NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021_1 EXAMINATIONS

COURSE CODE: **PHY456**
COURSE TITLE: **NUCLEAR REACTOR PHYSICS**
CREDIT UNIT: **3**
TIME ALLOWED: **(2½ HRS)**

INSTRUCTION: ***Answer question 1 and any other four questions***

QUESTION 1

(a). Calculate the energy liberated when a helium nucleus is formed by the fusion of two deuterium nuclei. (Mass of deuterium is 2.01478u, mass of helium nucleus is 4.00388u)**(4 marks)**

(b). List the two main types of nuclear reactor **(2 marks).**

(c). Mention five(5) components of nuclear reactors**(5 marks)**

(d). Explain nuclear criticality **(2 marks)**

(e). Define neutron flux **(2 marks)**

(f). When is resonance absorption said to occur? **(2 marks)**

(g). Under what conditions can the neutron flux Φ be realized from diffusion equation? **(2 marks)**

(h). A block of aluminum has a density of 2.699 g/cm3. If the gram atomic weight of aluminum is 26.9815 g, calculate the atom density of the aluminum. (Avogadro's number, $N_A = 6.022\times10^{23}$ atoms/mole)**(3 marks)**

QUESTION 2

(a). Explain (i) microscopic cross section for absorption (ii) microscopic cross section for scattering (iii) total microscopic cross section **(6 marks)**

(b). Assuming that uranium-236 has a nuclear quantum energy level at 6.8 MeV above its ground state, calculate the kinetic energy a neutron must possess to undergo resonant absorption in uranium-235 at this resonance energy level **(6 marks)**.

QUESTION 3

(a). As observed in the laboratory system, a 6 MeV proton is incident on a stationary carbon-12 target. Find the velocity of the center-of-mass system. Take the mass of the proton to be 1 u. **(7 marks)**.

(b). Calculate the energy liberated when a helium nucleus is formed by the fusion of two deuterium nuclei. (mass of $_1H^2$ is 2.01478u, mass of $_2He^4$ is 4.00388u. 1u = 931 MeV) **(5 marks)**.

QUESTION 4

(a). List the three desirable characteristics of a moderator **(3 marks)**.

(b). Calculate the average number of elastic collisions required for a fast neutron, born with an average energy of about 2 MeV to slow down to a thermal neutron, with an average energy of about 0.025 eV for deuterium, which is a heavy form of hydrogen with one proton and one neutron. **(9 marks)**.

QUESTION 5

(a). Give three differences between the mechanisms of nuclear fission and nuclear fusion. **(6 marks)**

(b). Explain why nuclear fusion is called a thermonuclear reaction **(6 marks)**.

QUESTION 6

(a). (i) Suppose the mean free path of a neutron is 100 cm and experienced five collisions before being absorbed. How far does it travel with other nuclei in the lattice? **(2 marks)**

(ii) Mention two boundary conditions which must be satisfied before we can obtaining neutron flux ϕ from the diffusion equation. **(2 marks)**

(iii) List two characteristics that are common to materials that neutrons move through easily **(2 marks)**

(b). Find the macroscopic thermal neutron absorption cross section for iron, which has a density of 7.86 g/cm^3. The microscopic cross section for absorption of iron is 2.56 barns and the gram atomic weight is 55.847 g. (Avogadro's number, $N_A = 6.022 \times 10^{23}$ atoms/mole) **(6 marks)**.