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MPHE–026

M. SC. (PHYSICS)

(MSCPH)

Term-End Examination

December, 2025

MPHE-026 : ELEMENTS OF REACTOR PHYSICS

Time : 2 Hours *Maximum Marks : 50*

Note : *Answer any* ***five*** *questions. Symbols have their usual meanings. The marks for each question are indicated against it. You may use a calculator.*

1. (a) Calculate the density of nuclear matter with nucleon mass = 1.67×10^{-24} g and $R_0 = 1.24$ fm. 5

(b) How many grams of ^{12}C can produce 8.2×10^4 MJ energy, if 4 eV of energy is produced when a ^{12}C atom is burnt ? Express your result in tons. 5

2. Establish the four factor formula :

$$K_\infty = \eta \varepsilon p f$$

for an infinite reactor. How this relation would be modified if the reactor is made only of ^{235}U or is made finite. 6+2+2

3. (a) A 2.6 MeV neutron collides with hydrogen. Calculate the probability that the energy of neutron is within the energy range 0.63 and 0.75 MeV after collision. If a neutron loses 0.75 MeV in LAB system, what is the scattering angle in the CM system ? 5

(b) On an average, the neutron loses half of its energy per collision with a target nucleus. How many elastic collisions are needed for a 2 MeV neutron to become a thermal neutron having an energy 0.4 eV ? 5

4. (a) Derive an expression for the slowing down time for neutrons in a scattering medium. If 2 MeV neutrons are slowed down to 0.025 eV in graphite, obtain the corresponding time for slowing down. Take $\Sigma_s = 0.385\,\text{cm}^{-1}$, $\xi = 0.158$ and $m = 1.67 \times 10^{-24}$ g. 7

(b) A neutron beam is incident on a stationary target of ^{19}F atoms. If the Q-value of the reaction $^{19}F(n, p)\ ^{19}O$ is 3.9 MeV, calculate the threshold energy of the reaction. 3

5. (a) Using the method of spherical harmonics for a non-multiplying 1-D plane geometry, write the exact infinite coupled equations. Hence, for a large absorbing system, obtain equations under P_1 approximation. 7

(b) Discuss briefly the different kinds of initial and boundary conditions which help to solve the transport equation. 3

6. (a) Write down the transport equation for a non-multiplying system. Obtain 1-D equation for a homogeneous moderating infinite slab. 1+4

   (b) State Fick's law. Write its mathematical expression. Discuss its importance in neutron transport. 1+1+3

7. Consider an infinite homogeneous moderating medium with a monoenergetic point source emitting S neutrons per second. Show that L^2 is equal to one-sixth the average of the square of the vector (crow-flight) distance that a neutron travels from the point where it is emitted to the point where it is finally absorbed. 10

8. Derive two-group diffusion equations for a critical homogeneous reactor for steady state case. Ignore the presence of delayed neutrons. 10

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