JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

UNIVERSITY EXAMIMATION FOR THE DEGREE IN SCIENCE IN RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT

3RD YEAR 2ND SEMESTER 2023/2024 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1306

COURSE TITLE: NUCLEAR ENERGY TECHNOLOGY

EXAM VENUE: **STREAM: BSc. REN ENGY TEC & MGT**

DATE: /04/2024 **EXAM SESSION:**

DURATION: 2 HOURS

Instructions

1. **Answer question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

QUESTION ONE (COMPULSORY) (30 Marks)

a. Define the following terms:
   i. Fusion (1 Mark)
   ii. Chain reaction (1 Mark)
   iii. Nuclear reactor (1 Mark)
b. Examine the need for breeder reactors to have more than one sodium loop for water/steam cycle. (3 Marks)
c. Illustrate using a neat diagram the key characteristics of the Canadian Deuterium Uranium reactor (CANDU). (4 Marks)
d. Compare and contrast a nuclear power plant in South Africa using light water as a moderator and a nuclear power plant in Ukraine using heavy water as a moderator. (4 Marks)
e. Examine the basics of operation of any nuclear power plant around the world. (5 Marks)
f. Using a neat diagram, illustrate the nuclear fuel cycle of a given power plant. (6 Marks)
g. Classify the economic problems associated with setting up of nuclear energy power plants (5 Marks)

QUESTION TWO (20 Marks)

a. Calculate the mass deficit, Δm (J/kg) of the following fission reaction

$^{235}U + n \rightarrow {}^{144}Cs + {}^{90}Rb + 2n$

Given, ^{235}U=235.043930 amu, ^{144}Cs=143.932077 amu, ^{90}Rb=89.914802 amu, n=1.008665 amu, 1 eV=1.602E(-19) J, 1 MeV=1.602E(-13)J, 1 amu=1.66E(-27)kg, Avagadro's number=6.023E(23) atoms/mole. (10 Marks)

b. Examine key objectives of a fourth generation reactor. (4 Marks).
c. Examine the major types of radioactive wastes, clearly specifying their examples. (6 Marks)

QUESTION THREE (20 Marks)

a. Calculate the mass deficit, Δm (J/kg) of the following fusion reaction (10 Marks)

$^{2}D + {}^{3}T \rightarrow {}^{4}He + n$

Given, ^{2}D=2.014102 amu, ^{3}T=3.0160493 amu, ^{4}He=4.002603 amu, n=1.00867 amu, 1 eV=1.602E(-19) J, 1 MeV=1.602E(-13)J, 1 amu=1.66E(-27)kg, Avagadro's number=6.023E(23) atoms/mole. (10 Marks)

b. Using neat diagrams, examine three types of nuclear reactors in use today. Compare and contrast these types of reactors. (10 Marks)

QUESTION FOUR (20 Marks)

a. Controlled nuclear fusion has been achieved on earth using the following reaction.

$^{2}H + {}^{3}H \rightarrow {}^{4}He + n$

Calculate the energy released during this reaction in J/kg

Given, H=1.00784 amu, ^{4}He=4.002603 amu, n=1.00867 amu, 1 eV=1.602E(-19) J, 1 MeV=1.602E(-13)J, 1 amu=1.66E(-27)kg, Avagadro's number=6.023E(23) atoms/mole. (10 Marks)

b. Examine two types of breeder reactors. (4 Marks)
c. Examine using relevant examples, the causes and effects of the Chernobyl and Three Mile Island nuclear power accidents to the environment. (6 Marks)

QUESTION FIVE (20 Marks)

a. Compare and contrast breeding and conversion as used in nuclear energy technology. (4 Marks)
b. Using a neat diagram, show the basic ingredients of a nuclear reactor highlighting their functions. (6 Marks)
c. Examine the biological effects of radioactive emissions to both humans and the environment. (10 Marks)