

## III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

## WATER RESOURCES ENGINEERING-I

(Civil Engineering)

Time: 3 hours

Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)

2. Answering the question in **Part-A** is compulsory

3. Answer any **THREE** Questions from **Part-B**

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**PART -A**

- 1 a) Differentiate between : runoff, yield of a drainage basin and surface runoff. [3M]
- b) Define (i) $\Phi$ -index;(ii)W-index; Give the relation between them. [4M]
- c) What is unit hydrograph? Explain clearly the basic postulates of unit hydrograph theory. [4M]
- d) What is flood routing? Write down basic flood routing equation. [3M]
- e) State Dupuit's assumptions for obtaining general equations governing ground water flow. [4M]
- f) State the advantages of hydraulic model studies. [4M]

**PART -B**

- 2 a) What is "Hydrologic cycle" and what is its importance? [4M]
- b) How will you determine the areal rainfall over a basin by (i) Arithmetic mean method, (ii) Thiessen polygon method, (iii) Isohyetal method. [8M]
- c) Describe with a neat sketch the construction and use of a float-type of a recording gauge. [4M]
- 3 a) Write short notes on: (i)Transpiration and transpiration ratio (ii) Water shed leakage [3M]
- b) Explain with sketches the following methods for calculating net storm rain: i) Infiltration capacity method. ii)  $\Phi$ -index method iii)W-index method [8M]
- c) Briefly describe any method by which you can measure the evaporation loss from a free-water surface. [5M]
- 4 a) Explain the procedure for derivation of Snyder's synthetic unit hydrograph for an ungaged catchment [8M]
- b) Enumerate and briefly discuss the various factors which affect the runoff from a catchment. [8M]
- 5 a) Describe step by step procedure that you will adopt for flood routing computations required for reservoirs under trial and error method. [8M]
- b) Discuss the various problems encountered during the operation of flood control reservoirs. [8M]



- 6 a) Describe the recuperation test for an open well. [8M]
- b) A well in a confined aquifer was pumped at a rate of 900 litres per minute for 8 hours. The aquifer was 6m thick. Time-drawdown data for an observation well 250m away was plotted on a semi logarithmic paper and it was found that the drawdown per log cycle was 1.68m and the time for zero drawdown was 5.2 minutes. Find T,k and S. Also determine the time during which Jacob method cannot be used at the observation well. [8M]
- 7 a) Explain the steps involved in rainfall-runoff modeling. [8M]
- b) Explain any one method of the hydrological model. [8M]

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**PART -A**

- 1 a) How will you measure the discharge of: [3M]  
i) a river? ii) a small stream? iii) a canal?  
b) Write short notes on orographic and turbulent ascent in precipitations. [4M]  
c) Define unit hydrograph and state its uses. [3M]  
d) Write a note on flood plain management. [4M]  
e) Differentiate between (i) Permeability and transmissibility (ii) Aquifers and aquicludes. [4M]  
f) What are the different types of similarities considered in hydraulic model studies. [4M]

**PART -B**

- 2 a) Distinguish between short range and long range weather forecasts. [4M]  
b) What is an intensity duration curve, and how will you proceed to derive such a curve for a given frequency at a rain gauge station from the available data of worst storms of different duration kept for a sufficient number of years. [8M]  
c) Discuss briefly the use of radars and satellites in weather detection and forecasting. [4M]
- 3 a) Discuss how will you used for determining the discharge (i) in a shallow river and (ii) in a wider river. What formulas are used for computing discharge measurements? [3M]  
b) What is evaporation? Mention the factors controlling the evaporation process. What do you understand by water budget determination of reservoir evaporation? [8M]  
c) What is meant by 'stream gauging'? Describe the velocity area method that is used for stream gauging. [5M]
- 4 a) What is unit hydrograph? Discuss its uses and explain how a 6-hour unit hydrograph can be determined from a given 3-hour unit hydrograph. [8M]  
b) State and explain the Rational Method which is used for computing the peak rate of runoff for the design of urban storm water drains. What are the limitations of this method? [8M]
- 5 a) Write broad outline of the National Policy on floods and flood management. [8M]  
b) What is meant by flood routing through reservoirs? Explain the steps involved in any one of the analysis. [8M]



- 6 a) What is Dupuit's equation? State the assumptions that enter in its development. Explain the Theis formula. What is well function? [8M]  
b) A 30cm dia well penetrates 20m below the static water table. After 24 hours of pumping at 5000lites per minute the water level in a test well at 100m away is lowered by 0.5m, and in a well at 30m away the draw down is 1m. What is transmissibility of the aquifer? [8M]
- 7 a) What do you understand by Instantaneous unit hydrograph? How will you construct it? [8M]  
b) Explain any one method of the hydrological model. [8M]

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**PART -A**

- 1 a) How would you determine statistically, the optimum number of rain gauges required to be installed in a given catchment. [3M]  
 b) Explain any two methods of reducing the evaporation loss from a free-water surface. [4M]  
 c) Explain how the following parameters affect run-off:- [4M]  
 (i) Shape of basin, (ii) Slope of basin, (iii) Meteorological condition, (iv) Vegetative condition.  
 d) How are the benefits of flood control estimated? [4M]  
 e) Define: Perched aquifers, Storage coefficient, Specific capacity of wells and Well loss. [4M]  
 f) What is meant by Instantaneous unit hydrograph? [3M]

**PART -B**

- 2 a) Explain briefly the rainfall-runoff process, indicating all the possible losses involved. [4M]  
 b) What is meant by rain gauge density? What are the standards prescribed for it for different regions? [8M]  
 c) What is a hydrograph and what is its use in hydrology? [4M]  
 3 a) What is a stage discharge curve? How is it affected by a changing stage of the river compared to a constant stage? [3M]  
 b) Write down the most common empirical formula used to calculate evaporation? What are the factors influencing evaporation? [8M]  
 c) Explain: (a) evaporation, (b) infiltration, (c) interception, (d) transpiration, (e) percolation, and (f) consumptive use. [5M]  
 4 a) List of various methods of determining runoff from the catchment. Give the various empirical formulae for determining the runoff indicating the area for which each of these formulae is applicable. [8M]  
 b) In a certain basin ordinates of a unit hydrograph (1cm-6hr) are given below: [8M]

|                   |   |   |    |    |    |    |    |    |    |
|-------------------|---|---|----|----|----|----|----|----|----|
| Time(in hr)       | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 |
| Ordinates(cumecs) | 0 | 4 | 12 | 25 | 18 | 12 | 7  | 4  | 0  |

Determine the peak flood and the total volume of flood flow in the basin corresponding to storm described below:

|             |     |      |
|-------------|-----|------|
| Period (hr) | 0-6 | 6-12 |
| Runoff (mm) | 10  | 20   |

Base flow at the time of storm was 5 cumecs.



- 5 a) How are the methods of flood control classified? Explain briefly. [8M]  
b) What is flood routing? Write down basic flood routing equation. Explain in detail any one method of flood routing. [8M]
- 6 a) State Dupuit's assumptions for obtaining general equations governing ground water flow. Derive an expression for the confined aquifer. How can the expression be used to evaluate the aquifer permeability? [8M]  
b) A 10cm diameter well was pumped at a uniform rate of 500 litres/min., while observations of drawdown were made in an observation well located at a distance of 50m from the well. The original head of water, measured from the top of the impervious layer was 25m. The hydraulic conductivity of the aquifer was  $1.83 \times 10^{-3}$  m/min. determine the drawdown at the face of the well and assuming that the flow to the unconfined aquifer is unsteady state. [8M]
- 7 a) What are the steps involved in rainfall-runoff modeling? [8M]  
b) Explain any one method of the hydrological model. [8M]

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**PART -A**

- 1 a) What is a hydrograph and what is its use in hydrology? [3M]  
b) Explain: i) evaporation, ii) infiltration, iii) transpiration, and iv) consumptive use. [4M]  
c) Explain briefly what is a unit hydrograph and a distribution graph is? [4M]  
d) Explain the terms: (i) Design flood (ii) Maximum probable flood and (iii) Standard project flood. [3M]  
e) Explain: i) Specific retention of a soil ii) Specific yield of an aquifer [4M]  
iii) Storage coefficient of an aquifer iv) Specific capacity of a well.  
f) What do you understand by rainfall-runoff modeling? [4M]

**PART -B**

- 2 a) Differentiate between Recording and Non-recording types of rain gauges. [4M]  
b) The isohyets for annual rainfall over a catchment were drawn and the areas of the strips between isohyets are obtained as below. Determine the average depth of annual precipitation over the area. [8M]

|                         |         |         |         |         |          |           |
|-------------------------|---------|---------|---------|---------|----------|-----------|
| Isohyets (mm)           | 450-550 | 550-650 | 650-750 | 750-950 | 950-1150 | 1150-1250 |
| Area (km <sup>2</sup> ) | 1200    | 3000    | 2800    | 1000    | 900      | 600       |

- c) Distinguish between 'cold clouds' and 'warm clouds', explaining simultaneously the process of formation of rain drops in each of them. [4M]
- 3 a) What do you understand by infiltration index? How do you determine it? [3M]  
b) Briefly describe any method by which you can measure the evaporation loss from a free-water surface. [8M]  
Explain any two methods of reducing the evaporation loss from a free-water surface.  
c) Enumerate the different methods which are used for stream gauging. Discuss any one of these methods in details. [5M]
- 4 a) Explain the procedure for derivation of Snyder's synthetic unit hydrograph for an ungaged catchment. [8M]



- b) An isolated intense storm of 30minutes duration occurred over a catchment basin of 283.28 hectares. The estimated average depth of precipitation was 6.35 cm over the entire area and half hourly stream flows resulting from the above storm were noted as follows: [8M]

| Time      | Q in cumecs | Time   | Q in cumecs |
|-----------|-------------|--------|-------------|
| 7.00am    | 3.40        | 1.00pm | 7.93        |
| 7.30am    | 3.35        | 1.30pm | 7.20        |
| 8.00am    | 3.30        | 2.00pm | 5.60        |
| 8.30am    | 4.00        | 2.30pm | 5.30        |
| 9.00am    | 6.40        | 3.00pm | 4.60        |
| 9.30am    | 6.90        | 3.30pm | -           |
| 10.00am   | 13.75       | 4.00pm | 4.40        |
| 10.30am   | 13.45       | 4.30pm | 3.85        |
| 11.00am   | 13.30       | 5.00pm | 3.75        |
| 11.30am   | 11.05       | 5.30pm | 3.70        |
| 12.00noon | 9.65        | 6.00pm | -           |
| 12.30pm   | 6.78        | 6.30pm | 3.70        |

Draw unit hydrograph for the above basin.

- 5 a) Discuss briefly the economics of flood control. How are the benefits of flood control estimated? [8M]  
 b) What is flood routing? Write down basic flood routing equation. Explain in detail any one method of flood routing. [8M]
- 6 a) Write short notes on the following: [8M]  
 i) Darcy's law for measuring velocity of ground water flows  
 ii) Permeability and transmissibility and their relationship  
 b) A well penetrating an aquifer which is underlain and overlain by impermeable layers was tested with uniform discharge of 1000 litres/min. The steady state drawdowns measured in two observation wells which were at 1m and 10m radial distances from the centre of the pumped well were 13.40m and 4.2m respectively. Determine the hydraulic properties of the aquifer if its saturated thickness is 10m. [8M]
- 7 a) What are the steps involved in hydrological model studies. Explain briefly any one method. [8M]  
 b) What do you understand by Instantaneous unit hydrograph? How will you construct it? [8M]

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**PART -A**

- 1 a) Explain hydrologic cycle with a neat sketch. [3M]
- b) Discuss Horton's infiltration equation. [4M]
- c) Describe briefly the various components of runoff. [4M]
- d) Define flood routing. What are the uses of flood routing? [3M]
- e) Define transmissivity, storage coefficient and hydraulic conductivity of an aquifer. [4M]
- f) Write a short note on rainfall-runoff modeling. [4M]

**PART -B**

- 2 a) Explain various types of precipitation. [4M]
- b) Describe double mass curve method to check the consistency of rainfall data [6M]
- c) The annual rainfalls in cm at a station for a period of 21 years from 1960 to 1980 are 97, 125, 103, 81, 101, 119, 103, 79, 102, 118, 98, 83, 105, 123, 100, 86, 99, 114, 91, 83 and 106. Determine the 75% dependable rainfall from frequency analysis. [6M]
- 3 a) Explain any three methods of estimating the evapotranspiration. [8M]
- b) Explain the double ring infiltrometer with adjustable depth of flooding with the help of a neat sketch. [8M]
- 4 a) Explain the various factors affecting the runoff. [6M]
- b) Given below are the ordinates of a 4-hour unit hydrograph of a basin in m<sup>3</sup>/s at one hour intervals. [10M]  
 4, 25, 44, 60, 70, 61, 52, 45, 38, 32, 27, 22, 18, 14, 11, 8, 6, 4, 2 and 1.  
 Derive 2-hour unit hydrograph.
- 5 a) Explain the Gumbel's method of estimation of T-year flood. [8M]
- b) Describe the various steps involved in the Pul's method of reservoir routing. [8M]
- 6 a) Derive an expression for the steady state discharge of a well fully penetrating into a confined aquifer. List out the assumptions made. [8M]
- b) During the recuperation test conducted on an open well in a region, the water level in the well was depressed by 3 m and it was observed to rise by 1.75 m in 75 minutes. What is the specific yield from wells in that region? What could be the yield from a well of 5 m diameter under a depression head of 2.5 m? What should be the diameter of the well to give a yield of 12 lit/s under a depression head of 2 m? [8M]
- 7 a) Define Instantaneous unit hydrograph. How does it differ from unit hydrograph of finite duration? [8M]
- b) Explain the concept of Clark's Instantaneous Unit Hydrograph. [8M]

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**PART -A**

- 1 a) What are the various forms of precipitation? [3M]  
 b) Define  $\phi$ -index and W-index and bring out the difference between them. [4M]  
 c) Describe any two methods of separating base flow from total runoff. [4M]  
 d) Differentiate between channel routing and reservoir routing. [3M]  
 e) Explain briefly various types of aquifers. [4M]  
 f) Write short note on rainfall-runoff modeling. [4M]

**PART -B**

- 2 a) Explain various methods of determination of average rainfall over a basin [6M]  
 b) Explain Intensity-Duration-Frequency curves. [4M]  
 c) The average annual rainfalls of 5 rain gauges in a basin are 89,54,45,41 and 55 cm. If the error in the estimation of basin mean rainfall should not exceed 10%, how many additional gauges should be installed in the basin? [6M]  
 3 a) Describe how the evaporation is measured using atmometers. Also explain various methods of reducing the evaporation from a water body. [8M]  
 b) A seven hour storm produced the following rainfall intensities in mm/h at half an hour intervals over a basin of area 1830 km<sup>2</sup> are 4, 9, 20, 18, 13, 11, 12, 2, 8, 16, 17, 13, 6 and 1. If the corresponding observed runoff is 36.6 million m<sup>3</sup>, estimate the  $\phi$ -index. [8M]  
 4 a) Explain any two methods of estimating runoff [6M]  
 b) The following are the ordinates of a 12-hour unit hydrograph. [10M]

|                          |   |      |      |      |      |     |     |    |
|--------------------------|---|------|------|------|------|-----|-----|----|
| Time (hr)                | 0 | 12   | 24   | 36   | 48   | 60  | 72  | 84 |
| Flow (m <sup>3</sup> /s) | 0 | 1600 | 2900 | 2600 | 1400 | 700 | 150 | 0  |

If successive 12 hour rainfall excesses are 1.5 cm, 3.0 cm and 0.75 cm for the catchment, obtain the ordinates of a resulting storm hydrograph if constant base flow of 20 m<sup>3</sup>/s is assumed.

- 5 a) What do you understand by the frequency factor? How is it determined for Gumbel's distribution? [8M]  
 b) Explain the method of determining the Muskingum parameters K and x of a reach from a pair of observed inflow and outflow hydrographs. [8M]



- 6 a) Derive the expression for the steady state discharge of well fully penetrating into a unconfined aquifer. [8M]  
b) Explain the terms (i) cone of depression (ii) specific yield (iii) flowing well (iv) Darcy's velocity. [8M]
- 7 a) Define Instantaneous unit hydrograph. How does it differ from unit hydrograph of finite duration? [8M]  
b) Explain the concepts of Nash model of Instantaneous Unit Hydrograph. [8M]

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**PART -A**

- 1 a) Explain various methods for finding the missing data of rainfall. [3M]
- b) Define pan coefficient. Discuss the relative merits and demerits of sunken, floating and land pans. [4M]
- c) Describe how unit hydrograph can be used to predict the runoff from storms. [4M]
- d) What is a design storm? What is Probable Maximum Flood? [3M]
- e) Distinguish between aquifer, aquitard and aquiclude. [4M]
- f) Write short note on rainfall-runoff modeling. [4M]

**PART -B**

- 2 a) Explain the Depth-Area-Duration curves [4M]
- b) What do you understand by dependable rainfall? How do you analyse the available data to obtain 75% dependable annual rainfall? [6M]
- c) Estimate the total volume of rainfall received in  $m^3$  in a basin consisting of 5 rain gauges. The polygon area of each station in hectare are 518,777, 906, 1495 and 748. The corresponding rainfalls in mm at each rain gauge station in the same order are 267, 198, 142, 114 and 81. [6M]
- 3 a) Discuss various factors affecting the evapotranspiration. [6M]
- b) Define  $\phi$ -index and W-index. [4M]
- c) A storm with uniform intensity of 1.6 cm/hour for a period of 8 hours occurring over a basin of area  $650 \text{ km}^2$  produced a runoff estimated to be 57.2 million  $m^3$ . Find the average infiltration rate during the storm. [6M]
- 4 a) List out various physiographic factors which affect runoff. Discuss their influence on the volume of runoff and on the time distribution of runoff. [8M]
- b) Given below are the ordinates of a unit hydrograph for a storm of 4-hour duration. Find ordinates of flood hydrograph when the maximum flood observed was  $400 \text{ m}^3/\text{s}$  and base flow was  $250 \text{ m}^3/\text{s}$ . [8M]

|                         |   |      |      |     |     |    |    |
|-------------------------|---|------|------|-----|-----|----|----|
| Time (hours)            | 0 | 4    | 8    | 12  | 16  | 20 | 24 |
| Flow ( $m^3/\text{s}$ ) | 0 | 1500 | 1200 | 600 | 220 | 80 | 0  |



- 5 a) Describe the method of estimating a T-year flood using Log-Pearson type-III distribution. [8M]  
b) Derive the Muskingum routing equation and the expressions for the routing coefficients  $C_0$ ,  $C_1$  and  $C_2$ . [8M]
- 6 a) Explain how yield of an open well can be determined using recuperation test. [8M]  
b) In a water table aquifer of 50 m thickness, a 20 cm diameter well is pumped at a uniform rate of  $0.05 \text{ m}^3/\text{s}$ . If the steady state drawdown measured in the observation wells located at 10 m and 100 m distances from the well are 6.5 and 0.25 m respectively, determine the hydraulic conductivity of the aquifer. [8M]
- 7 a) Explain the concepts of Nash model of Instantaneous Unit Hydrograph. [8M]  
b) What is a hydrological model? Explain any one of them. [8M]

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**PART -A**

- 1 a) How to estimate the optimum number of rain gauges required in a basin? [3M]  
 b) Discuss the factors affecting evaporation. [4M]  
 c) What is a S-hydrograph? How it is constructed? What are its uses? [4M]  
 d) Distinguish between return period and exceedence of probability. [3M]  
 e) Write short note on occurrence of ground water. [4M]  
 f) Write short non on rainfall-runoff modeling. [4M]

**PART -B**

- 2 a) Describe any three types of rain gauges for measurement of rainfall with neat sketches. [4M]  
 b) Describe the procedure involved in the analysis for developing intensity-duration-frequency relationships. Sketch a typical set of these curves. [8M]  
 c) Rain gauge station X did not function for a part of a month during which a storm occurred. The storm produced rainfalls of 84,70 and 96 mm at three surrounding stations A, B and C respectively. The normal annual rainfalls at the stations X,A,B and C are respectively 770, 882, 736 and 944 mm. Estimate the missing storm rainfall at station X. [4M]
- 3 a) Explain how the evapotranspiration can be estimated using the Blaney-Criddle and Thornthwaite equations. [8M]  
 b) What are the factors affecting infiltration? Explain how infiltration can be measured using the double ring infiltrometer. [8M]
- 4 a) What is stream gauging? How it is useful? Explain the area-velocity method of stream gauging. [8M]  
 b) Given below are the observed flows (cumecs) from a storm of 6 hour duration on a stream with a drainage area of 316 km<sup>2</sup>. Assume a constant base flow of 17 cumecs. Derive a 6-hour duration unit hydrograph. [8M]

|           |    |       |     |      |      |      |    |
|-----------|----|-------|-----|------|------|------|----|
| Time (hr) | 0  | 12    | 24  | 36   | 48   | 60   | 72 |
| Flow      | 17 | 254.5 | 150 | 87.7 | 53.8 | 31.1 | 17 |

- 5 a) Describe the method of estimating a T-year flood using Gumbel's distribution. [8M]  
 b) Describe the Pul's method of reservoir routing. [8M]



- 6 a) Derive the expression for yield of a open well by recuperation test. [8M]
- b) A 20 cm well penetrates fully a confined aquifer of thickness 30 m. When the well is pumped at rate of 250 litre/minute the steady state drawdown in the two observation wells located at 10 m and 100 m distance from the pumping well are found to be 3.5 and 0.05 m respectively. Calculate the permeability and the transmissivity of the aquifer. [8M]
- 7 a) Define Instantaneous unit hydrograph. How does it differ from unit hydrograph of finite duration? [8M]
- b) Explain the concept of Clark's Instantaneous Unit Hydrograph. [8M]

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