Faculty of Engineering- Civil Engineering Department

HYDROLOGY AND HYDRAULICS – CE 435

(Final - Exam)

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Date: 27 October 2020

Time: 17:00-18:30 -

Question #1: (10 points)

An air mass is at a temperature of 26°C with relative humidity of 55%. Determine

es (a) Saturation vapour pressure From the graph → at 26C° → $e_s = 25.65$ mm Hg

ΔS (b) Saturation deficit $= \Delta s = e_s - e_a = 11.54$

ea (c) Actual vapour pressure in mbar and mm Hg $= 0.55 * 25.65 = 14.1075$ mm Hg $= 18.76$ mbar

(d) Dew point From the graph ≃ 16°C

(e) Wet bulb temperature

By trial →

$(17.3 - 14.675) = 0.485(26 - 19)$

$3.225 = 3.206$

Question #2: (25 points)

A catchment area noting that 35 mm of rain fell in a discharge area of 78.2 square kilometers over a period of one hour started at 01:00. The following table shows the measured runoff through the area in the unit of time. Calculate and draw one-hour unit hydrograph

Time, hr	Measured flow, m3/s	Time, hr	Measured flow, m3/s
0	0	10	2.83
1	1	11	2.38
2	1.2	12	2.02
3	2.97	13	1.76
4	24.1	14	1.64
5	51.5	15	1.47
6	32.3	16	1.39
7	11.2	17	1.27
8	5.95	18	0
9	3.77		

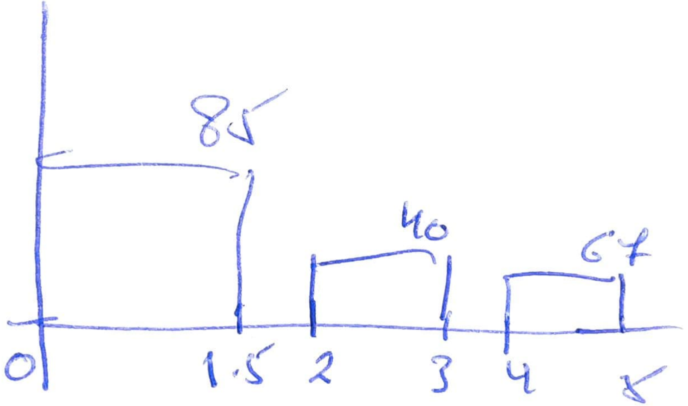
ii. Compute and plot the hydrograph of surface runoff for two periods of heavy rain occurring: First storm: of 85mm rain between midnight and 01-30 hr; and 40mm rain between 02-00 and 03-00 hr. Second storm: of 67mm rain between 04-00 and 05-00 hr.

Assume a constant loss rate of 18mm and a constant base flow of $8m^3/s$ Comment about your graph.

$$d = \frac{0.36 \times 1 \Sigma 148.75}{78.2}$$

$$= 6.84$$

Base Flow



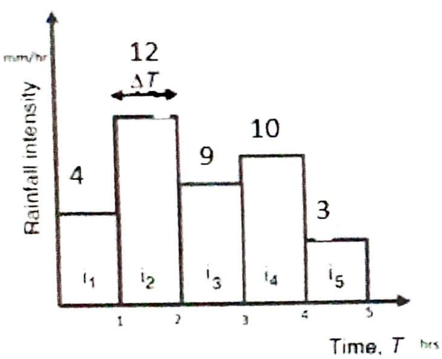
Use the Penman nomogram to solve its equation to predict expected daily evapotranspiration from field plants at latitude 60 degrees north in March and June, for an expected rate of evapotranspiration 65 percent of the expected evaporation, under the following conditions:

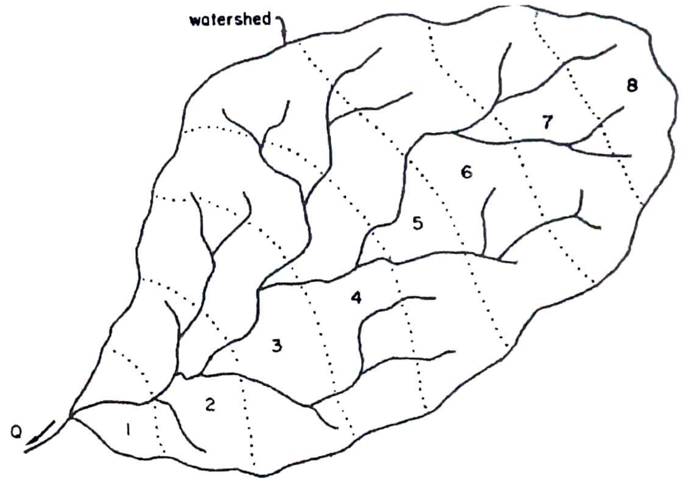
	March	June
Intermediate air temperature (° C)	5.5	15
Medium relative humidity (%)	79	77
Sky coverage (% clouds)	45	55
Relative velocity of wind (m/s)	2.5	3

Question #4: (15 points)

A catchment can be divided into eight sub-areas by isochrones in the manner shown in the below table. For the shown storm event, estimate the flow rate (in m^3s^{-1}) coming out of the catchment area after 6 hours.

Hour	1	2	3	4	5	6	7	8
Area in km^2	14	30	84	107	121	95	70	55





$$Q = i_6(A_1) + i_5(A_2) + i_4(A_3) + i_3(A_4) + i_2(A_5) + i_1(A_6)$$

$$= 0 + 3 \times 30 + 10 \times 84 + 9 \times 107 + 12 \times 121 + 4 \times 95$$

$$= 90 + 840 + 963 + 1452 + 380$$

$$Q = \frac{3725 \times 1000}{3600}$$

$$\approx 1034.72 \text{ m}^3/\text{s}$$

Tabulated below is the inflow (I) to a river reach where the storage constants are K = 10 h and x = 0.3. Use the Muskingum streamflow-routing technique to determine the outflow (O) hydrograph and the outflow peak in time and magnitude.

Time h	*Inflow (I)* m^3/s	O m^3/s		
0	0	0		
5	26.9	14.3		
10	24.1	17.5		
15	62.3	37.5		
20	133.1	85.9		
25	172.7	132.75		
30	152.9	145.23 →	Max	value
35	121.8	134.71	Peak =	145.22 m^3/s
40	90.6	112.67		
45	70.8	91.64	at	35 h
50	53.8	72.4		
55	42.5	57.2		
60	34.0	45.34		
65	28.3	37.9		
70	0			

$$O_{i+1} = C_0 I_{i+1} + C_1 I_i + C_2 O_i$$

$K = 10h, \quad x = 0.3, \quad \Delta t = 5h$

$$C_0 = \frac{-(10 \times 0.3) + (0.5 \times 5)}{10 \times (1 - 0.3) + (0.5 \times 5)} = -0.05$$

$$C_1 = \frac{(10 \times 0.3) + (0.5 \times 5)}{10 \times (1 - 0.3) + (0.5 \times 5)} = 0.579$$

$$C_2 = 1 - C_0 - C_1$$

$$= 1 + 0.05 - 0.58$$

$$= 0.474$$