**PHE-14**

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

## MATHEMATICAL METHODS IN PHYSICS-III

**Valid from January 1, 2020 to December 31, 2020**

**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**

**2020**

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:

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ENROLMENT NO. : ……

NAME : ……

ADDRESS : ……

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COURSE CODE : ……..

COURSE TITLE : ……..…….

ASSIGNMENT NO. : ……..…

STUDY CENTRE : ……..……. DATE : ….……...……

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**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, 2020 to December 31, 2020**. 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/2020**
**Max. Marks: 100**

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

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1. a) i) Define skew-hermitian matrix, orthogonal matrix and unitary matrix with an example of each.

   ii) Show that matrix $A$ given below is skew-hermitian:

$$A = \begin{bmatrix} 0 & -5-i & -2+3i \\ 5-i & -3i & -6 \\ 2+3i & 6 & 6i \end{bmatrix} \qquad (3+2)$$

   b) Show that every eigenvalue of a unitary matrix is of unit modulus. (5)

   c) Identify the conic section whose equation is

$$5x^2 - 4xy + 5y^2 = 4 \qquad (5)$$

   d) Define covariant and contravariant tensors of rank two. What is the rank of a scalar tensor? Show that the Kronecker delta function is a mixed tensor of rank 2. (5)

   e) Show that the roots of the equation $z^4 - 1 = 0$ form a cyclic group of order 4. (5)

2. a) Show that the function $\omega = \sin z$ satisfies the Cauchy-Riemann and Laplace equations. (5)

   b) Evaluate the integral

$$\oint_C \frac{5z^2 - 3z + 2}{(z-1)^3} dz$$

   where $C$ is any simple closed curve enclosing $z = 1$. (5)

   c) Obtain the Laurent series expansion of the function $\frac{e^z}{(z-2)^2}$ about the singularity $z = 2$. (5)

   d) Using the method of residues, show that:

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

3. a) Determine the Fourier transform of the function :

$$f(t) = \begin{cases} \sin 3t & -\pi \le t \le \pi \\ 0 & \text{otherwise} \end{cases} \qquad (10)$$

b) Determine the Laplace transform of $f(t) = t^2 e^{2t}$. (5)

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

$$y'' - 3y' + 2y = 6\mathrm{e}^{-t}; \quad y(0) = 3, \quad y'(0) = 3 \tag{10}$$

4. a) Show that $P_1(x)$ is orthogonal to $[P_n(x)]^2$ on the interval $(-1, 1)$. (5)

b) Show that

$$J_0(x) - J_2(x) = 2\frac{d}{dx}[J_1(x)] \tag{5}$$

c) Expand the function $f(x) = x^4 - 1$ in a series of the form $\sum_{k=0}^{\infty} A_k P_k(x)$. (10)

d) Using Rodrigue's formula, obtain expression for the Hermite polynomial $H_3(x)$ and show that $H_3'(x) = 6H_2(x)$. (5)

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