MPHE-026

ASSIGNMENT BOOKLET

M.Sc. (Physics) Programme

(MSCPH)

ELEMENTS OF REACTOR PHYSICS

Valid from 1st July, 2024 to 30th June, 2025

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

(2024-25)

Dear Student,

Please read the section on assignments in the Programme Guide for M.Sc. (Physics) before attempting this Tutor Marked Assignment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignment is in this booklet, and it consists of two parts: Part A and Part B. The total marks of both parts are 100, of which at least 40% are needed to pass.

Instructions for Formatting Your Assignments

Before attempting the assignment, please read the following instructions carefully:

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

	ROLL NO.: ………………………………………..…
	NAME: ……………………………………………..…
	ADDRESS: ………………………………………….
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COURSE CODE:………………………….	
COURSE TITLE: …………………………	
ASSIGNMENT CODE: …………………..	
STUDY CENTRE: ………………………..	**DATE:** ………………….………………….............

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
3) Leave 4 cm margin on the left, top and bottom of your answer sheet.
4) Your answers should be precise and in your own words.
5) Solve Part A and Part B of this assignment, and **submit the complete assignment answer sheets containing Parts A and B within the due date.**
6) The assignment answer sheets are to be submitted to your Study Centre as per the schedule. **Answer sheets received after the due date will not be accepted.**

   We strongly suggest that you retain a copy of your answer sheets.
7) This assignment is **valid from 1st July 2024 to 30th June 2025**. If you have failed in this assignment or fail to submit it by 30th June 2025, then you need to get the assignment for the year 2025-26, and submit it as per the instructions given in the Programme Guide.
8) **You cannot fill the examination form for this course** until you have submitted this assignment. For any queries, please contact: drsgupta@ignou.ac.in. Please note that we do not provide answers to the questions in this Assignment. We wish you good luck.

Tutor Marked Assignment
ELEMENTS OF REACTOR PHYSICS

Course Code: MPHE-026
Assignment Code: MPHE-026/TMA/2024-25
Max. Marks: 100

Note: Attempt all questions. The marks for each question are indicated against it.

PART A

1. a) Calculate the macroscopic scattering cross section for natural uranium. Given $\rho = 18.9\ \text{g/cm}^3$, percentage weight of ^{235}U in natural uranium is 0.713; the rest being ^{238}U. The scattering cross sections for ^{235}U and ^{238}U isotopes being 15 b and 13.8 b, respectively. (5)

   b) Distinguish between prompt and delayed neutrons released in fission and discuss their importance. (5)

   c) The average number of neutrons produced per fission is 2.5. What would happen in a second, if every neutron released in fission causes another fission? Assume a generation time of 0.1 second. (5)

   d) i) What is the difference between slowing down density and flux of neutrons? (2)

   ii) If the reference neutron energy is 10 MeV, calculate the lethargy at 200 keV, and 0.025 eV? (3)

   e) Discuss the concept of breeding and doubling time and describe how abundant fertile actinides could be converted to excellent fissile actinides. (5)

2. a) Define LAB and CM coordinate frames of reference used to study the kinematics of two- body collision. Obtain an expression of kinetic energy of a neutron after collision in the LAB system. (5)

   b) 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)

   c) Derive an expression of average logarithmic energy decrement per collision (ξ). Hence, show that for large mass number, it is independent of energy. Using this formula, plot average logarithmic energy decrement for different nuclides of mass number *A.* (10)

   d) If a 10 MeV neutron is collided with ^{238}U nuclide, compare the average energy loss of neuron if they undergo a) inelastic scattering and b) elastic scattering. (5)

PART B

3. a) Define angular neutron flux and angular current density. The neutron flux at a particular location in a reactor core is 1×10^{14} neutrons $\mathrm{cm}^{-2}\mathrm{s}^{-1}$. What is the average density $(in\ \text{neutrons}\ \mathrm{cm}^{-3})$ of the thermal neutrons at the same location in the core? (5)

   b) Write the basic assumptions made to derive the transport equation. Hence, derive the Boltzmann transport equation for a multiplying system in terms of neutron flux. (10)

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

   d) Discuss the initial, boundary and source conditions. (5)

4. a) For an arbitrary volume V of material in which one speed neutrons interacts with medium nuclei, if $n(\vec{r}, t)$ is the neutron density at $\vec{r}$ and at time t, obtain the equation of continuity. Also, obtain equation for steady state. (5)

   b) The scattering cross-section of Carbon at 1 eV is 4.8 barn. Estimate the diffusion coefficient of Carbon. Assume that Σ_a is almost negligible. (5)

   c) Write two-group criticality condition for a bare homogeneous reactor. Using this equation, show that the six factor criticality condition for two group theory is given by $\eta f p \in P_f P_t = 1$.The symbols have their usual meanings. (10)

   d) Write the Fermi-age critical equation for a bare reactor based on continuous slowing down model. Reduce it to two- group critical equation for large assemblies (for small values of B_g^2). (5)

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