

EGERTON



UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2012/2013

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

AGEN 356: HYDROLOGY

STREAM: 2010 (Y3) B. SC. AGEN

TIME: 2 hours

DAY/TIME: THURSDAY, 03.00 – 05.00

DATE: 16-05-2013

INSTRUCTIONS:

1. The paper contains **FIVE (5)** questions.
2. Attempt question **ONE (1)** and any other **THREE (3)** questions
3. Shown in parenthesis are marks for each question.
4. Use neat and clear sketches where necessary
5. Observe examination regulations as outlined on the answer booklet
6. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**

**QUESTION ONE (30 marks) - COMPULSORY**

- (a) List **three (3)** common “errors” in precipitation measurement. **(3 marks)**
- (b) Give **two (2)** reasons why Engineers need stream flow data. **(2 marks)**
- (c) During a calibration exercise in a river for a flow measuring structure, the following data was collected: The discharge at a staff reading of 7.8 m was 66.28 m<sup>3</sup>/s. At a different calibration exercise for the same site, the discharge at a staff gauge reading of 5.5 m was 53.47 m<sup>3</sup>/s. Determine the rating equation,  $Q = aH^c$  of the structure. **(3 marks)**
- (d) A catchment is related to a hydrometric station from where long term observations of the mean annual discharge is obtained as 82 m<sup>3</sup>/s. From an Isohyetal map and the divide of the catchment, the data in Table 1 were determined:



**Table 1: Catchment data**

Isohyets (mm)	Area (km <sup>2</sup> )
800 - 850	150
850 - 900	270
900 - 950	720
950 - 1000	1055
1000 -1050	1400
1050 -1100	630
1100 -1150	350
1150 -1200	100

Compute:

- (i) The mean annual precipitation of the catchment (5 marks)
  - (ii) Mean annual runoff depth (3 marks)
  - (iii) Runoff coefficient (2 marks)
- (e) What return period should a water resources manager adopt in the design of a runoff drainage system if the officer is only willing to accept a 10% risk of flooding in the 25 years of expected life of the drainage channel? (6 marks)
- (f) (i) Which test is carried out to determine the consistency of rainfall data? (1 mark)  
(ii) Outline any **four (4)** reasons for inconsistency in rainfall data. (2 marks)
- (g) Define the following Hydrological terms:
- (i) Time of concentration ( $T_c$ )
  - (ii) Base flow
  - (iii) Isohyets. (3 marks)

**QUESTION TWO (20 marks)**

- (a) What is probability? Explain the rules of probability as it is used in hydrology. (5 marks)
- (b) Explain the following hydrologic terms:
- (i) River stage (1 mark)
  - (ii) Rating curve (1 mark)
- (c) The following terms relate to the flow and transport in porous medium. Explain the physical meaning of each term. Use the relevant mathematical expressions where applicable:
- (i) Specific discharge (2 marks)
  - (ii) Transmissivity (2 marks)



- (d) The data given in Table 2 (River flow data) presents observed flows from a storm of six- hour duration rainfall at a gauging station draining a catchment area of 90 km<sup>2</sup>. Derive the Direct Runoff Ordinates (DRO) and Unit hydrograph Ordinates (UH). Draw the two graphs on the same axes. (9 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

**QUESTION THREE (20 marks)**

- (a) Define the following terms and where possible, give examples.

(i) Through flow (1 mark)

(ii) Aquifer (1 mark)

- (b) (i) The data given in Table 3 (discharge data) was obtained at a river flow measuring structure. If the current meter equation is  $V = 0.032 + 0.32N$ , compute the discharge Q using the mid section method. (7 marks)

- (ii) Using a clearly labelled sketch, outline the components of a typical hydrograph resulting from an isolated period of rainfall? (3 marks)

**Table 3: Discharge data**

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

- (c) A well was pumped at a constant discharge rate of 60 m<sup>3</sup>/hr from a confined aquifer. The aquifer is 20 m thick, its hydraulic conductivity is 10 m/s and its specific storage is estimated as 10<sup>-6</sup>. Calculate the expected water level in an observation well located 40 m from the pumping well 3 hours after the commencement of pumping. (8 marks)



**QUESTION FOUR (20 marks)**

- (a) State any three (3) dupuit-Forchheim assumptions. (3 marks)
- (b) (i) List any two (2) methods that can be used in ground water exploration. (2 marks)  
 (ii) With a neat sketch, explain the characteristics of a Time-Distance Plot in Seismic refraction geophysics method. (4 marks)
- (c) A Seismic refraction survey was conducted in an area where a dam site investigation was being carried out. The Seismic waves were detected by means of geophones placed at intervals of 15m. The first geophone was placed at 15m from the shot point (source of vibrations). Use the data given in Table 4 to compute:
- (i) Critical distance (5 marks)  
 (ii) Velocity of overburden (2 marks)  
 (iii) Velocity of bedrock (2 marks)  
 (iv) Depth to bedrock (2 marks)

**Table 4: Seismic data for the Dam site**

Geophone	First arrival Time (s)
1	0.015
2	0.031
3	0.046
4	0.062
5	0.077
6	0.089
7	0.094
8	0.099
9	0.105
10	0.110
11	0.115
12	0.121

**QUESTION FIVE (20 marks)**

- (a) Define the following Hydrological terms:
- (i) Air mass  
 (ii) Front  
 (iii) Vadose water  
 (iv) Storage Coefficient (4 marks)
- (b) (i) Explain the terms in Dracy's equation. (2 marks)



- (ii) In a field test, it was observed that a time of 4 hours was required for a tracer to travel from one observation well to another. The wells are 28 m apart and the difference in water surface is 0.5 m. Samples of the aquifer between the wells indicated that the porosity was about 18%. Compute the coefficient of permeability of the aquifer assuming that it is homogeneous. **(4 marks)**
- (c) Derive an expression for ground water discharge from unconfined aquifer. **(5 marks)**
- (d) A well penetrating an aquifer which is underlain and overlain by impervious layers was tested with a uniform discharge of 1300 L/min. The steady state drawdowns into two pairs of observation wells which were 1m and 10 m radial distance and in line with the well were 12.6 and 4.4 m, 14.6 m and 5.0 m, respectively. Determine the Transmissivity and Hydraulic conductivity of the aquifer its saturated thickness is 12 m. **(5 marks)**

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