BPHE-104/PHE-04

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

MATHEMATICAL METHODS IN PHYSICS-I

Valid from January 1, 2021 to December 31, 2021

It is compulsory to submit the Assignment before filling up 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.**

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THE PEOPLE'S UNIVERSITY

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

2021

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 we 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 : ………………………………………

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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.
5) While solving problems, clearly indicate the question number along with the part being solved. Be precise. 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, 2021 to December 31, 2021**. 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-I

Course Code: BPHE-104/PHE-04
Assignment Code: BPHE-104/PHE-04/TMA/2021
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) Determine the value of a constant α such that the projection of a vector $\vec{\mathbf{A}} = \alpha\hat{\mathbf{i}} + \hat{\mathbf{j}} + 3\hat{\mathbf{k}}$ on the vector $\vec{\mathbf{B}} = 3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 6\hat{\mathbf{k}}$ is 5 units. (5)

   b) For the vectors $\vec{\mathbf{a}}$, $\vec{\mathbf{b}}$, $\vec{\mathbf{c}}$ and $\vec{\mathbf{d}}$ show that:

   $$(\vec{\mathbf{a}}\times\vec{\mathbf{b}}) \,.\, (\vec{\mathbf{c}}\times\vec{\mathbf{d}}) + (\vec{\mathbf{b}}\times\vec{\mathbf{c}}) \,.\, (\vec{\mathbf{a}}\times\vec{\mathbf{d}}) + (\vec{\mathbf{c}}\times\vec{\mathbf{a}}) \,.\, (\vec{\mathbf{b}}\times\vec{\mathbf{d}}) = 0$$ (5)

2. a) Obtain the unit tangent vector for a vector function

   $$\vec{\mathbf{a}}(t) = (2t+5)\hat{\mathbf{i}} + (t^2+1)\hat{\mathbf{j}} + (1-t^3)\hat{\mathbf{k}} \text{ at } t=1.$$ (5)

   b) Determine the direction of maximum increase of the scalar field $f(x, y, z) = x\,e^y + z^2$ at the point $O(1, \ln 2, 3)$. (5)

3. a) Determine the value of n for which the vector field $\vec{\mathbf{F}} = r^n\vec{\mathbf{r}}$ is solenoidal, where $\vec{\mathbf{r}} = x\hat{\mathbf{i}} + y\,\hat{\mathbf{j}} + z\,\hat{\mathbf{k}}$. (5)

   b) Show that for any scalar field ϕ:

   $$\vec{\nabla}\times(\phi\vec{\nabla}\phi) = 0.$$ (5)

4. a) Obtain the curl of the following vector field:

   $$\vec{\mathbf{F}} = 2\rho^2\hat{\mathbf{e}}_\rho - z\cos\phi\,\hat{\mathbf{e}}_\phi + 3z\sin\phi\,\hat{\mathbf{e}}_z$$ (5)

   b) Obtain the divergence of the following vector field:

   $$\vec{\mathbf{A}} = \left(\hat{\mathbf{e}}_r + r\cos\theta\,\hat{\mathbf{e}}_\theta + r\,\hat{\mathbf{e}}_\phi\right)$$ (5)

5. Determine the work done by a force $\vec{\mathbf{F}} = xy\,\hat{\mathbf{i}} + yz\,\hat{\mathbf{j}} + xz\,\hat{\mathbf{k}}$ in taking a particle along the path defined by the equation $\vec{\mathbf{r}}(t) = t\,\hat{\mathbf{i}} + 2t^2\hat{\mathbf{j}} + t^3\hat{\mathbf{k}},\ 0 \le t \le 1$ from $t=0$ to $t=2$. Is the force conservative? (10)

6. Using Gauss' theorem calculate the flux of the vector field $\vec{\mathbf{A}} = x^3\hat{\mathbf{i}} + x^2z\,\hat{\mathbf{j}} + yz\hat{\mathbf{k}}$ through the surface of a cube of side 2 units. (10)

7. Using Green's theorem evaluate the integral: $\int_C \left(y^3dx + 3x^3dy\right)$ where C is the contour along the circle $x^2 + y^2 = 1$ taken counter clockwise. (10)

8. A homogeneous triangular lamina has the vertices (0, 0), (3, 0) and (0, 3). Obtain the coordinates of the centre of mass of the lamina. (10)

9. a) An athlete is running in five races and in each race he has a 70% chance of winning. What is the probability that he will win at least two races? (5)

   b) The average number of cars arriving at a particular red light each day is 4. Assuming a Poisson distribution, calculate the probability that on a given day, less than three cars will arrive at the red light. (5)

10. The following readings were recorded in an experiment to determine the Young's modulus for a steel bar.

Load (g)	0	10	20	30	40	50
Shift (cm)	0	0.6	1.25	2.05	2.6	3.2

Determine the correlation coefficient, the regression equation and the standard error of estimate for the data. (10)

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