

**ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)**

MATHEMATICAL METHODS IN PHYSICS-III

Valid from January 1, 2025 to December 31, 2025

**It is compulsory to submit the Assignment before filling in the
Term-End Examination Form.**

Please Note

- You can take electives (56 or 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.
- You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.
- At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits out of those 64 credits should be from lab courses.
- You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the responsibility will be yours.



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

2025

Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide for Elective Courses that the University sent you after your enrolment. 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.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

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

ENROLMENT NO. :

NAME :

ADDRESS :

.....

.....

COURSE CODE :

COURSE TITLE :

ASSIGNMENT NO. :

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. Do not copy answers from study material.
- 5) While solving problems, clearly indicate the question number along with the part being solved. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.
- 6) **This assignment will remain valid from January 1, 2025 to December 31, 2025.** However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response.

We wish you good luck.

Tutor Marked Assignment
MATHEMATICAL METHODS IN PHYSICS-III

Course Code: PHE-14
Assignment Code: PHE-14/TMA/2025
Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

1. a) Determine the eigenvalues and eigenvectors of the following matrix A :

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 1 \\ 3 & 2 & 3 \end{bmatrix} \quad (5)$$

- b) Show that the eigenvectors belonging to distinct eigenvalues of a hermitian matrix are orthogonal to each other. (5)
- c) For the quadratic equation $2x^2 + 4xy - y^2 = 24$, write down the matrix of coefficients and diagonalize it. Recast it in new variables and identify the conic section it represents. (5)
- d) Define covariant and contravariant vectors. Show that velocity and acceleration are contravariant vectors. (5)
- e) Show that the set of all real numbers excluding zero is a group under multiplication. (5)
2. a) Using the method of residues, evaluate the contour integral,

$$\int_C \frac{e^{iz}}{(z^2 + 1)} dz \quad \text{where } C \text{ is defined by } |z| < 4. \quad (5)$$

- b) Evaluate the integral

$$\int_0^{2\pi} \frac{d\theta}{2 + \cos\theta} = \frac{2\pi}{\sqrt{3}} \quad (10)$$

- c) Using the Cauchy-Riemann equations, show that $w = \log z$ is analytic when z is not zero. (5)
- d) Write Laurent series for the function

$$f(z) = \frac{1}{z(z+2)^3}$$

about the pole $z = -2$. (5)

3. a) Determine the Fourier transform of the function $f(t) = e^{-|t|}$. Hence deduce that:

$$\int_0^{\infty} \frac{dx}{1+x^2} = \frac{\pi}{2} \quad (10)$$

b) Using the definition determine the Laplace transform of the function $f(t) = e^{3t}$ if it exists. (5)

c) Using the method of Laplace transform, solve the following initial value problem:

$$y'' - 10y' + 9y = 5t; \quad y(0) = -1, \quad y'(0) = 2 \quad (10)$$

4. a) Obtain the first three terms in the expansion of the following function in a series of the form $\sum_{k=0}^{\infty} A_k P_k(x)$:

$$f(x) = \begin{cases} \cos x & \text{for } 0 \leq x \leq \pi/2 \\ 0 & \text{for } \pi/2 \leq x \leq \pi \end{cases} \quad (10)$$

b) Using the following expression for a Bessel function of order m :

$$J_m(x) = \sum_{k=0}^{\infty} (-1)^k \frac{1}{k! \Gamma(m+k+1)} \left(\frac{x}{2}\right)^{2k+m}$$

show that

i) $J_0'(x) = J_1(x)$

ii) $\frac{d}{dx}[xJ_1(x)] = xJ_0(x)$ (10)

c) Using Rodrigue's formula, obtain the expression for $L_3(x)$. (5)
