



**UNIVERSITY EXAMINATIONS**

NJORO CAMPUS

SECOND SEMESTER 2011/2012

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE  
IN AGRICULTURAL ENGINEERING

AGEN 356: HYDROLOGY

STREAM: 2009 (Y3) AGEN

TIME: 2 HOURS

DAY/TIME: FRIDAY, 08.30 – 10.30 AM

DATE: 04/05/2012

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**INSTRUCTIONS:**

1. The paper consists of **FIVE (5)** questions.
  2. Attempt **QUESTION ONE** and **ANY OTHER THREE** questions.
  3. All questions carry equal marks.
  4. Marks for each question are shown in parenthesis.
  5. Use neat and clear sketches where necessary
  6. Observe examination regulations as outlined on the answer booklet
  7. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**
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**QUESTION ONE (COMPULSORY)**

(a) Write short notes on the following principles and terms as used in engineering hydrology

- (i) Double mass curve
- (ii) Rainfall hyetograph
- (iii) Isohyets
- (iv) Unit hydrograph
- (v) Cone of depression.

**(10 marks)**

- (b) Compute the average precipitation by arithmetic average method and Thiessen polygon method from the following data presented in Table 1. (4 marks)

**Table 1: Precipitation data**

Station Number	Precipitation (mm)	Area (m <sup>2</sup> )
1	30.8	45
2	34.6	40
3	32.0	30
4	24.6	38

- (c) A well 3 meters in diameter has its normal water level 3 meters below the ground level. By pumping water level in the well is depressed to 10 metres below the ground level. In 4 hours the water rises by 5 meters. Calculate the specific yield of the well. (5 marks)
- (d) Estimate the return period of a rainfall whose probability of exceedence is 5%. Also determine the probability that this rainfall may occur in the next 5 years. (6 marks)

## QUESTION TWO

- (a) Define the following Hydrological terms: (10 marks)
- (i) Radius of influence
  - (ii) Aquifer
  - (iii) Extreme event
  - (iv) Hydrologic budget.
  - (v) Recession curve.
- (b) Describe the various methods of measuring the velocity of a stream. (6 marks)
- (c) During a profile survey, the highest point of a catchment in Nakuru County was 987 m above the lowest point which was 2435.2 m away. Estimate the time of concentration of a storm with a rainfall intensity of 4 mm/hr for sufficient runoff to be generated at the outlet of the catchment. (5 marks)
- (d) Using mathematical equations show the difference in ground water flow between: (4 marks)
- (i) Pore water velocity, and
  - (ii) Average linear velocity.



**QUESTION THREE**

- (a) What are the factors that affect the runoff from a catchment? (10 marks)
- (b) List **THREE** most commonly used methods of boring a tube well. (3 marks)
- (c) The data given in Table 2 presents observed flows from a storm of six- hour duration rainfall at a gauging station draining an area of 90 km<sup>2</sup>. Derive the Direct Runoff Ordinates (DRO) and Unit hydrograph Ordinates (UH). (8 marks)

**Table 2: River flow data**

<b>Time (h)</b>	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42
<b>Flow (m<sup>3</sup>/s)</b>	15.3	36.0	65.7	84.7	77.6	60.3	42.5	33.2	27.8	24.4	21.3	19.0	17.3	16.4	16.2
<b>Base flow (m<sup>3</sup>/s)</b>	15.3	14.5	13.6	12.8	13.3	13.6	14.0	14.2	14.5	14.7	15.0	15.3	15.6	15.9	16.2

- (d) Briefly outline **FOUR** Concepts of probability in hydrology. (4 marks)

**QUESTION FOUR**

- (a) Define the following terms as used in hydrology
  - (i) Stream gauging.
  - (ii) Overland flow.
  - (iii) Direct runoff. (3 marks)
- (b) A tube well is driven in a confined aquifer of 24 m thickness. The aquifer is met 25 m below a ground level. The static water table is 15 m below the ground level. The discharge of the tube well is found to be 6000 m<sup>3</sup>/day when depression head is 12.25 m. Permeability is 24.50 m/day. Find the diameter of the tube well. Take radius of circle of influence as 300 m. (12 marks)
- (c) During a calibration exercise of a flow measurement structure, flow rates of 54.58 m<sup>3</sup>/s and 68.33 m<sup>3</sup>/s at stages 6.1 m and 8.3 m, respectively were recorded. Establish the rating equation of the structure,  $Q = aH^c$ , where, a and c are the constants to be established. (4 marks)
- (d) Outline the procedure followed while using Gumbel method of analyzing extreme events. (6 marks)

**QUESTION FIVE**

- (a) (i) Differentiate between the Hydrograph and the rating curve as used in engineering hydrology. (2 marks)
- (ii) Explain how the field of hydrology is key in mitigating of some of today's climate related pressing issues. (3 marks)
- (b) Derive a mathematical expression for groundwater radial flow in an unconfined aquifer and state Dupuit-Forcheimer-assumption. (10 marks)
- (c) Why is hydrologic frequency analysis important to a water resources engineer? (2 marks)
- (d) Data given in the Table 3 below were obtained at a river flow measuring structure. If the current meter equation is  $V = 0.032 + 0.32N$ , compute the discharge (Q) using mid-section method. (8 marks)

**Table 3: Discharge data**

<b>Distance from left Bank (m)</b>	0	2	4	6	9	12	15	18	20	22	23	24
<b>Depth (m)</b>	0	0.50	1.10	1.95	2.25	1.85	1.75	1.65	1.50	1.25	0.75	0.0
<b>Number of Revolutions</b>	0	90	85	130	140	118	110	105	90	80	75	0
<b>Time (s)</b>	0	165	120	120	120	120	120	120	120	120	135	0

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