

MPHE-026

ASSIGNMENT BOOKLET

**M.Sc. (Physics) Programme
(MSCPH)**

ELEMENTS OF REACTOR PHYSICS

Valid from 1st January, 2026 to 31st December, 2026



**School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2026)**

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:

.....

.....

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 January 2026 to 31st December 2026**. If you have failed in this assignment or fail to submit it by 31st December 2026, then you need to get the assignment for the year 2027, 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/2026
Max. Marks: 100

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

PART A

1. a) Calculate, using Weiszäcker formula, the binding energy per nucleon for ${}_{92}^{235}\text{U}$.
Given: $\alpha = 15.8$, $\beta = 17.8$, $\gamma = 23.7$, $\delta = 0.71$
- $$\varepsilon = \begin{cases} 34 & \text{for even - even or odd - odd nuclei.} \\ 0 & \text{otherwise} \end{cases} \quad (5)$$
- b) Define reaction rate. Write its mathematical formula. Explain each term involves in it. (5)
- c) Differentiate between neutron elastic scattering and inelastic scattering. Draw elastic scattering cross-section curves for ${}^1_1\text{H}$ and ${}^{56}_{26}\text{Fe}$ and write their features. (3+2)
- d) i) What are prompt and delayed neutrons? Discuss the role of delayed neutrons in reactor safety. (3)
- ii) Draw and explain the energy variation of fission cross-sections for ${}_{92}^{238}\text{U}$ and ${}_{92}^{232}\text{Th}$. (2)
- e) Derive the four factor formula and explain each term involves in it with mathematical steps. Hence, obtain six-factor formula. (5)
2. a) Show that the average cosine of scattering angle in the LAB system ($\bar{\mu}_L$) is given by $\bar{\mu}_L = \frac{2}{3A}$, where A is the mass number of nucleus. Is this relation applies to hydrogen? (5)
- b) The initial energy of a neutron is 2 MeV, calculate the maximum energy loss due to elastic scattering in ${}^{238}\text{U}$. (5)
- c) Describe the Fermi-age theory and derive Fermi-age approximation of slowing down equation for a weak absorbing medium. Discuss the S-G approximation. (10)
- d) 5 MeV neutron is scattered through an angle of 45 degrees in a collision with ${}^2\text{H}$ nucleus. Calculate the energy of scattered neutrons and energy of the recoiling nucleus. (5)

PART B

3. a) Derive neutron transport equation in terms of angular neutron flux for a heterogeneous multiplying assembly. Rewrite simplified form of this equation for a non-multiplying and homogeneous assembly. (10)
- b) What are (i) initial and boundary conditions, and (ii) Interface boundary conditions? (2)
- c) Using the transport equation for a non-multiplying system and homogeneous assembly, derive the integral form of transport equation using the method of characteristics. What do you understand by "Optical path length" of the medium? (5+2)
- d) What do you understand by constant cross-section approximation? Derive the steady state equation for a plane geometry. Also write the transport equation for a spherical geometry. (1+4+1)

4. a) Starting with the general form of transport equation, obtain the diffusion equation

$$J(\vec{r}, \vec{E}, t) = -D(\vec{r}, E', t) \nabla \phi(\vec{r}, \vec{E}, t) \quad (10)$$

- b) State Fick's law. Discuss its importance in neutron transport /diffusion. Write the assumptions used to derive Fick's law and hence derive its expression. (5)
- c) Derive two-group diffusion equations for a critical homogeneous reactor in steady state. (5)
- d) Show that the root mean square crow-flight distance for neutrons from an infinite plane source in an infinite medium is $\sqrt{2}L$. (5)
