NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PHYSICS
2025_2 EXAMINATIONS

COURSE CODE: PHY 456
COURSE TITLE: NUCLEAR REACTOR PHYSICS
CREDIT UNIT: 3
TIME ALLOWED: 3 HRS
INSTRUCTION: Answer question 1 and any other three questions

CONSTANTS (Planck's constant divide by 2π) = 1.055×10^{-34} Js
= 9.0×10^{9} N.m^2/C^2

Electron charge (e)	= 1.6×10^{-19}C
Electron mass	= 9.1×10^{-31} kg
Mass of Hydrogen	= 1.007825 u
Mass of neutron	= 1.008665 u
Boltzmann constant (k_B)	= 1.381×10^{-23} J/K
Avogadros Number (N_A)	= 6.022×10^{-23} atoms/mole
1 eV	= 1.6×10^{-19} J
1 u	=1.66×10^{-27} kg

QUESTION 1

A. List five ways in which neutrons can interact with nuclei. (5 marks)

B. What is a moderator? (2 marks)

C. What is a nuclear reactor? (2 marks)

D. What is meant by the following terms: nuclear power, nuclear energy and atomic energy? (7.5 marks)

E. Consider the following nuclear fusion reaction that uses deuterium and tritium as fuel.

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + X$$

(i). Complete the reaction equation. What is the name of the new particle released during the reaction? (2.5 mark)

(ii). Determine the mass defect of a single reaction, given the following information.
$^{2}_{1}H = 2.0141\ amu$, $^{3}_{1}H = 3.016049\ amu$, $^{4}_{2}H = 4.0026\ amu$, $^{1}_{0}n = 1.0087\ amu$ (3 marks)

(iii). Determine the energy in joules released during a single fusion reaction. (3 marks)

QUESTION 2

A. What is a Cross Section in nuclear physics? **(3 marks)**

B. Show that macroscopic collision density F is given by **(12 marks)**

QUESTION 3

A. Define neutron moderation, hence list two examples of good moderators. (4.5 marks)

B. With the aid of a suitable diagram, explain two frames of reference considered for neutron thermalization. **(6 marks)**

C. List any 3 parts of a nuclear reactor? (4.5 marks)

QUESTION 4

A. List two types of frames of references considered for neutron moderation. **(5 marks)**

B. Show that fractional energy, $\frac{E_1}{E_0} = \frac{[1+A^2+2ACos\theta]}{[1+A]^2}$ **(10 marks)**

QUESTION 5

A. What is meant by a reactor poison? (2 marks)
B. Calculate the power density of a typical PWR reactor such as Koeberg Unit 1 (4 marks)
C. Explain how the temperature coefficient of reactivity is largely determined by the resonances in 238U. (3 marks)
D. List the main component in nuclear reactor (6 marks)

QUESTION 6

A List and discus any four component of Nuclear Reactor (8 marks)

B Enumerate and discus any three type of Nuclear reactor (4.5 marks)

C. What is the medium utilization factor? (2.5 marks)