FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY

Bachelor of Science Honors in Marine and Freshwater Sciences Degree

Level III, Semester II Examination -2023/2024

LIM 3252: Groundwater Exploration and Extraction **Time: 1 hour and 30 minutes**

Answer **All** questions in **Part A** and **any Two (2)** out of the three questions in **Part B**.

Part A

Question 01 **(Total 40 Marks)**

1. Explain four types of hydrogeological formations. (05 marks)
2. List down the direct and indirect groundwater exploration methods. (06 marks)
3. Explain the concepts of linear losses and nonlinear losses in well hydraulics. (06 marks)
4. Draw a fully labeled diagram of a well and briefly describe the function of each of its components. (07 marks)
5. What are the impacts of groundwater over-exploitation and possible solutions for them? (08 marks)
6. As a university student, how can you contribute in preventing groundwater contamination during your daily activities? (08 marks)

Part B

Question 02 **(Total 30 marks)**

Groundwater exploration involves identifying and evaluating underground water sources using different techniques.

A) Explain the esoteric methods used for groundwater exploration. (05 marks)

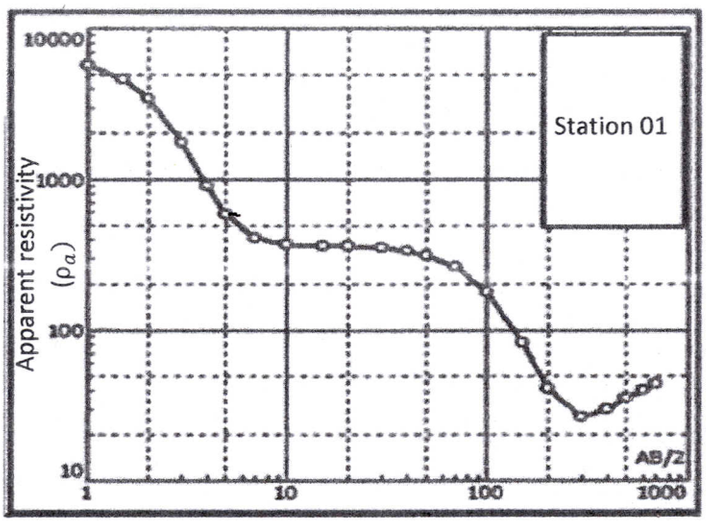
B) Briefly discuss how soil and microbiological methods are used in groundwater exploration. (06 marks)

C) The Electric Resistivity Method is a widely used geophysical technique for groundwater exploration.

a) Draw a schematic diagram of the Schlumberger electrode arrangement used in the Electric Resistivity Method, where the potential electrode spacing is denoted as "a" and the current electrode spacing is denoted as "ℓ". (05 marks)

b) Derive the equation for apparent resistivity using fundamental principles. (07 marks)

c) Explain how to find groundwater using the Electric Resistivity Method, referring to the following graph. (07 marks)



Question 03 **(Total 30 marks)**

Wells are vital for extracting groundwater for various purposes such as supplying water for domestic, agricultural, and industrial applications. Proper well design and drilling techniques are essential for their efficiency and sustainability.

A) Briefly describe different types of wells based on their construction. (06 marks)

B) Explain the key factors considered in well design. (08 marks)

C) A step drawdown test was conducted on a pumping well. The initial water level was measured at 12 m below the ground surface. After pumping at a discharge rate of 1200 m³/day, the drawdown was 1.8 m. Subsequently, when the discharge rate was increased to 2500 m³/day, the stabilized drawdown was 7.3 m.

a) Calculate the values of the aquifer loss coefficient (B) and the well loss coefficient (C). (10 marks)

b) Determine the specific capacity of the well at a discharge rate of 1400 m³/day. (06 marks)

Question 04 **(Total 30 marks)**

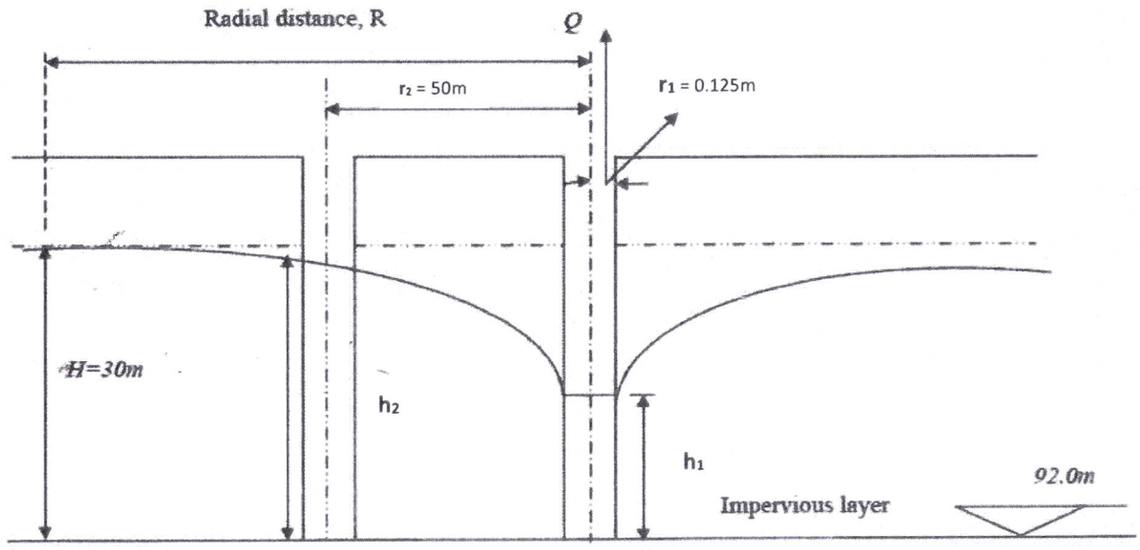
A pumping test is a method used in hydrogeology to evaluate well performance and aquifer characteristics by pumping groundwater from a well and monitoring the water level response in both the pumping well and surrounding observation wells.

A) Define the following terms: (i) Storativity (ii) Transmissivity. (06 marks)

B) State the key assumptions made in the analysis of the pumping test. (06 marks)

C) A pumping test was conducted on a fully penetrating tube well in an unconfined aquifer under steady-state conditions. The following observations were recorded:

- Well diameter = 25 cm
- Pumping discharge = 300 m^3/hr
- Elevation of original water table (before pumping) = 122.0 m
- Elevation of water in the pumping well (during steady pumping) = 117.1 m
- Elevation of water in an observation well = 121.3 m
- Elevation of the impervious layer = 92.0 m
- Radial distance of the observation well from the pumping well = 50 m



Dupuit–Forchheimer Formula for unconfined aquifer : $\frac{Q}{2\pi K}\ln\left(\frac{r_2}{r_1}\right) = \frac{h_2^2 - h_1^2}{2}$

Using the given data, determine:

(a) The transmissivity and the hydraulic conductivity of the aquifer material. (10 marks)

(b) The radius of influence (R) of the well. (08 marks)

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