



**TECHNICAL UNIVERSITY OF MOMBASA**  
**FACULTY OF APPLIED AND HEALTHY SCIENCES**  
**DEPARTMENT OF MATHEMATICS AND PHYSICS**  
**UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF**  
**TECHNOLOGY IN RENEWABLE ENERGY AND ENVIRONMENTAL**  
**PHYSICS (BTRE)**

**APS 4430: GEOTHERMAL ENERGY**  
**SPECIAL/ SUPPLIMENTARY EXAMINATIONS**

**SERIES: SEPTEMBER 2018**

**TIME: 2 HOURS**

**DATE: SEPTEMBER 2018**

**INSTRUCTION TO CANDIDATES**

You should have the following for this examination. *Answer Booklet, examination pass and student ID.* This paper consists of FIVE questions. Answer question ONE (COMPULSORY) and ANY other TWO questions. The maximum marks for each question is shown. Do not write on the question paper. Mathematical tables and scientific calculators may be used.

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**QUESTION ONE (30 MKS)**

- (a) (i) Define the terms geothermal energy resources. (1mk)  
(ii) Mention sources of the internal energy of the earth. (3mks)  
(b) Give any five different Geothermal Energy Sources. (5mks)  
(c) Discuss four positive attributes of geothermal energy exploitation. (6mks)  
(d) Using well sketched diagrams, discuss the methods of electricity generation from geothermal energy from hydrothermal fluid resources. (15mks)

**QUESTION TWO (20MKS)**

- (a) Using well drawn diagrams, discuss the following geothermal energy resources:  
(i) Geo-pressurized Brines. (6mks)  
(ii) Hot dry rock systems. (6mks)  
(iii) Magma Geothermal resource. (6mks)  
(b) Discuss any two geothermal exploitation Harmful Effects. (2mks)

### **QUESTION THREE (20MKS)**

- (a) (i) What is a geothermal system? (2mks)  
(ii) A geothermal system consists of three major elements: List them. (3mks)  
(iii) What is a hydrothermal system? (1mk)
- (b) Identification and quantification of geothermal resources require geological, hydrological, geophysical, and geochemical techniques that gather information regarding the potential use of specific sites. Discuss any FIVE geothermal exploration items that these techniques should address. (10mks)
- (c) List and discuss any three resistivity controlled rocks parameters that correlate to a geothermal activity. (4mks)

### **QUESTION FOUR (20MKS)**

- (a) Hydrothermal systems can be identified and classified according to their hydrological system. Classify magmatic related hydrothermal systems into their two major classes and list two subclasses in each case. (6mks)
- (b) (i) Calculate the geothermal power potential of a site that covers 50 km<sup>2</sup> with a thermal crust of 2 km, where the temperature gradient is 240<sup>o</sup> C. At this depth the specific heat of rock is determined to be 2.5 J/cm<sup>3</sup>, and the mean surface temperature is measured at 15<sup>o</sup> C. (3mks)
- (ii) Assuming that only 2 percent of the available thermal energy of the geothermal mass could be used to provide power from electricity generation, how many years would it take to produce 1000 MW/yr of power? (3mks)
- (c) The degree to which geothermal exploitation affects the environment is proportional to the scale of its exploitation. Discuss this statement. (8mks)

### **QUESTION FIVE (20MKS)**

- (a) Discuss the importance of the following exploration methods:
- (i) Geological and hydrogeological studies (5mks)
  - (ii) Geochemical surveys (5mks)
  - (iii) Geophysical surveys (5mks)
  - (iv) Drilling of exploratory wells (3mks)
- (b) Describe the Controlled Source Audiomagnetotelluric method. (2mks)