



MASENO UNIVERSITY
UNIVERSITY EXAMINATIONS 2015/2016

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE IN EARTH SCIENCE WITH INFORMATION
TECHNOLOGY**

MAIN CAMPUS

NGA 302: GROUNDWATER HYDROLOGY

Date: 18th January, 2016

Time: 11.00 -1.00pm

INSTRUCTIONS:

- **Answer Question ONE and any other TWO questions.**
- **Sketch maps and diagrams should be used whenever appropriate.**



1. a) Explain Darcy's law and its limitation in groundwater flow analysis. (6 marks)
- b) Explain the aquifer properties of igneous, sedimentary and metamorphic rocks. (6marks)
- c) Differentiate the following terms as applied in groundwater studies
- i) Aquifuge and aquitard (4 marks)
 - ii) Specific storage and storage coefficient (4 marks)
 - iii) Primary porosity and Secondary porosity (4 marks)
- d) A well is located in confined aquifer with a hydraulic conductivity of 14.9 m/day and a storativity of 0.0051. The aquifer is 20.1 m thick and is pumped at a rate of 2725 m³/day. What is the drawdown at a distance of 7.0 m from the well after 1 day of pumping? (6 marks)
2. a) Describe the function and characteristics of aquifer material. (10 marks)
- b) A well that is screened in a confined aquifer is to be pumped at a rate of 165,000 ft³ /day for 30 days. If the aquifer transmissivity is 5320 ft² /day, and the storativity is 0.0007, what is the drawdown at distances of 50, 150, 250, 500, 1000, 3000, 5000, and 10,000 ft? (10 marks)
3. a) Explain the assumptions made when calculating the hydraulic properties in confined aquifers. (10 marks)
- b) A well that pumps at a constant rate of 78,000 ft³ /day has achieved equilibrium so that there is no change in the drawdown with time. The well taps a confined aquifer that is 18 ft thick. An observation well 125 ft away has a head of 277 ft above sea level; another observation well 385 ft away has a head of 291 ft. Compute the value of aquifer transmissivity using Thiem equation (10 marks)
4. a) Distinguish between the following:
- i) Artesian aquifer and water table aquifer (4 marks)
 - ii) Piezometric surface and potentiometric surface (4 marks)
 - iii) Natural and Artificial groundwater recharge (4 marks)

- b) Using the Thiem-Dupuits method show from basic principles that the coefficient of Transmissivity is given by the equation,

$$T = \frac{Q \log_{10} \left(\frac{r_1}{r_2} \right)}{2.72(S_1 - S_2)}$$

where

r_1 and r_2 = radial distances of observation wells from test borehole

s_1 and s_2 = drawdowns in the observation wells

Q = yield of the well (8 marks)

5. a) Discuss geo-hydrological factors affecting groundwater distribution in Kenya and their effect on groundwater exploitation (10 marks)
- b) A borehole fully penetrates a 25m thick confined aquifer. After a long period of pumping at a constant rate of $0.05 \text{ m}^3/\text{s}$, the drawdown at a distance of 50m and 150m from the borehole were observed to be 3m and 1.2m respectively.
- i) Compute the hydraulic conductivity of the aquifer (6 marks)
- ii) Determine the transmissivity of the aquifer (4 marks)
6. a) Discuss the significance of flownets in groundwater flow analysis (10marks)
- b) A well is being pumped from an unconfined aquifer that has initial saturated thickness of 30 m. This aquifer has similar vertical and horizontal conductivities (i.e., $K_v = K_h = 10 \text{ m/day}$) with $S_s = 0.0001 \text{ m}^{-1}$ and $S_y = 0.2$. Calculate drawdown at observation well, located at 5.477 m away from the pumping well, at time $t = 1$ day (early time) and $t = 50$ day (late time). Use $Q = 100 \text{ m}^3/\text{day}$. (10 marks)