of the Moving Boat and Area-Velocity method of discharge measurement? (CO1:PO1:4)

2. **(a)** Why is the hydrologic cycle considered as a system? What are the subsystems of the hydrologic cycle? (CO2:PO2:4)

(b) Explain the application of remote sensing in hydrology with examples and its advantages and disadvantages. (CO2:PO2:6)

(c) Explain with figures the differences between a hydrograph and a unit hydrograph (CO2:PO2:5)

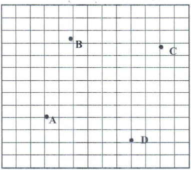
(d) The rates of rainfall for the successive 30 min period of a 3-hour storm are: 1.6, 3.6, 5.0, 2.8, 2.2, 1.0 cm/hr. The corresponding surface runoff is estimated to be 3.6 cm. Establish the φ-index. (CO2:PO2:5)

3. **(a)** Explain the relationship between runoff efficiency and the size of the catchment. (CO2:PO2:4)

(b) Classify runoff according to the source. What is the difference between a tributary and a distributary? (CO2:PO2:4)

(c) Why does attenuation occur during flood routing? (CO2:PO2:4)

(d) In a rectangular area four rain gauges A, B, C and D are located in the given figure. The recorded rainfall for December is as follows: Station A: 125mm, Station B: 165mm, Station C: 80mm and Station D: 50mm. Use the Arithmetic and Thiessen method to compute the areal rainfall of the rectangle for the month of December. (CO2:PO2:10)



4. (a) What are the applications of probability in Hydrology? Give two real-life examples. (CO2:PO2:4)

(b) A 24-hour storm occurred over a catchment of 1.8 km^2 area and the total rainfall observed was 10 cm. An infiltration capacity curve prepared had the initial infiltration capacity of 1 cm/hr. and attained a constant value of 0.3 cm/hr. after 15 hours of rainfall with a Horton's constant $k = 5\ hr^{-1}$. An IMD pan installed in the catchment indicated a decrease of 0.6 cm in the water level (after allowing for rainfall) during 24 hours of its operation. Other losses were found to be negligible. Determine the runoff from the catchment. Assume a pan coefficient of 0.7. (CO2:PO2:5)

(c) The following data were taken from 5 gage stations. What is the missing rainfall at station X? (CO2:PO2:5)

Gage	Average Annual Rainfall (cm)	Monthly Rainfall (cm)
A	45	3.4
B	24	2.7
C	33	4.1
D	57	3.7
X	37	?

5. (a) The direct runoffs from a 4-hr unit hydrograph are shown in the following table. Derive a 6-hr unit hydrograph using S-curve method. Determine the peak flow if the effective rainfall in three successive 6-hr periods is 1.2, 0.5, 0.6 and 0.8 cm. (CO3:PO3:14)

Time (hr.)	0	2	4	6	8	10	12	14	16	18	20	22	24
Flow (m^3/sec)	0	25	100	150	190	170	110	70	30	20	6	1.5	0

(b) The following data are from 9.6 cm of rainfall that lasted for 6 hrs. in a 133 km² catchment. Determine the unit hydrograph (draw in a graph) and the ϕ index if the base flow is 10 m³/sec. What would be the peak flow from a 12-hr unit hydrograph? (CO3:PO3:12)

Time (hr.)	0	2	4	6	8	10	12	14
Discharge (m³/sec)	10	182	396	526	303	140	59	10

(c) The peak flow from 6 hr. unit hydrograph in catchment M is 200 m³/sec and occurs at 37 hr. Determine the peak flow and base period from 6 hr. of effective rainfall in catchment N which is in the same area from the following table using Synerder's method. (CO3:PO3:10)

Item	Catchment M	Catchment N
L_c	76 km	52 km
L	148 km	106 km
A	2718 km²	1400 km²

$$T_p = \frac{t_R}{2} + t_p'$$

$$t_p' = \frac{21}{22} t_p + \frac{t_R}{4}$$

$$t_p = C_t (L L_a)^{0.3}$$

$$Q_p = 2.78\ C_p A / t_p'$$

6. (a) The inflow data of a river are shown in the following table. Determine the attenuation and the lag time if K = 20 hours and X = 0.25. Assume the initial outflow as 100 m³/sec. (8.67) (CO4:PO4:12)

Time (hrs.)	12	24	36	48	60	72	84	96	108	120
Discharge (m³/sec)	100	300	680	500	400	310	230	180	100	50

(b) The regression analysis of a 30-year flood data at a point on a river yielded a sample mean of 1401 m³/sec and a standard deviation of 851 m³/s. For what discharge would you design the structure to provide 95% assurance that the structure would not fail in the next 76 years? Use Gumbel's method. The value of the mean and standard deviation of the reduced variate for N = 30 are 0.53622 and 1.11238, respectively (CO4:PO4:9)

(c) The inflow and outflow hydrographs for a reach of a river are given below. Determine the value of the Muskingum coefficients K and x (range: 0.2 to 0.3) for the reach applying minimum 3 trials in graph paper. (CO4:PO4:16)

Time (hr.)	0	24	48	72	96	120	144	168	192	216
Inflow (cumec)	35	125	575	740	456	245	144	95	67	50
Outflow (cumec)	39	52	287	624	638	394	235	142	93	60