Benha University
Faculty of Engineering at Shoubra
Civil Engineering Department
Water Resources and Hydraulics Engineering

Mid 2nd Term Exam, 20 Marks
Date: 5 / 4 / 2018
Water Resources Management
MSc, CVE 609, Duration: 1 hour

Question (1) *(8 Marks)*

A- *State True or False & Correct the False* (4*1 = 4 Marks)

1) The hydrological cycle describes the movement of water above the earth surface.
2) The total volume of water in the world is varying due to climate changes.
3) A double mass curve is used to determine the data of a specific rain gauge.
4) An isohyet is a line that has constant values for the rain.

B- During three months, a catchment received 384 mm of rain with evapo-transpiration of 105 mm and losses to groundwater of 30 mm. The catchment area is 40 km^2 with a population of 150,000 capita and a min consumptive use of 180 Lit/capita/day. (2*2 = 4 Marks)

1) What is the expected runoff?
2) Is this water sufficient for a year?

Question (2) *(12 Marks)*

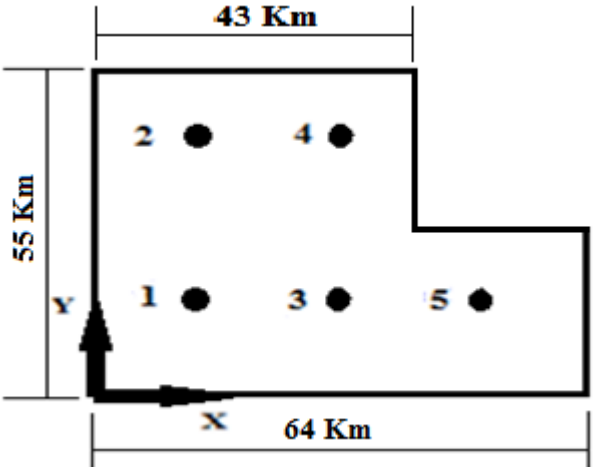
A- For the data in the table: (4+3 = 7 Marks)

1) Draw the hyetograph? 2) Determine the accumulated depth at 9:15?

Time	8:00	8:21	8:33	8:56	9:26	10:06
Accumulated depth (mm)	0	3	23	56	110	145

B- A catchment has 5 rain stations that are located as shown in the figure. (5 Marks)
Employing Thiessen polygon method with horizontal and vertical lines only, calculate the average rainfall depth?

Station No	**X_i (km)**	**Y_i (km)**	**P_i (mm)**
1	10	15	44
2	10	45	55
3	32	15	48
4	32	45	58
5	54	15	52



Best Wishes ***Dr. Alaa El-Hazek***

A Model Answer **MSc, (609), 5 / 4 / 2018**

Question (1) **(8 Marks)**

A- (4*1 = 4 Marks)

1	The hydrological cycle describes the movement of water above the earth surface.	F	below & above
2	The total volume of water in the world is varying due to climate changes.	F	constant
3	A double mass curve is used to determine the data of a specific rain gauge.	F	check
4	An isohyet is a line that has constant values for the rain.	T	---

B- (2*2 = 4 Marks)

1) $\Delta S = P - R - G - ET$

Assume, $\Delta S = 0$

$R = P - G - ET = 384 - 105 - 30 = 249$ mm

$R = 0.249*(40*10^6) = 9.96*10^6$ m^3

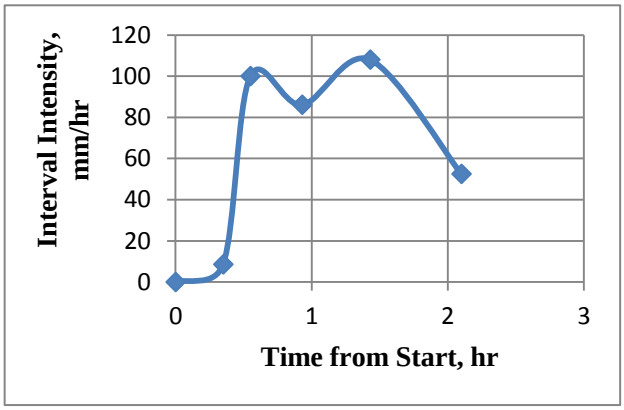
2) Consumptive use = $(9.96*10^9 / 150{,}000) / 365 = 181.9$ Lit/capita/day

This water is sufficient for a year.

Question (2) **(12 Marks)**

A- 1) (4+3 = 7 Marks)

Time	Acc. Depth, mm	Interval Depth, mm	Interval Time, hr	Time from Start, hr	Interval Intensity mm/hr
08:00	0			0	0
08:21	3	3	0.35	0.35	8.6
08:33	23	20	0.2	0.55	100
08:56	56	33	0.38	0.93	86.8
09:26	110	54	0.5	1.43	108
10:06	145	35	0.67	2.1	52.2



2) At 9:15, Time from start = 1.25

From the curve, the interval intensity = 103 mm/hr

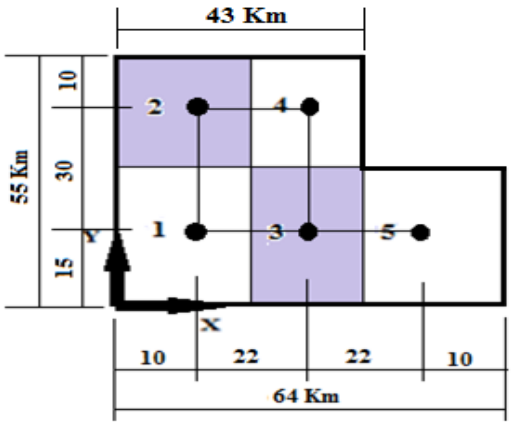
The interval intensity = Interval depth / interval time

The interval depth = the interval intensity * interval time = 103 * (19 / 60) = 32.6 mm

The accumulated depth = 32.6 + 56 = 88.6 mm

B- (5 Marks)

Station No	X_i (km)	Y_i (km)	P_i (mm)	Area (Km^2)
1	10	15	44	21*30 = 630
2	10	45	55	21*25 = 525
3	32	15	48	22*30 = 660
4	32	45	58	22*25 = 550
5	54	15	52	21*30 = 630
				A_T = 2,995



P = (44*630) + (55*525) + (48*660) + (58*550) + (52*630) / 2,995 = 51.1 mm

Benha University
Faculty of Engineering at Shoubra
Civil Engineering Department
Water Resources and Hydraulics Engineering

Mid 2nd Term Exam, 20 Marks
Date: 5 / 4 / 2018 (San. Eng.)
Water Resources Management
MSc, CVE 609, Duration: 1 hour

Question (1) *(8 Marks)*

A- *State True or False & Correct the False* (4*1 = 4 Marks)

1) The hydrological cycle describes the movement of water above the earth surface.
2) The total volume of water in the world is varying due to climate changes.
3) A double mass curve is used to determine the data of a specific rain gauge.
4) An isohyet is a line that has constant values for the rain.

B- During three months, a catchment received 633 mm of rain with evapo-transpiration of 105 mm and losses to groundwater of 30 mm. The catchment area is 40 km^2 with a population of 300,000 capita and a min consumptive use of 180 Lit/capita/day. (2*2 = 4 Marks)

1) What is the expected runoff?
2) Is this water sufficient for a year?

Question (2) *(12 Marks)*

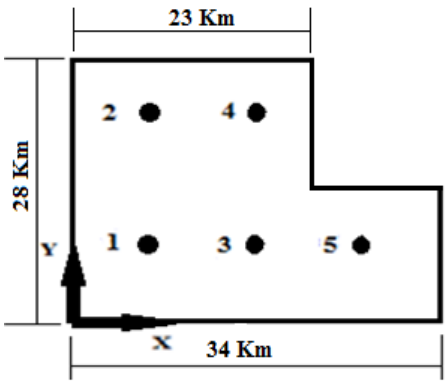
A- For the data in the table: (4+3 = 7 Marks)

1) Draw the hyetograph? 2) Determine the accumulated depth at 7:15?

Time	6:00	6:21	6:33	6:56	7:26	8:06
Accumulated depth (mm)	0	3	23	56	110	145

B- A catchment has 5 rain stations that are located as shown in the figure. (5 Marks)
Employing Thiessen polygon method with horizontal and vertical lines only, calculate the average rainfall depth?

Station No	**X_i (km)**	**Y_i (km)**	**P_i (mm)**
1	5	8	44
2	5	23	55
3	17	8	48
4	17	23	58
5	29	8	52



Best Wishes ***Dr. Alaa El-Hazek***

A Model Answer **MSc, (609), 5 / 4 / 2018** **(San. Eng.)**

Question (1) **(8 Marks)**

A- (4*1 = 4 Marks)

1	The hydrological cycle describes the movement of water above the earth surface.	F	below & above
2	The total volume of water in the world is varying due to climate changes.	F	constant
3	A double mass curve is used to determine the data of a specific rain gauge.	F	check
4	An isohyet is a line that has constant values for the rain.	T	---

B- (2*2 = 4 Marks)

1) $\Delta S = P - R - G - ET$

Assume, $\Delta S = 0$

$R = P - G - ET = 633 - 105 - 30 = 498$ mm

$R = 0.498*(40*10^6) = 19.92*10^6$ m^3

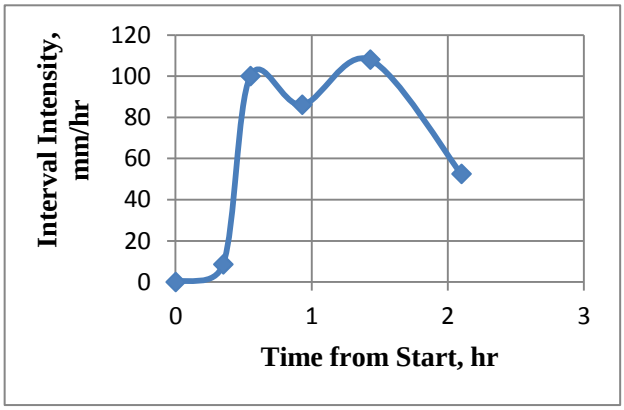
2) Consumptive use = $(19.92*10^9 / 300{,}000) / 365 = 181.9$ Lit/capita/day

This water is sufficient for a year.

Question (2) **(12 Marks)**

A- 1) (4+3 = 7 Marks)

Time	Acc. Depth, mm	Interval Depth, mm	Interval Time, hr	Time from Start, hr	Interval Intensity mm/hr
06:00	0			0	0
06:21	3	3	0.35	0.35	8.6
06:33	23	20	0.2	0.55	100
06:56	56	33	0.38	0.93	86.8
07:26	110	54	0.5	1.43	108
8:06	145	35	0.67	2.1	52.2



2) At 7:15, Time from start = 1.25

From the curve, the interval intensity = 103 mm/hr

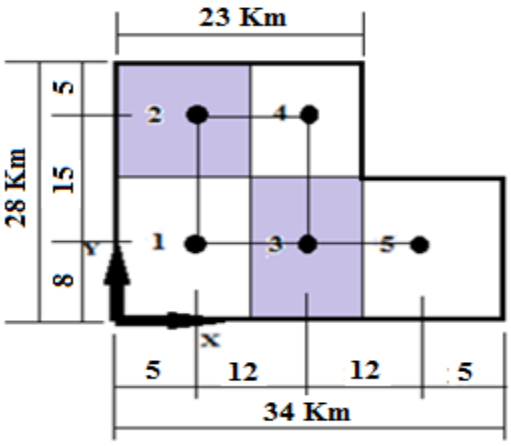
The interval intensity = Interval depth / interval time

The interval depth = the interval intensity * interval time = 103 * (19 / 60) = 32.6 mm

The accumulated depth = 32.6 + 56 = 88.6 mm

B- (5 Marks)

Station No	X_i (km)	Y_i (km)	P_i (mm)	Area (Km^2)
1	5	8	44	11*15.5 = 170.5
2	5	23	55	11*12.5 = 137.5
3	17	8	48	12*15.5 = 186
4	17	23	58	12*12.5 = 150
5	29	8	52	11*15.5 = 170.5
				A_T = 814.5



P = (44*170.5) + (55*137.5) + (48*186) + (58*150) + (52*170.5)/814.5 = 41,558.5/814.5 = 51 mm

Benha University
Faculty of Engineering at Shoubra
Civil Engineering Department
MSc, Water Resources and Hydraulics Eng

Final 2nd Term Exam
Date: 12 / 5 / 2018
Water Resources Management
CVE 609 Duration : 3 hours

- Answer all the following questions.
- Illustrate your answers with sketches when necessary.
- No. of questions: 3
- Total Mark: 60 Marks

Question (1) (10+10 = 20 Marks)

A- *State True or False & Correct the False:*

1) In all areas, the porosity is less than 1.
2) For dry soil, the soil moisture content = the porosity.
3) Horton's equation assumes that infiltration rate increases with time.
4) Permeability is a property of the porous media only, not the fluid.
5) The water table is the level at which the groundwater pressure is equal to atmospheric pressure.
6) The pressure head in a confined aquifer is represented by the piezometric surface.
7) An artesian spring is formed where the ground surface falls below the piezometric surface.

B- The cumulative annual precipitation (2010 – 2017), mm, for gauge A and the average of some other gauges is shown in the table.

Year	2010	2011	2012	2013	2014	2015	2016	2017
Average Gauges	37	73	114	150	184	238	282	314
Gauge A	33	61	94	124	148	206	252	283

1) Draw the double mass curve?
2) What is the annual precipitation for gauge A at the year 2011?
3) Determine the date of the variation of gauge A?
4) Find a correction ratio to adjust incorrect values?
5) Calculate the correct cumulative precipitation for gauge A at the year 2016?

Question (2) (10+10 = 20 Marks)

A- For a catchment, the initial and final infiltration capacities are 3.5 and 0.6 mm/hr with time constant of 4.1 hr^{-1}.

$f_t = f_c + (f_0 - f_c)e^{-kt}$	$F = f_c T + (1/k)(f_0 - f_c)(1 - e^{-kT})$

1) Determine the infiltration rates after 0, 10 min, 20 min, 1 hr, 1.5 hr and 2 hr?
2) Find the total volume of infiltration over the 2 – hr period?

B- The given table shows the rainfall data for a watershed that is 560 acre and has 228.7 acre-ft volume of runoff. Determine the ϕ - index for the watershed?

Time, hr	0 – 2	2 – 5	5 – 7	7 – 10	10 – 12
Rainfall intensity, in/hr	1.4	2.3	1.1	0.7	2.75

Question (3) (10+10 = 20 Marks)

A- A 16 inch diameter well supplies 0.5 cfs to a small farm. The well completely penetrates a 60 ft thick unconfined aquifer. The drawdown in the well is 10 ft and the radius of influence is 1500 ft in the current steady-state operation. The farm would like to increase the pumping rate to 0.67 cfs with well drawdown of 14 ft. Determine whether the new situation will or will not affect the farm's neighbor 2000 ft away?

$$Q = (\pi K)\frac{(h1^2 - ho^2)}{ln\frac{r1}{ro}}$$

B- A well fully penetrates a 25 m thick confined aquifer. After a long period of pumping at a constant rate of 0.05 m^3/sec, the drawdown at distances of 50 m and 150 m from the well were observed to be 3 m and 1.2 m, respectively. Find the transmissivity?

$$Q = (2\pi bK)\frac{(h1 - ho)}{ln\frac{r1}{ro}}$$

Examiners Board: ***Dr. Alaa El-Hazek***

A Model Answer MSc, (609), 12 / 5 / 2018

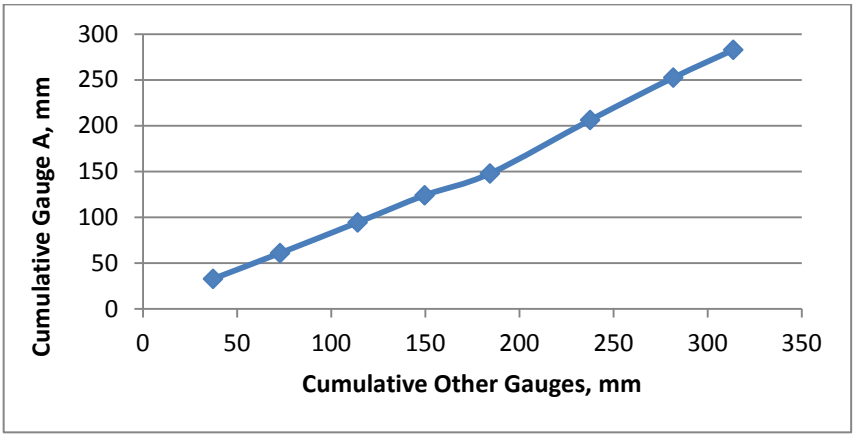
Question (1) (10+10 = 20 Marks)

A-

1	In all areas, the porosity is less than 1.	T	---
2	For dry soil, the soil moisture content = the porosity.	F	saturated
3	Horton's equation assumes that infiltration rate increases with time.	F	decreases
4	Permeability is a property of the porous media only, not the fluid.	T	---
5	The water table is the level at which the groundwater pressure is equal to atmospheric pressure.	T	---
6	The pressure head in a confined aquifer is represented by the piezometric surface.	T	---
7	An artesian spring is formed where the ground surface falls below the piezometric surface.	T	---

B-

1) The double mass curve.



2) At the year 2011, $P_A = 61 - 33 = 28$ mm
3) The variation of gauge A starts at the year 2014.
4) Original Slope = (124 – 33) / (150 – 37) = 91 / 113 = 0.81
   Varied Slope = (283 – 148) / (314 – 184) = 135 / 130 = 1.04
   Correction Ratio = 0.81 / 1.04 = 0.78
5) The correct cumulative precipitation for gauge A at the year 2016 = 252*0.78 ≈ 197 mm

Question (2) (10+10 = 20 Marks)

A-

1) $f_t = f_c + (f_0 - f_c)e^{-kt}$

t, hr	0	0.167	0.333	1	1.5	2
f_t, mm/hr	3.5	2.04	1.35	0.648	0.606	0.601

2) $F = f_c T + (1/k)(f_0 - f_c)(1 - e^{-kT})$

F = 1.91 mm

B- Q = Volume / Area = (228.7*12) / 560 = 4.9 in

Area above the ϕ - index = 4.9 in

2(1.4 - ϕ) + 3(2.3 - ϕ) + 2(1.1 - ϕ) + 3(0.7 - ϕ) + 2(2.75 - ϕ) = 4.9

Try ϕ = 1.5

3(2.3 – 1.5) + 2(2.75 – 1.5) = 4.9

ϕ = 1.5 inch/hr

Question (3) (10+10 = 20 Marks)

A- r_o = 8 in Q = 0.5 cfs r_1 = 1500 ft

h_1 = 60 ft $h_1 - h_o$ = 10 ft h_o = 60 – 10 = 50 ft

$0.5 = (\pi * k)\frac{(60^2-50^2)}{ln\frac{1500}{8/12}}$ k = 0.00112 ft/s

r_o = 8 in Q = 0.67 cfs h_1 = 60 ft

$h_1 - h_o$ = 14 ft h_o = 60 – 14 = 46 ft

$0.67 = (\pi * o.00112)\frac{(60^2-46^2)}{ln\frac{r1}{8/12}}$ r_1 = 1609.98 ft ≈ 1610 ft < 2000 ft

The new situation will not affect the farm's neighbor 2000 ft away.

B- Q = 0.05 m^3/s $h_2 - h_1$ = 3 – 1.2 = 1.8 m

r_1 = 50 m r_2 = 150 m b = 25 m

$$Q = (2\pi bK)\frac{(h2-h1)}{ln\frac{r2}{r1}}$$

$$0.05 = (2\pi * 25 * K)\frac{(1.8)}{ln\frac{150}{50}}$$

K = $1.9*10^{-4}$ m/s

T = K * b = $1.9*10^{-4}$ * 25 = 0.00475 m^2/s