SOLUTION MIDTERM 2015

A-Multiple choice questions

1. Which of the following describes a 'Thiessen polygon'? (a) A network of rainfall gauges; (b) A spatially localised area of the catchment that contributes infiltration excess overland flow when the remainder of the catchmnent does not; (c) contours of equal rainfall across an area; (d) polygons created by drawing straight lines at equal distances between points (such as rain gauge locations) ans=d
2. In the Penman combination method, which component of the energy budget equation only depends of the latitude? (a) long wave radiation; (b) short wave radiation at the ground level; c) short wave radiation on the top of the atmosphere; (d) the albedo ans=c
3. The dew point temperature is the temperature at which (a) water vapour content is minimum, (b) the air become saturated with vapour, (c) the air pressure is minimum and (d) none of the above ans=b;
4. Which one of the following responses is not true? For a continuous random variable X, (a) $P(-\infty \le X \le +\infty) = 1$; (b) $P(X \le X_1) < P(X \le X_2)$ *when* $X_1 \le X_2$; (c) $P(X = X_0) = 0$; (d) $\int_{-\infty}^{+\infty} f(x)dx = 1$ ans=b
5. Which one of the following areal precipitation calculation method is the least precise? a) the arithmetic average method; the isohyetal method; the thiessen polygon method. ans=a

B-short answers (three lines at most):

1. When is regional frequency analysis preferable to local frequency analysis? when there not ennough observations at the site of interest
2. Why do hydrologic risk increase with variability? because variability mean unpredictability in hydrology
3. Explain how the shape of a probability distribution can describe our knowledge (or ignorance) about a given hydrological variable. a flat distribution reflects ignorance. A distribution with a narrow support means more certainty
4. In the Penman combination method evaporation is estimated as the weighted average of two factors. Explain what these factors are and the rationale for using both in the formula. The two components are solar radiation and wind speed. Both contribute to evaporation with different mechanism. Ignoring one of the two would lead to inaccuracy
5. Cite three factors that affect travel time in a watershed and explain why they lead to shorter (or longer) travel times. high slope= short time of concentration; high flowpath roughness means long time of concentration. High concentration of streams mean shorter time of concentration

SOLUTION PROBLEM 2

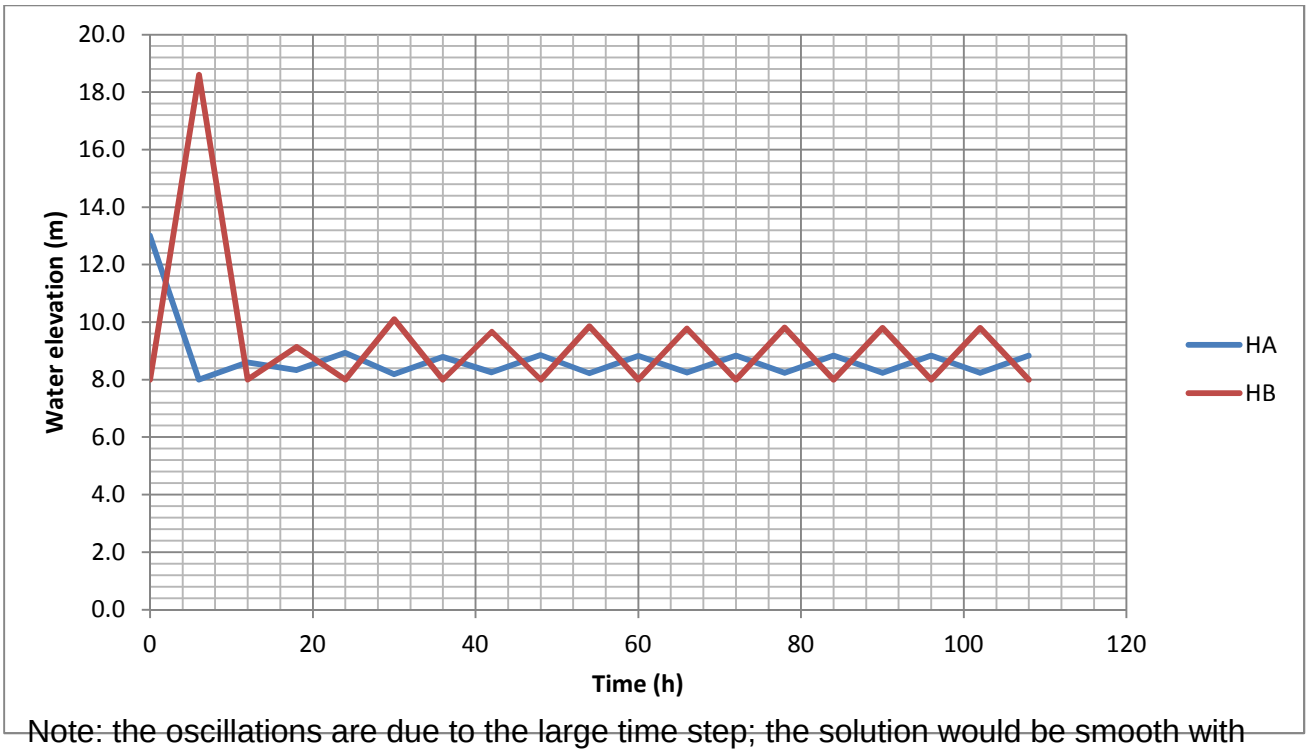
Water balance equation for reservoir A

$\Delta h_a = \max\left(h_a - h_b, \frac{P*\Delta t*1000 - Q_a \Delta t}{1000}\right)$: because of physical constraints (h_a has to be higher than h for flow to occur from A to B)

Water balance equation for reservoir B

$\Delta h_b = \max\left(8 - h_b, \frac{P*\Delta t*1000 + 1000 \times \Delta h_a - Q_b \Delta t}{1000}\right)$: because of physical constraints (h has to be higher than 8 for water to flow out of B)

T (h)	h_a	h_b	$h_a - h_b$	Q_a	Volume Out of A (theoric) $Q_a \Delta t$	PCP in A	PCP in B	Discharge out of B Q_b	Volume out of B (theoric) $Q_b \Delta t$	Δh_a (theoric)	Actual Δh_a	Volume out of A	Δh_b (theoric)	Actual Δh_b
0	13.0	8.0	5.0	40.00	864000.0	600.0	300.0	0.0	0.0	-863.4	-5.0	-5000.0	10.6	10.6
6	8.0	18.6	-10.6	0.00	0.0	600.0	300.0	60.0	1296000.0	0.6	0.6	600.0	-2592.6	-10.6
12	8.6	8.0	0.6	0.04	864.0	600.0	300.0	0.0	0.0	-0.3	-0.3	-264.0	1.1	1.1
18	8.3	9.1	-0.8	0.00	0.0	600.0	300.0	0.2	3654.7	0.6	0.6	600.0	-7.9	-1.1
24	8.9	8.0	0.9	0.06	1347.8	600.0	300.0	0.0	0.0	-0.7	-0.7	-747.8	2.1	2.1
30	8.2	10.1	-1.9	0.00	0.0	600.0	300.0	0.3	6790.0	0.6	0.6	600.0	-14.2	-2.1
36	8.8	8.0	0.8	0.05	1135.0	600.0	300.0	0.0	0.0	-0.5	-0.5	-535.0	1.7	1.7
42	8.3	9.7	-1.4	0.00	0.0	600.0	300.0	0.3	5410.5	0.6	0.6	600.0	-11.4	-1.7
48	8.9	8.0	0.9	0.06	1228.6	600.0	300.0	0.0	0.0	-0.6	-0.6	-628.6	1.9	1.9
54	8.2	9.9	-1.6	0.00	0.0	600.0	300.0	0.3	6017.5	0.6	0.6	600.0	-12.6	-1.9
60	8.8	8.0	0.8	0.05	1187.4	600.0	300.0	0.0	0.0	-0.6	-0.6	-587.4	1.8	1.8
66	8.2	9.8	-1.5	0.00	0.0	600.0	300.0	0.3	5750.4	0.6	0.6	600.0	-12.1	-1.8
72	8.8	8.0	0.8	0.06	1205.5	600.0	300.0	0.0	0.0	-0.6	-0.6	-605.5	1.8	1.8
78	8.2	9.8	-1.6	0.00	0.0	600.0	300.0	0.3	5867.9	0.6	0.6	600.0	-12.3	-1.8
84	8.8	8.0	0.8	0.06	1197.6	600.0	300.0	0.0	0.0	-0.6	-0.6	-597.6	1.8	1.8
90	8.2	9.8	-1.6	0.00	0.0	600.0	300.0	0.3	5816.2	0.6	0.6	600.0	-12.2	-1.8
96	8.8	8.0	0.8	0.06	1201.1	600.0	300.0	0.0	0.0	-0.6	-0.6	-601.1	1.8	1.8
102	8.2	9.8	-1.6	0.00	0.0	600.0	300.0	0.3	5839.0	0.6	0.6	600.0	-12.3	-1.8
108	8.8	8.0	0.8	0.06	1199.5	600.0	300.0	0.0	0.0	-0.6	-0.6	-599.5	1.8	1.8



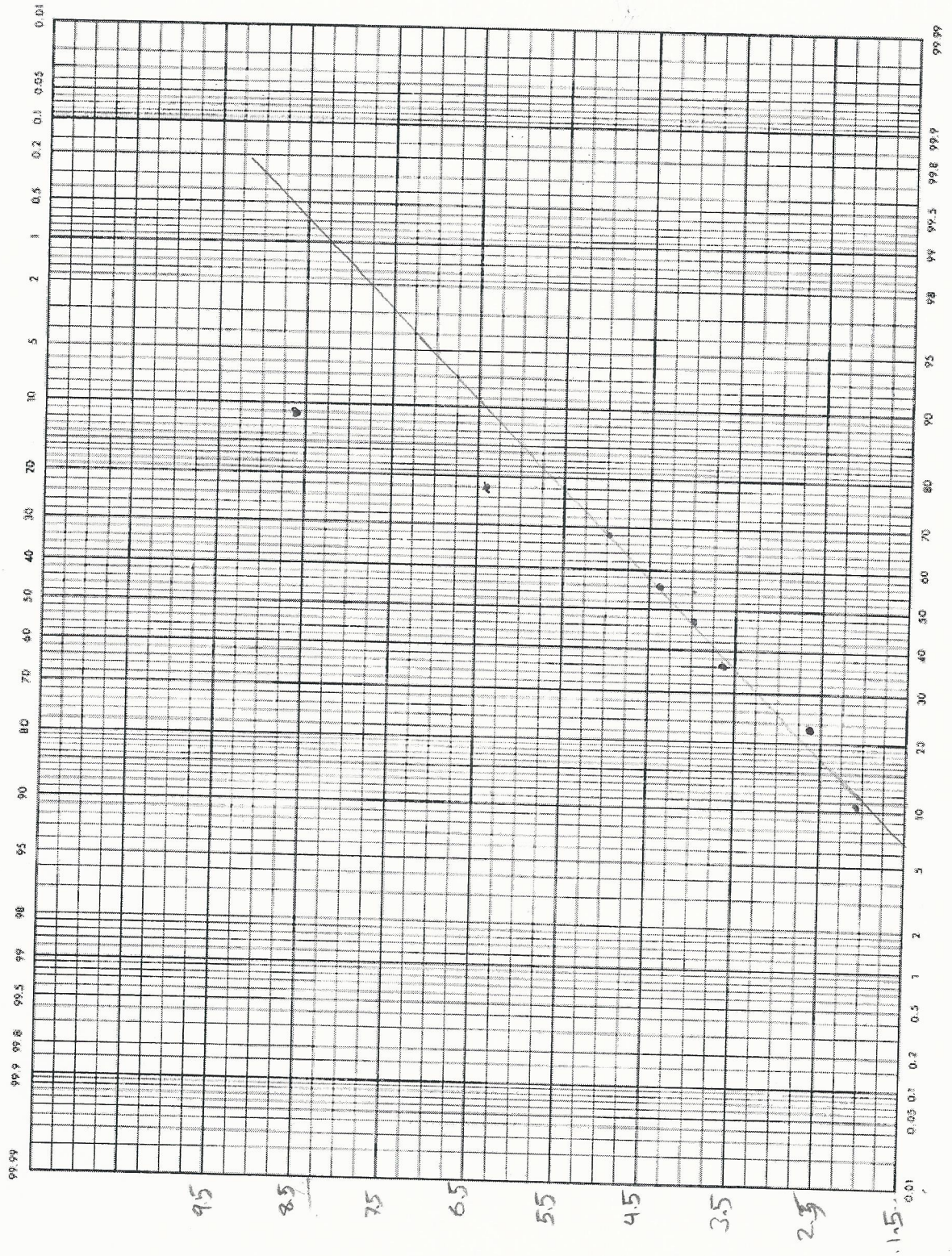
Note: the oscillations are due to the large time step; the solution would be smooth with shorter time scales (and therefore more iterations)

SOLUTION PROBLEM 3 (30 pts)

Rank (i)	Value	Exceedance probability (Weibull)
1	8.62	0.11111111
2	6.43	0.22222222
3	5.01	0.33333333
4	4.49	0.44444444
5	3.99	0.55555556
6	3.59	0.66666667
7	2.55	0.77777778
8	2.13	0.88888889

PROBLEM 3

CVG3120-HYDROLOGY
PROF. SEIDOU OUSMANE



$T = \frac{1}{100} \Rightarrow p = 0.01 = 1\% \longrightarrow x = 8.25$ in

Probability exceedance of 7 in = 5%

Problem 4 (a)

Runoff volume : $V_a = P - S\left(12 - \frac{S}{P + 0.8S}\right)$

$S = \frac{1000}{CN - 10}$

Wooded : CN = 55 for soil B, CN = 70 for Soil C (30%, 70%)

$CN = 0.3 \times 55 + 0.7 \times 70 = \underline{66}$

Residential : CN = 75 for soil B, CN = 83 for soil C

$CN = (0.3 \times 75) + (0.7 \times 83) = \underline{81}$

Mean CN : $(0.4 \times 66) + (0.6 \times 81) = 75$

$S = \frac{1000}{75} - 10 = 3.33$

$V_a = 7 - 3.33\left(12 - \frac{3.33}{7 + (0.8 \times 3.33)}\right)$

$= 5.80$ in

b) the percent of imperviousness is divided by two

$$CN_w = CN_p(1-f) + f(98)$$

Soil b : $61(0.81) + 0.19 \times 98 = \boxed{68}$

Soil c : $74(0.81) + 0.19 \times 98 = \boxed{79}$

wooded : $CN = 65.5$

Residential : $CN = 68$ for soil B, $CN = 79$ for soil C

$$CN = (0.3 \times 68) + (0.7 \times 79) = 76$$

Mean CN : $(0.4 \times 66) + (0.6 \times 76) = 72$

$$S = \frac{1000}{72} - 10 = 3.89$$

$$V_a = 7 - 3.89\left(12 - \frac{3.89}{7 + (0.8 \times 3.89)}\right)$$

$$= 5.69 \text{ in}$$

c) 50 % of imperviousness is disconnected.

$$CN_c = CN_p + I_f (98 - CN_p)(1 - 0.5R)$$

soil b : $61 + 0.38(98 - 61)(1 - 0.5(0.5)) = 72$

soil c : $74 + 0.38(98 - 61)(1 - 0.5(0.5)) = 85$

Wooded : $CN = 66$

Residential $CN = 72$ for soil B, $CN = 85$ for soil C

$CN = (0.3 \times 72) + (0.7 \times 85) = 81$

Mean CN $(0.4 \times 66) + (0.6 \times 81) = 75$

$$S = \frac{1000}{75} - 10 = 3.33$$

$$V_a = 7 - 3.33 \left(12 - \frac{3.33}{7 + (0.8 \times 3.33)}\right)$$

$= 5.80$ in.