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

**Mid 2nd Term Exam, 50 Marks**
**Date: 18 / 4 / 2017**
**Water Resources Management**
**MSc, CVE 609, Duration: 1 hour**

## Question (1) *(20 Marks)*

**A-** *State True or False & Correct the False* *(5*2 = 10 Marks)*

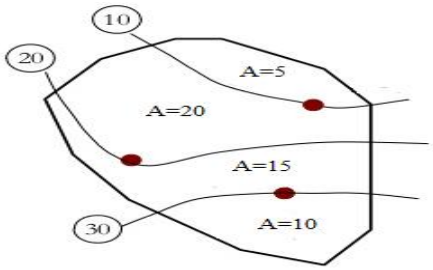
1) The hydrological cycle describes the movement of water below the earth surface.
2) The total volume of water in the world is varying due to climate changes.
3) Runoff is the variety of ways by which water moves under the land.
4) A double mass curve is used to determine the data of a specific rain gauge.
5) An isohyet is a line that has different values for the rain.

**B-** During two months, a catchment received 254 mm of rain with evapo-transpiration of 85 mm and losses to groundwater of 20 mm. The catchment area is 65 $km^2$. *(2*5 = 10 Marks)*

1) What is the expected runoff (liters)?
2) If the water use is 160 liters / person / day, how many people can be served by this water?

## Question (2) *(30 Marks)*

**A-** Find the average rainfall depth? *(10 Marks)*




**B-**Draw the hyetograph? *(20 Marks)*

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

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

***A Model Answer*** **MT - MSc, (609), 18 / 4 / 2017**

**Question (1)** **(20 Marks)**

**A-** *(5*2 = 10 Marks)*

| | | | |
|---|---|---|---|
| 1 | The hydrological cycle describes the movement of water below the earth surface. | F | below & above |
| 2 | The total volume of water in the world is varying due to climate changes. | F | constant |
| 3 | Runoff is the variety of ways by which water moves under the land. | F | across |
| 4 | A double mass curve is used to determine the data of a specific rain gauge. | F | check |
| 5 | An isohyet is a line that has different values for the rain. | F | constant |

**B-** *(2*5 = 10 Marks)*

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

Assume, $\Delta S = 0$

$R = P - G - ET = 254 - 85 - 20 = 149$ mm

$R = 0.149*(65*10^6)*10^3 = 9.685*10^9$ lit

**2)** No of people = $9.685*10^9 / (160*60) = 1{,}008{,}854$ Capita

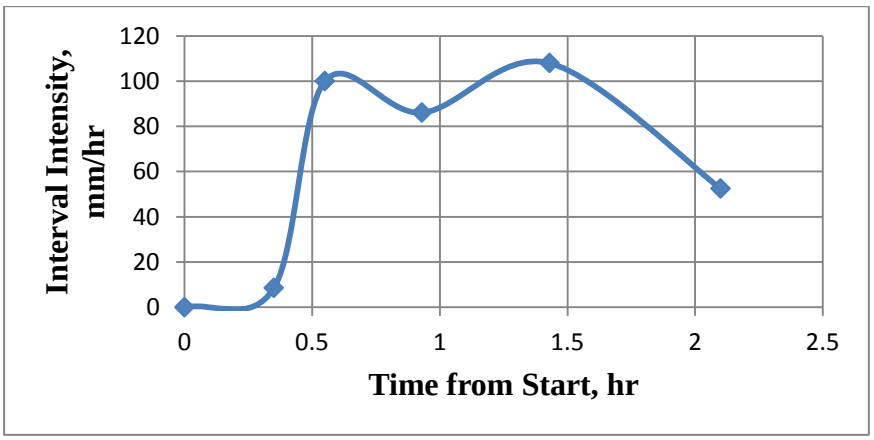
**Question (2)** **(30 Marks)**

**A-** P = [(5*5) + (20*15) + (15*25) + (10*35)] / 50 *(10 Marks)*

P = 21 mm

**B-** *(20 Marks)*

| Time | Accumulated 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 | 8.57 |
| 08:33 | 23 | 20 | 0.2 | 0.55 | 100 |
| 08:56 | 56 | 33 | 0.38 | 0.93 | 86.09 |
| 09:26 | 110 | 54 | 0.5 | 1.43 | 108 |
| 10:06 | 145 | 35 | 0.67 | 2.1 | 52.5 |



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

**Final 2nd Term Exam**
**Date: 20 / 5 / 2017**
**Water Resources Management**
**CVE 609**
**Duration : 3 hours**

- Answer all the following questions.
- Illustrate your answers with sketches when necessary.
- No. of questions: 4 (Two Pages)
- Total Mark: 200 Marks

**Question (1)** (25+25 = 50 Marks)

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

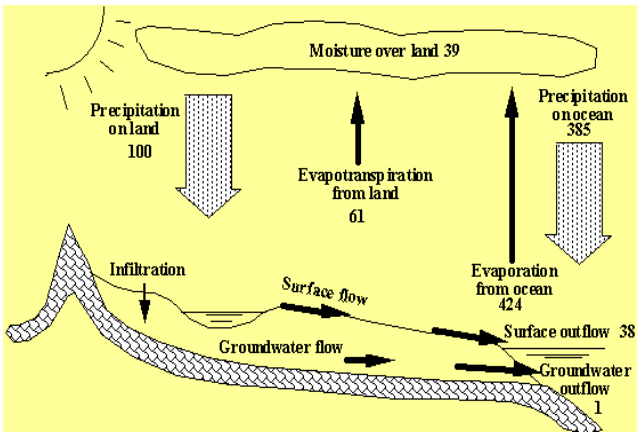
1) The surface runoff for clay more than that for sand.
2) In some areas, the porosity = 1.
3) For dry soil, the soil moisture content = the porosity.
4) Horton's equation assumes that infiltration rate is varied with time.
5) Permeability is a property of the porous media only, not the fluid.

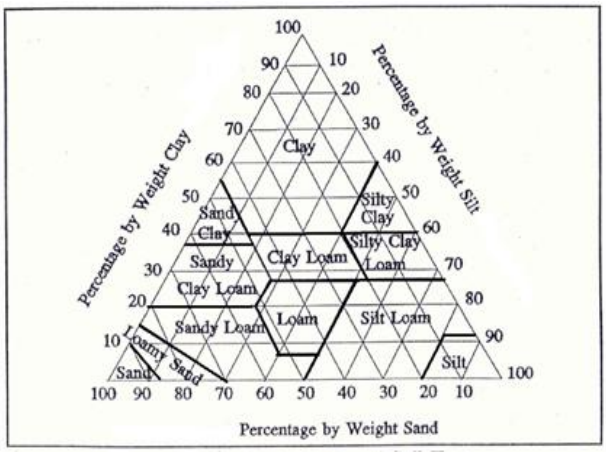
**B-** The cumulative annual precipitation (2009 – 2016), mm, for gauge A and the average of some other gauges is shown in the table.

1) Draw the double mass curve?
2) What is the annual precipitation for gauge A at the year 2010?
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 2015?

| Year | Average Gauges | Gauge A |
|---|---|---|
| 2009 | 37 | 33 |
| 2010 | 73 | 61 |
| 2011 | 114 | 94 |
| 2012 | 150 | 124 |
| 2013 | 184 | 148 |
| 2014 | 238 | 206 |
| 2015 | 282 | 252 |
| 2016 | 314 | 283 |

**Question (2)** (30+20 = 50 Marks)




**A-** From the figure, show water balance:
1) In the atmosphere?
2) On land?
3) Over oceans and seas?

**B-** From the figure, find the soil texture for:
1) Combination 10% sand, 85% silt, 5% clay?
2) Combination 40% sand, 30% silt?

**Question (3)** (25+20+5 = 50 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 $hr^{-1}$.

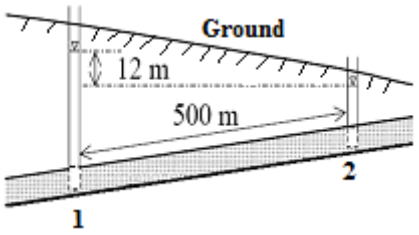
| $f_t = f_c + (f_0 - f_c)e^{-kt}$ | $F = f_c T + (1/k)(f_0 - f_c)(1 - e^{-kT})$ |
|---|---|

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

**C-** For the confined aquifer with two piezometers shown in the figure, what is direction of the groundwater flow? Why?




**Question (4)** (25+25 = 50 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.

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

Determine whether the new situation will or will not affect the farm's neighbor 2000 ft away?

**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.

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

Find the transmissivity?

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

## *A Model Answer* **Final - MSc, (609), 20 / 5 / 2017**

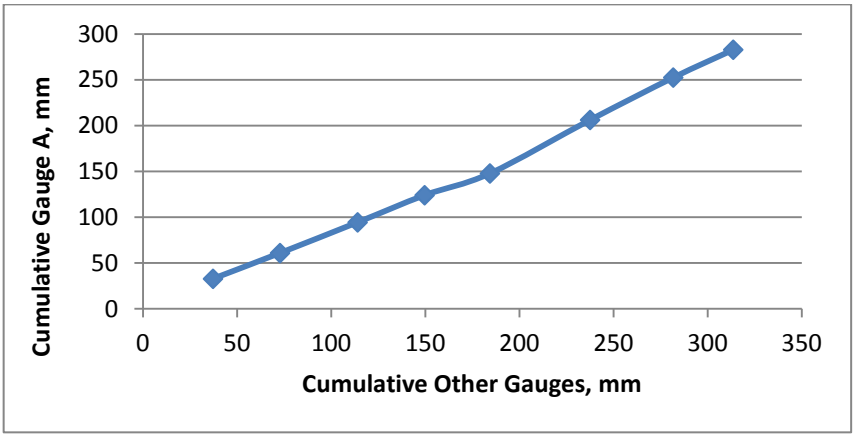
**Question (1)** (25+25 = 50 Marks)

**A-**

| | | | |
|---|---|---|---|
| 1 | The surface runoff for clay more than that for sand. | T | |
| 2 | In some areas, the porosity = 1. | F | porosity ≤ 0.75 (≠1) |
| 3 | For dry soil, the soil moisture content = the porosity. | F | saturated |
| 4 | Horton's equation assumes that infiltration rate is varied with time. | T | |
| 5 | Permeability is a property of the porous media only, not the fluid. | T | |

**B-**

1) The double mass curve.




| Year | Average Gauges | Gauge A |
|---|---|---|
| 2009 | 37 | 33 |
| 2010 | 73 | 61 |
| 2011 | 114 | 94 |
| 2012 | 150 | 124 |
| 2013 | 184 | 148 |
| 2014 | 238 | 206 |
| 2015 | 282 | 252 |
| 2016 | 314 | 283 |

2) At the year 2010, $P_A = 61 - 33 = 28$ mm

3) The variation of gauge A starts at the year 2013.

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 2015 = 252*0.78 ≈ 197 mm

**Question (2)** (30+20 = 50 Marks)

**A-**

1) In the atmosphere:
P = ET
100 + 385 = 61 + 424

2) On land:
P = ET + R + G
100 = 61 + 38 + 1

3) Over oceans and seas:
P + R + G = E
*385 + 38 + 1 = 424*

**B-**

1) Silt

2) Clay loam

**Question (3)** (25+20+5 = 50 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

**C-** The direction of the groundwater flow is from point (1) to point (2).
Because $H_1 > H_2$ (or $E_2 > E_1$).

**Question (4)** (25+25 = 50 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 $m^2/s$

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**Water Resources and Hydraulics Engineering**

**Mid 2nd Term Exam, 50 Marks**
**Date: 2 / 5 / 2017**
**Special Studies in Water Resources Eng.**
**Ph D, CVE 713, Duration : 1 hours**

## Question (1) *(20 Marks)*

**A-** *State True or False & Correct the False* *(5*2 = 10 Marks)*

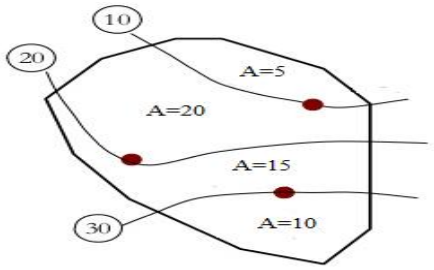
1) The total volume of water in the world is varying due to climate changes.
2) Water lost due to transpiration is greater than water lost due to evaporation.
3) Evaporation from oceans is greater than evaporation from the land.
4) In South Africa, evaporation in January is smaller than evaporation in August.
5) Water as surface runoff moves due to kinetic energy.

**B-** During three months, a catchment received 381 mm of rain with evapo-transpiration of 128 mm and losses to groundwater of 30 mm. The catchment area is 65 $km^2$, and 63 mm of the water is to be stored. *(2*5 = 10 Marks)*

1) What is the expected runoff (liters)?
2) If the water use is 160 liters / person / day, how many people can be served by this water?

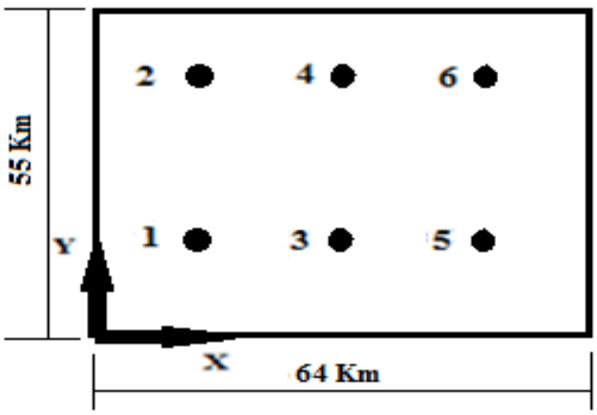
## Question (2) *(30 Marks)*

**A-** Find the average rainfall depth? *(10 Marks)*




**B-** A catchment has 6 rain stations that are located as shown in the figure. *(20 Marks)*
Using horizontal and vertical lines only, calculate the average rainfall depth employing Thiessen polygon method?

| 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 |
| 6 | 54 | 45 | 59 |




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

## *A Model Answer* **MT - Ph D, (713), 2 / 5 / 2017**

**Question (1)** (20 Marks)

**A-** (5*2 = 10 Marks)

| | | | |
|---|---|---|---|
| 1 | The total volume of water in the world is varying due to climate changes. | F | constant |
| 2 | Water lost due to transpiration is greater than water lost due to evaporation. | F | smaller |
| 3 | Evaporation from oceans is greater than evaporation from the land. | T | --- |
| 4 | In South Africa, evaporation in January is smaller than evaporation in August. | F | greater |
| 5 | Water as surface runoff moves due to kinetic energy. | F | potential energy (gravity) |

**B-** (2*5 = 10 Marks)

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

$R = P - G - ET - \Delta S = 381 - 128 - 30 - 63 = 160$ mm

$R = 0.16*(65*10^6)*10^3 = 10.4*10^9$ lit

**2)** No of people = $10.4*10^9 / (160*90) = 722{,}222$ Capita

**Question (2)** (30 Marks)

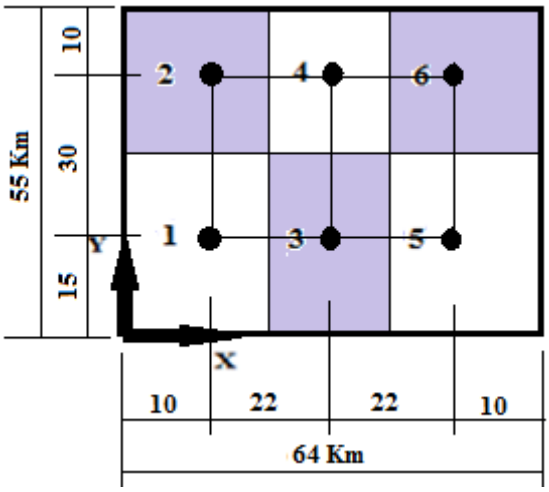
**A-** $P = [(5*5) + (20*15) + (15*25) + (10*35)] / 50$ (10 Marks)

$P = 21$ mm

**B-** (20 Marks)

***Thiessen Method***

| 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 |
| 6 | 54 | 45 | 59 | 21*25 = 525 |
| | | | | $A_T = 3520$ |




$P = (44*630) + (55*525) + (48*660) + (58*550) + (52*630) + (59*525) / 3520 = 52.25$ mm

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**Civil Engineering Department**
**PhD, Water Resources and Hydraulics Engineering**

**Final 2nd Term Exam**
**Date: 20 / 5 / 2017**
**Special Studies in Water Resources Engineering**
**CVE 713 Duration : 3 hours**

- Answer all the following questions.
- Illustrate your answers with sketches when necessary.
- The exam consists of two pages.
- No. of questions: 4
- Total Mark: 200 Marks

**Question (1)** (25+25 = 50 Marks)

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

1) Horton's equation assumes that infiltration rate is varied with time.
2) Evapo-transpiration is the loss of water from a vegetated surface through the combined processes of soil evaporation and plant transpiration.
3) When infiltration capacity exceeds the rainfall intensity, there will be surface runoff.
4) An aquifer is an impermeable water-bearing geologic formation.
5) The well is an artesian if the ground surface rises above the piezometric surface.

**B-** The cumulative annual precipitation (2009 – 2016), mm, for gauge A and the average of some other gauges is shown in the table.

6) Draw the double mass curve?
7) What is the annual precipitation for gauge A at the year 2010?
8) Determine the date of the variation of gauge A?
9) Find a correction ratio to adjust incorrect values?
10) Calculate the correct cumulative precipitation for gauge A at the year 2015?

| Year | Average Gauges | Gauge A |
|---|---|---|
| 2009 | 37 | 33 |
| 2010 | 73 | 61 |
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| 2015 | 282 | 252 |
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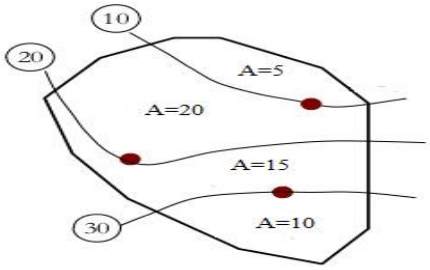
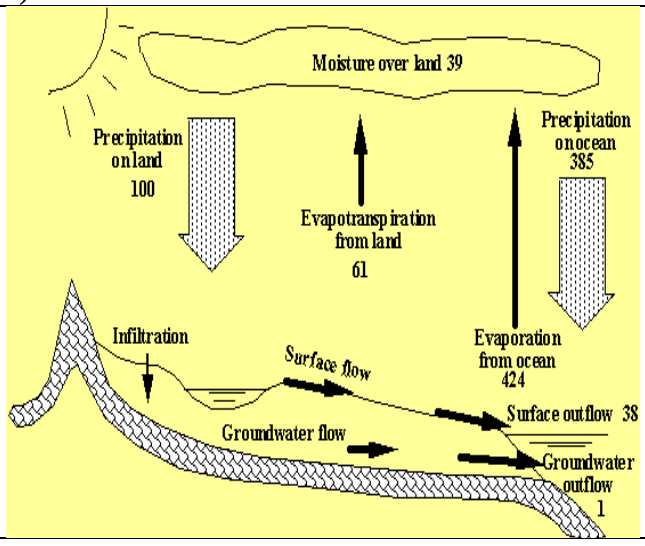
**Question (2)** (20 + 30 = 50 Marks)

**A-** Find the average rainfall depth?



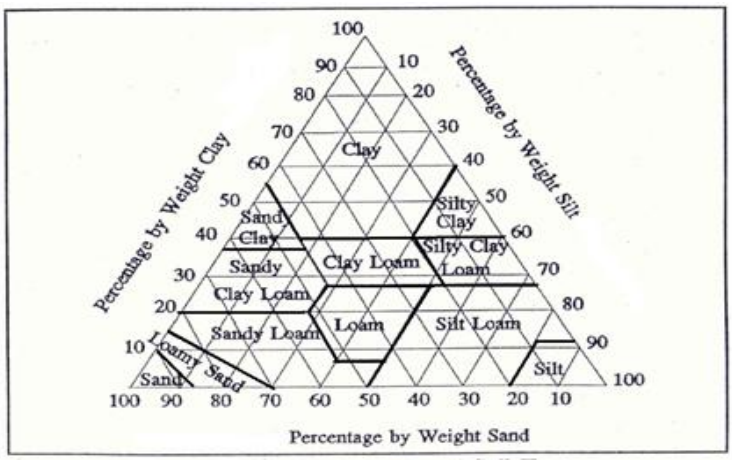

**B-** From the figure, show water balance:
1) In the atmosphere?
2) On land?
3) Over oceans and seas?



**Question (3)** (20 + 25 + 5 = 50 Marks)

**A-** From the figure, find the soil texture for the following combinations:

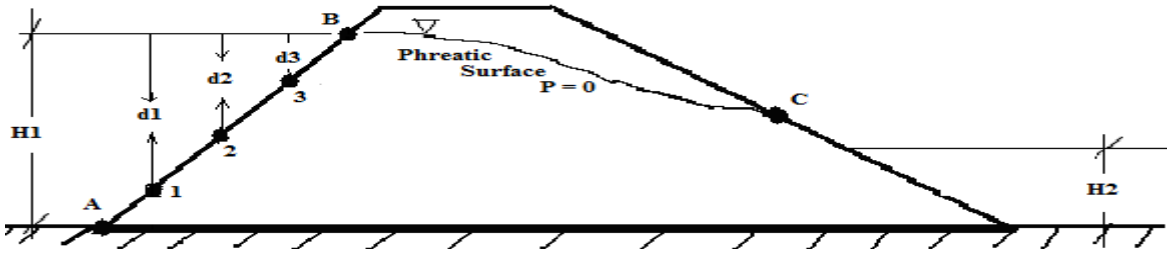
1) 10% sand, 85% silt, 5% clay?
2) 40% sand, 30% silt?




**B-** The 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 | Rainfall intensity, in/hr |
|---|---|
| 0 – 2 | 1.4 |
| 2 – 5 | 2.3 |
| 5 – 7 | 1.1 |
| 7 – 10 | 0.7 |
| 10 – 12 | 2.75 |

**C-** For the dam shown in the figure, show that the piezometric head ($h = (P/\rho g) + z$) on the surface AB = $H_1$ at any point on the surface (i.e. show that $h_1 = h_2 = h_3 = H_1$)?




**Question (4)** (20 + 30 = 50 Marks)

**A-** An unconfined aquifer is 95 ft thick, and is penetrated by 8 inch diameter well that pumps at a rate of 0.11 cfs. The radius of influence is 500 ft, the permeability is $4*10^{-4}$ ft/sec.

$$Q = (\pi k)\frac{(ho^2 - hw^2)}{ln\frac{ro}{rw}}$$

Determine the drawdown at the well?

**B-** 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.

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

Determine whether the new situation will or will not affect the farm's neighbor 2000 ft away?

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

# A Model Answer  Final - Ph D, (713), 20 / 5 / 2017

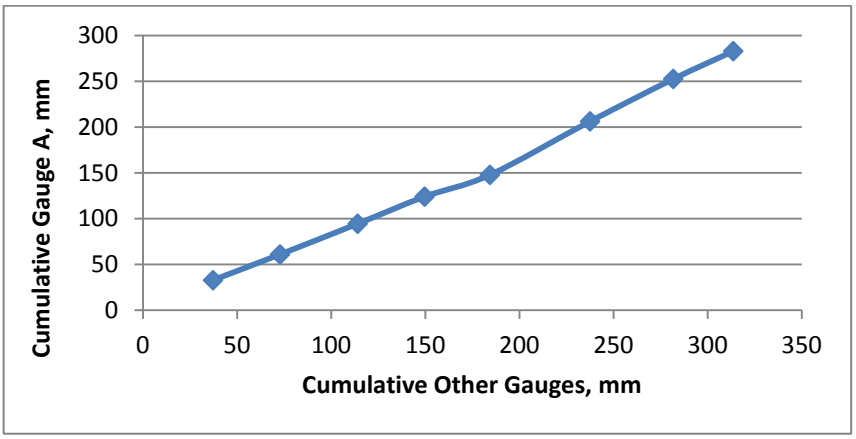
**Question (1)** (25+25 = 50 Marks)

**A-**

| No | Statement | T/F | Correction |
|---|---|---|---|
| 1 | Horton's equation assumes that infiltration rate is varied with time. | T | --- |
| 2 | Evapo-transpiration is the loss of water from a vegetated surface through the combined processes of soil evaporation and plant transpiration. | T | --- |
| 3 | When infiltration capacity exceeds the rainfall intensity, there will be surface runoff. | F | will not be |
| 4 | An aquifer is an impermeable water-bearing geologic formation. | F | permeable |
| 5 | The well is an artesian if the ground surface rises above the piezometric surface. | T | --- |

**B-**

1) The double mass curve.




2) At the year 2010, $P_A = 61 - 33 = 28$ mm

3) The variation of gauge A starts at the year 2013.

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 2015 = 252*0.78 ≈ 197 mm

**Question (2)** (20+30 = 50 Marks)

**A-**

P = [(5*5) + (20*15) + (15*25) + (10*35)] / 50

P = 21 mm

**B-**

1) In the atmosphere:
P = ET
100 + 385 = 61 + 424

2) On land:
P = ET + R + G
100 = 61 + 38 + 1

3) Over oceans and seas:
P + R + G = E
385 + 38 + 1 = 424

**Question (3)** (20+25+5 = 50 Marks)

**A-** *The soil texture for the following combinations:*

1) Silt
2) Clay loam

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

Area above the ϕ - index = 4.9 in

$2(1.4 - \phi) + 3(2.3 - \phi) + 2(1.1 - \phi) + 3(0.7 - \phi) + 2(2.75 - \phi) = 4.9$

Try $\phi = 1.5$

$3(2.3 - 1.5) + 2(2.75 - 1.5) = 4.9$

$\phi = 1.5$ inch/hr

**C-** $h = (P/\rho g) + z = (\rho g * d/\rho g) + z = d + z = d + (H - d) = H$

$h_1 = h_2 = h_3 = H_1$

**Question (4)** (20 + 30 = 50 Marks)

**A-** $Q = (\pi k)\frac{(ho^2 - hw^2)}{ln\frac{ro}{rw}}$

$0.11 = (\pi * 4 * 10^{-4})\frac{(95^2 - hw^2)}{ln\frac{500}{4/12}}$ $h_w = 91.5$ ft

Drawdown = $h_o - h_w = 95 - 91.5 = 3.5$ ft

**B-** $r_w = 8$ in Q = 0.5 cfs $h_o = 60$ ft $r_o = 1500$ ft

$h_o - h_w = 10$ ft $h_w = 60 - 10 = 50$ ft

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

$r_w = 8$ in Q = 0.67 cfs $h_o = 60$ ft

$h_o - h_w = 14$ ft $h_w = 60 - 14 = 46$ ft

$0.67 = (\pi * 0.00112)\frac{(60^2 - 46^2)}{ln\frac{ro}{8/12}}$ $r_o = 1609.98$ ft ≈ 1610 ft < 2000 ft

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