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(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

(MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN RENEWABLE ENERGY TECHNOLOGY

COURSE CODE: RET 344

COURSE TITLE: GEOTHERMAL AND NUCLEAR ENERGY

DATE: 27.04.2022 **TIME: 3PM -5PM**

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over

QUESTION ONE [30 marks]

A) As an engineer in the energy sector, you are tasked with development of a geothermal power plant. Provide the items to be included in the capital expenditure (6 Marks)

B) Calculate the initial temperature and heat content per square kilometer above 40^0C of an aquifer of thickness 0.5km, depth 3km, porosity 5%, under sediments of density $2700kgm^{-3}$, specific heat capacity $840Jkg^{-1}K^{-1}$ and temperature gradient 30^0Ckm^{-1}. Suggest a use for the heat if the average surface temperature is 10^0C. (3 Marks)

C) Explain whether or not Kenya should invest in nuclear energy (8 Marks)

D) Describe by differentiating the THREE classes of geothermal regions (3 marks)

E) Using a well labelled diagram, differentiate between nuclear fission and nuclear fusion (6 Marks)

F) After 24.0 days, 2.00 milligrams of an original 128.0 milligram sample remain. Calculate half-life of the sample (4 Marks)

QUESTION TWO [20 marks]

A) A sandstone aquifer at $T_1 = 70^oC$ is 20 m thick and 100 m wide. The density, specific heat, porosity and permeability are 2.3×10^3 kg/m^3, 1000 J/kg^{o}C, 0.02, 2×10^{-9} s-m^3/kg, respectively. Estimate the volume flow rate (Q) needed to generate a power output P of 1 MW and the pressure drop required for a borehole separation at L = 1 km in length. Assume the water at inlet is at $T_o = 10^oC$, water density ρ_w = 103 kg/m^3 and C_w = 4000 J/kg^{o}C (6 Marks)

B) With the aid of a well labelled diagram, describe the operation of pressurized water reactor (8 Marks)

C) Using a well labelled diagram, describe the functions of various parts of a fission reactor (6 Marks)

QUESTION THREE [20 marks]

A) $^{226}_{88}Ra$, a common isotope of radium, has a half-life of 1620 years. Calculate the first order rate constant for the decay of radium-226 and the fraction of a sample of this isotope remaining after 100 years (4 Marks)

B) Explain eight advantages of sonic drilling for geothermal installations (8 Marks)

C) Describe four classes or radioactive waste (8 Marks)

QUESTION FOUR **[20 marks]**

A) Explain four objectives of advanced geothermal drilling and logging technologies (4 Marks)

B) Using a well labelled diagram explain the working principle of a geothermal reservoir (8 Marks)

C) Over a period of 1 year a nuclear power plant with an output rating of 1075 MWe actually delivers 255,000 MWd of electric power to the utility grid. During this time, the plant was down-that is, inoperable-28 days for refueling, 45 days for repairs to the nuclear portions of the plant, and 1 8 days for repairs to the conventional portions of the plant.

I. What was the plant capacity factor during the year? (4 Marks)

II. What was the plant availability? (4 Marks)