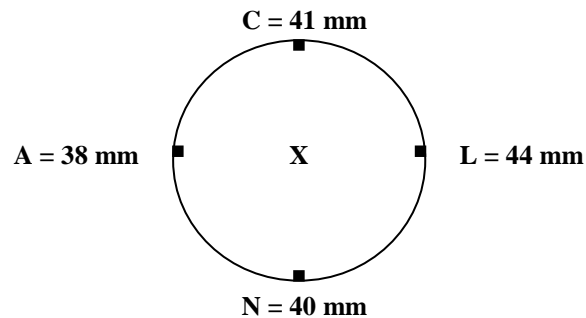


1

Rainfall over catchment area is 90 min duration. The rain gage distribution is shown in the figure; the radius of the circle is 4 km.

- 1- Find the rain depth of the point (X) which is in the center of the circle
- 2- Average depth of rainfall over the area use the Best Method
- 3- Accuracy frequency of the Rainfall



2

Describe the hydrological water budget with the aid of examples, the significant features of global water balance studies, list the major activities in which hydrological studies are important, describe briefly the sources of hydrological data in Kurdistan Region of Iraq.

3

A catchment area has six rain gauge stations. in a year, the annual rainfall recorded by the gauges are as follows:

Stations	A	B	C	D	E	F
Rainfall (cm)	82.6	102.9	180.3	110.3	98.8	136.7

For a 10% error in the estimation of the mean rainfall, calculate the optimum number of the stations in the catchment area.

A- If for a given basin in a given period. P= precipitation, ET= evapotranspiration, R= total runoff and ΔS = increase in the storage of water in the basin. the hydrological water budget equation states

- (a) $P = R - ET \pm \Delta S$
- (b) $R = P + ET - \Delta S$
- (c) $P = R + ET + \Delta S$
- (d) none of these

Choose the correct answer and justify with reasons?

B- Define unit hydrograph and describe with figure.

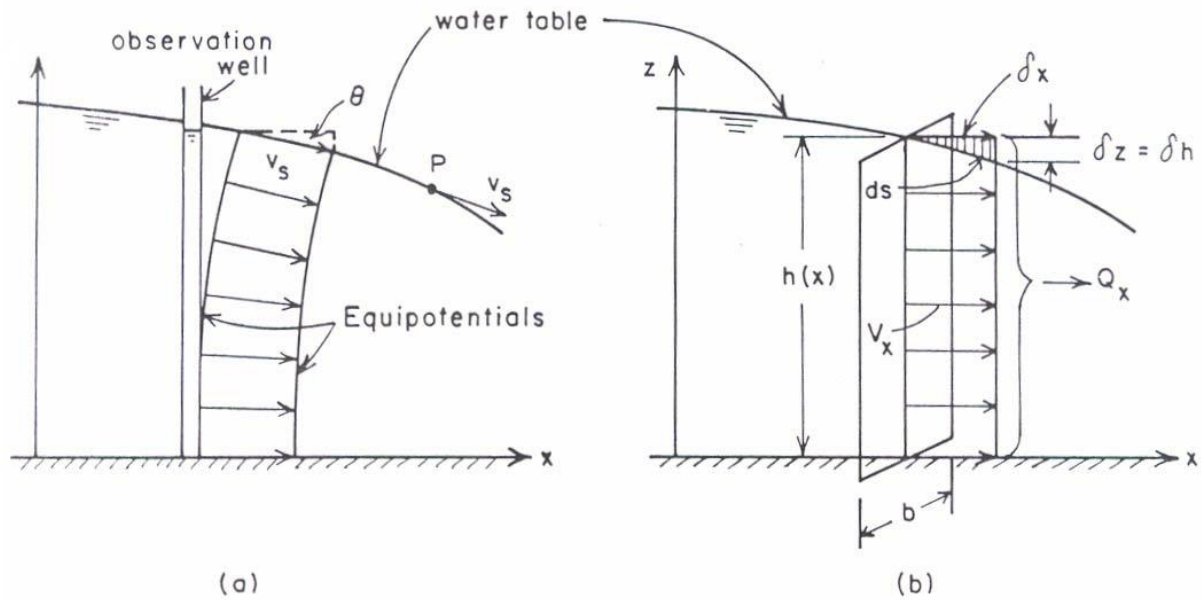
C- Straight line method is one of the important methods of base flow separation compare it with the other separation techniques (advantage and disadvantages) with figure as much as possible.

The groundwater level in aquifer before pumping is 31 m, when the pumping start within the discharge of 0,02 liter/s, the drawdown in the observation wells 20 m and 120 m apart .was 4.2 m and 1.6 m respectively. Find the transmissivity.

6

Derive Dupuit equation according to the below figure.

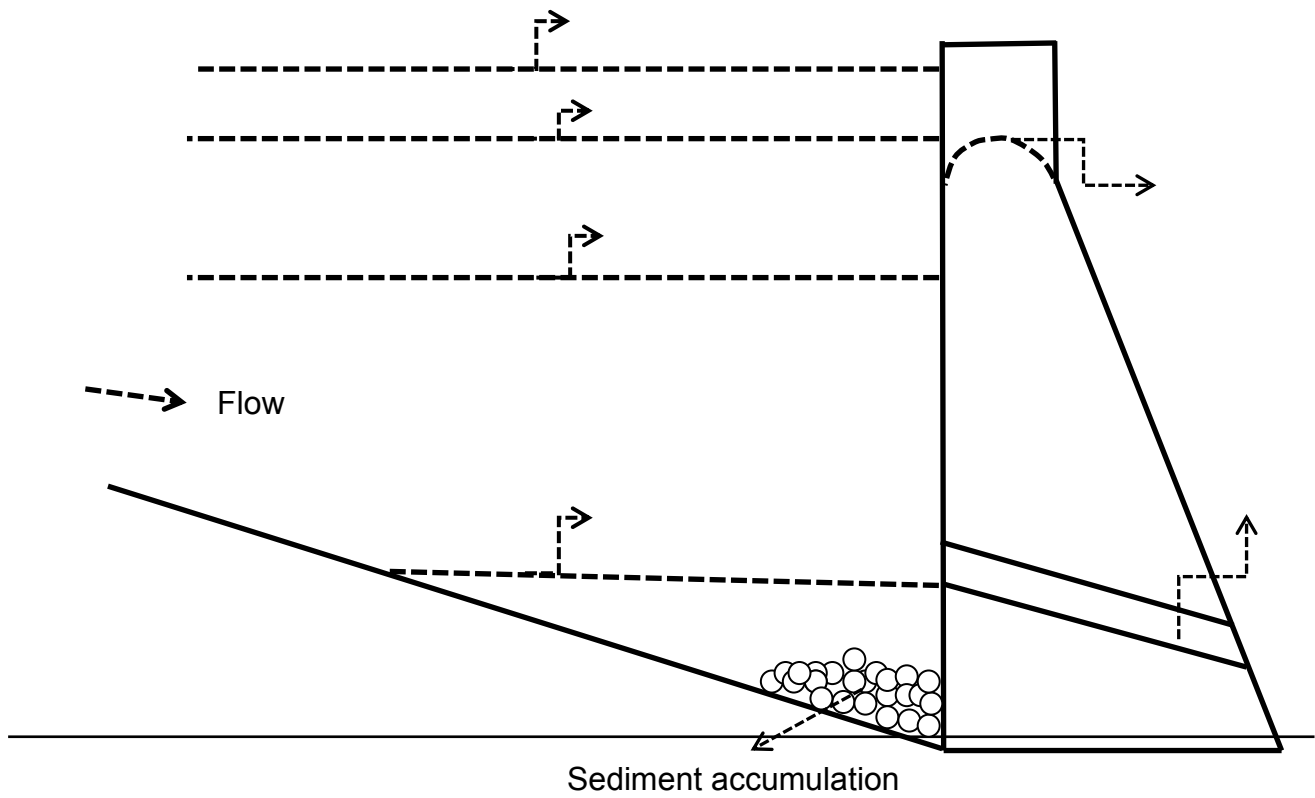
$$\frac{d^2h^2}{dx^2} = 0$$



7

Describe with figures: aquifers, aquiclude, aquitard, leaky confined aquifer, Perched Aquifer

please fill the storage zones in the reservoir (upstream & downstream) from the dam, and define each briefly.



9

- A- Indicate the differences between aquifer & aquifuge using graphs and diagrams.
 - B- State the differences between (Confined Aquifer) & (non-confined Aquifers) using graphs.
-

10

The discharge of an artesian well is $1.6 \text{ m}^3/\text{minute}$, the drawdown for the observation wells (for 150 is 0.75 m) (for 300 is 0.6 m) respectively.

The aquifer's thickness is 6 m.

- A- Find the permeability of the aquifer
 - B- If the porosity of the aquifer (0.3) by gradient of 0.002 find the discharge for one meter if the depth of aquifer = 6 m.
-

11

A- What are the ways and methods to recharge ground water, sketch with graph

B- What is the difference between Open-well and Deep well

12

Derive the equation of measuring (Open well Hydraulics) with figures and calculations

13

Find average intensity over the area of 5 km^2 within 60 minute duration with

Frequency of (once) in 10 years.

t	2	6	8	10	20	40	60	100	200
t*	3	4	4.2	4.4	4.85	5.3	5.6	5.9	6.3

14

A catchment area has seven raingauge stations. In a year the annual rainfall recorded by the gauges are as follows:

Station	P	Q	R	S	T	U	V
Rainfall (cm)	130.0	142.1	118.2	108.5	165.2	102.1	146.9

For a 5% error in the estimation of the mean rainfall, calculate the minimum number of additional stations required to be established in the catchment.

15

A- The normal annual precipitation of five rain gauge stations in a catchment area P,Q, R, S, and T are respectively 125, 102, 76, 116 and 137 cm. During a particular storm the precipitation recorded by stations P, Q, R, and S are 13.2, 9.2, 6.8 and 10.2 cm respectively. The instrument at station T was inoperative during the storm. Estimate the rainfall at station T during that storm.

B- Find the average intensity over the area within 2 hours.

16

A- What are the components of the Hydrograph? Define Unit Hydrograph.

B- Describe the separation techniques between Base Flow and Hydrograph (support your answer with figure)

17

A well 0.5 m in diameter penetrates 33 m below the static water table. after a long period of pumping at a rate of $80 \text{ m}^3/\text{hr}$, the drawdowns in wells 18 and 45 m from the pumped well were found to be 1.8 and 1.1 m respectively.

(a) What is the transmissivity of the aquifer?

(b) What is the approximate drawdown in the pumped well?

(c) Determine the radius of influence of the pumping well.

18

- Distinguish between the precipitation and rainfall
- Explain the method for estimation of missing rainfall data.
- How can you get the catchment area?
- What is a Double Mass Curve? What is its use?

Explain various methods for the separation of base flow a hydrograph. Why the separation of flow is required

The precipitation for a certain basin has been recorded for several years at 5 gages as shown in the below table. The data at one of the gages (site Y_t) is suspected to be inconsistent relative to that at the other four sites. The table below shows data for Y_t and the average data for the other four sites (called X). Adjust the data of (Y_t site) using the suitable method so that they are consistent with those of the recent years.

Year	Gage y_t	Average of 4 gages x_t
1979	668	780
1980	570	762
1981	681	878
1982	601	754
1983	483	761
1984	1186	1056
1985	940	887
1986	616	656
1987	950	791
1988	773	840
1989	646	706

-
- A- Describe the zones of the underground surface and classify each with very clear illustration figures
- B- Capillary fringe is not considered as groundwater why?
- C- The unit of Intrinsic Permeability is L^2 the same as area, what is the reason behind that? prove with equations unit.
-

21

A well fully penetrates a 25 m thick aquifer. after a long period of pumping at a constant rate of $0.05 \text{ m}^3/\text{s}$, the drawdowns at distances of 50 m and 150 m from the well were observed to be 3 and 1.2 m respectively within piezometric lines. Determine the hydraulic conductivity and the transmissivity.

22

A well penetrates an aquifer. prior to pumping, the water level = 25 m. after a long period of pumping at a constant rate of $0.05 \text{ m}^3/\text{s}$. the drawdowns at distances of 50 m and 150 m from the well were observed to be 3 m and 1.2 m, respectively. Determine the hydraulic conductivity.

23

Define Ripple method (Mass Curve) and compare it with Double Mass Curve

Find Maximum and Initial storage capacity only mathematically for the dam as follow:

Year	1969	1970	1961	1962	1963	1964	1965	1966	1967	1968
Annual Discharge in Milliar m^3	73	78	86	90	120	100	80	60	73	70

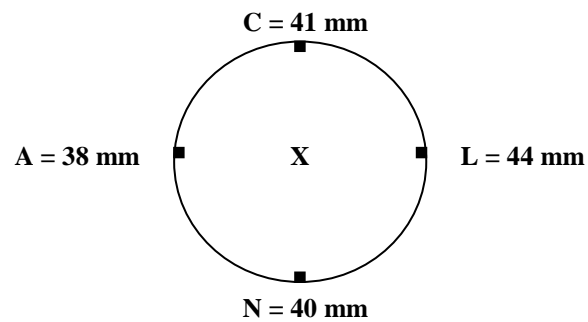
24

The initial infiltration capacity of a watershed is estimated as 1.5 in./hr , and the $K=0.35 \text{ hr}^{-1}$. The infiltration capacity is 0.2 in./hr . Use Horton's equations find:

- (A) infiltration rate at time 10 min, 30 min, 1 hr, 2 hr, and 6 hr.
- (B) the total volume of infiltration over the 6 hr period.

Rainfall over catchment area is 90 min duration. The rain gage distribution is shown in the figure; the radius of the circle is 4 km.

- 1- Find the rain depth of the point (X) which is in the center of the circle
- 2- Average depth of rainfall over the area use the Best Method
- 3- Accuracy frequency of the Rainfall



The annual precipitation data at rainfall gage station x presumably on the University of Baghdad were to be tested for consistency from 1972 through 1987. Data at eight neighboring gage stations also were obtained and are presented on the following table.

- 1- Test the consistency of station x records. If a change in regime is identified, report the year in which the change occurred.
- 2- Adjust station x records so that the regime before the break is maintained for all values.

<u>Year</u>	<u>Precipitation at x, mm</u>	<u>8-station average, mm</u>
1972	35	28
1973	37	29
1974	39	31
1975	35	27
1976	30	25
1977	25	21
1978	20	17
1979	24	21
1980	30	26
1981	31	31
1982	35	36
1983	38	39
1984	40	44
1985	28	32
1986	25	30
1987	21	23

Yearly flows entering into the reservoir of a dam are shown in the table below; determine the maximum and minimum storage capacity required to obtain a yield along the year equal to the average inflow.

Year	Yearly flow Million m³
1963	120
1964	100
1965	80
1966	60
1967	73
1968	70
1969	73
1970	78
1961	86
1962	90

The distance between two observation wells in an unconfined aquifer is 70 m. static water surface elevations are 75.0 m in well *A*, and 74.4 m in well *B*. The tracer injected from well *A* reaches well *B* in 36.7 hr. Soil porosity is 13%, aquifer thickness is 30 m. Determine the hydraulic conductivity, transmissivity of the aquifer.

28

Find average intensity over the area of 5 km^2 within 60 minute duration with

Frequency of (once) in 10 years.

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C- The normal annual precipitation of five rain gauge stations in a catchment area P,Q, R, S, and T are respectively 125, 102, 76, 116 and 137 cm. During a particular storm the precipitation recorded by stations P, Q, R, and S are 13.2, 9.2, 6.8 and 10.2 cm respectively. The instrument at station T was inoperative during the storm. Estimate the rainfall at station T during that storm.

D- Find the average intensity over the area within 2 hours.

31

C- What are the components of the Hydrograph? Define Unit Hydrograph.

D- Describe the separation techniques between Base Flow and Hydrograph (support your answer with figure)

A well 0.5 m in diameter penetrates 33 m below the static water table. after a long period of pumping at a rate of $80 \text{ m}^3/\text{hr}$, the drawdowns in wells 18 and 45 m from the pumped well were found to be 1.8 and 1.1 m respectively.

- (d) What is the transmissivity of the aquifer?
- (e) What is the approximate drawdown in the pumped well?
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- D- Describe the zones of the underground surface and classify each with very clear illustration figures
- E- Capillary fringe is not considered as groundwater why?
- F- The unit of Intrinsic Permeability is L^2 the same as area, what is the reason behind that? prove with equations unit.

A well fully penetrates a 25 m thick aquifer. after a long period of pumping at a constant rate of $0.05 \text{ m}^3/\text{s}$, the drawdowns at distances of 50 m and 150 m from the well were observed to be 3 and 1.2 m respectively within piezometric lines. Determine the hydraulic conductivity and the transmissivity.

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38

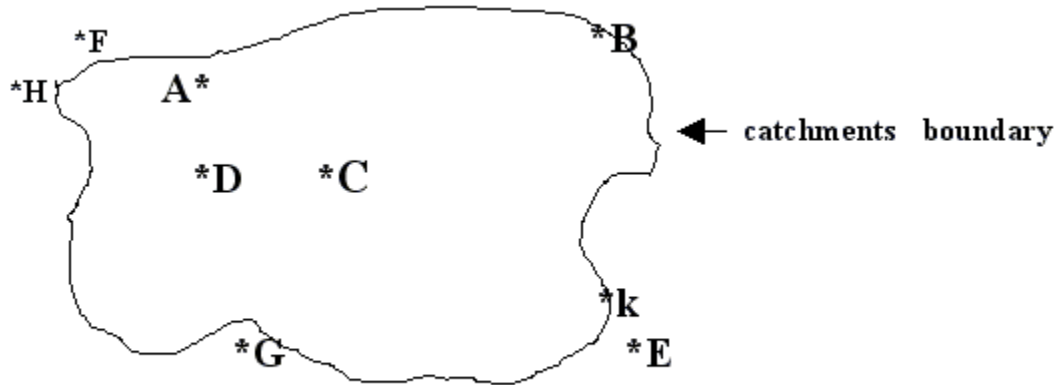
The initial infiltration capacity of a watershed is estimated as 1.5 in./hr , and the $K=0.35 \text{ hr}^{-1}$. The infiltration capacity is 0.2 in./hr . Use Horton's equations find:

- (A) infiltration rate at time 10 min, 30 min, 1 hr, 2 hr, and 6 hr.
(B) the total volume of infiltration over the 6 hr period.

A 1 m diameter well penetrates vertically through aquifer 50 m thick. when the well is pumped at $50 \text{ m}^3/\text{h}$, the drawdown in a well 50 m away is 10 m and in another well 100 m away is 3 m. what is the approximate drawdown in the well? also compute transmissivity. take the initial piezometric level as 200 m above the datum.

What is the assumption of Dupuit? describe it with figure and illustration.

Using the data in the below table and the raingage distribution shown in the figure (1) below With 120 minutes duration and invers Gamma= 5.98 , Station C is at the center of the area (catchments)



Figur (1)

Gage	A	B	C	D	E	F	G	H	K
Rainfall in (mm)	?	?	?	42	36	39	40	41	?
Average Rainfall in(mm)	47.7	25	48	44.3	?	36.8	48.1	42	40

- Find the area of the catchment ?
- Find the Average intensity over the area in mm/hr
- Discuss the result

What is the method of measuring average precipitation of the area? describe each with figure briefly

- C- Indicate the differences between aquifer & aquifuge using graphs and diagrams.
- D- State the differences between (Confined Aquifer) & (non-confined Aquifers) using graphs.

- A 30-cm well completely penetrates an unconfined aquifer of saturated depth 40m. After a long period of pumping at a steady rate of 0.025 m³/s, the drawdown in two observation wells 25 and 75m from the pumping well were found to be 3.5 and 2.0m respectively. Determine the transmissivity of the aquifer. What is the drawdown at the pumping well?

- What are the ways and methods to recharge ground water, sketch with graph
- What is the difference between Open-well and Deep well

46

Derive the equation of measuring (Open well Hydraulics) with figures and calculations?

47

The percentage of earth covered by oceans is about?

48

The percentage of total quantity of water in the world that is saline is about?

49

The percentage of total quantity of fresh water in the world available in the liquid form is about?

50

In the hydrological cycle the average residence time of water in the global is?

51

Considering the ratio of annual precipitation to runoff = r_0 for all the continents on the earth is?

52

A watershed has an area of 300 ha. Due to a 10 cm rainfall event over the watershed a stream flow is generated and at the outlet of the watershed it lasts for 10 hours. Assuming a runoff/rainfall ratio of 0.20 for this event, the average stream flow rate at the outlet in this period of 10 hours is?

53

The normal annual rainfall at stations A, B and C situated in meteorologically homogeneous region are 175 cm, 180 cm and 150 cm respectively. In the year 2000, station B was inoperative and stations A and C recorded annual precipitations of 150 cm and 135 cm respectively. The annual rainfall at station B in that year could be estimated to be nearly?

54

The average pan coefficient for the standard US Weather Bureau class A pan is?

55

A canal is 80 km long and has an average surface width of 15 m. If the evaporation measured in a class A pan is 0.5 cm/day, the volume of water evaporated in a month of 30 days is (in m³)?

56

The ISI standard pan evaporimeter is what?

57

The chemical that is found to be most suitable as water evaporation inhibitor is?

58

Wind speed is measured with?

59

If the wind velocity at a height of 2 m above ground is 5.0 kmph, its value at a height of 9 m above ground can be expected to be in km/h about?

60

Evapotranspiration is confined?

61

Lysimeter is used to measure?

62

The science and practice of water flow measurement is known as?

63

The following is not a direct stream flow determination technique?

64

A stilling well is required when the stage measurement is made by employing a?

65

In a river carrying a discharge of $142 \text{ m}^3/\text{s}$, the stage at a station A was 3.6 m and the water surface slope was 1 in 6000. If during a flood the stage at A was 3.6 m and the water surface slope was $1/3000$, the flood discharge (in m^3/s) was approximately?

66

In a triangular channel the top width and depth of flow were 2.0 m and 0.9 m respectively. Velocity measurements on the centre line at 18 cm and 72 cm below water surface indicated velocities of 0.60 m/s and 0.40 m/s respectively. The discharge in the channel (in m³/s) is?

67

In the moving-boat method of stream-flow measurement, the essential measurements are?

68

Which of the following instruments is not connected with stream flow measurement?

69

The surface velocity at any vertical section of a stream is?

70

If a gauging section is having shifting control due to backwater effects, then?

71

The dilution method of stream gauging is ideally suited for measuring discharges in?

72

Base-flow separation is performed by?

73

A unit hydrograph has one unit of?

74

The basic assumptions of the unit-hydrograph theory are?

75

The D-hour unit hydrograph of a catchment may be obtained by dividing the ordinates of a single peak direct runoff hydrograph (DRH) due to a storm of D hour duration by which?

76

A storm hydrograph was due to 3 h of effective rainfall. It contained 6 cm of direct runoff. The ordinates of DRH of this storm are?

77

An IUH is a direct runoff hydrograph of ?

78

An instantaneous unit hydrograph is a hydrograph of?

79

A hydraulic structure has been designed for a 50 year flood. The probability that exactly one flood of the design capacity will occur in the 75 year life of the structure is?

80

The prism storage in a river reach during the passage of a flood wave is?

81

A geological formation which is essentially impermeable for flow of water even though it may contain water in its pores is called?