BPHCT-133

ASSIGNMENT BOOKLET

BACHELOR OF SCIENCE
(BSCM)

ELECTRICITY AND MAGNETISM

Valid from 1st January, 2024 to 31st December, 2024

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2024)

Dear Student,

Please read the section on assignments in the Programme Guide for B.Sc. 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. The assignment is in this booklet, and it consists of two parts, Part A and B. The total marks of all the parts are 100, of which 35% are needed to pass it.

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.
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 shall not be accepted.**

   We strongly suggest that you retain a copy of your answer sheets.
7) This assignment is **valid from 1st January, 2024 to 31st December, 2024**. If you have failed in this assignment or fail to submit it by 31st December, 2024, then you need to get the assignment for the year 2025, 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: srjha@ignou.ac.in. We wish you good luck.

Tutor Marked Assignment
ELECTRICITY AND MAGNETISM

Course Code: BPHCT-133
Assignment Code: BPHCT-133/TMA/2024
Max. Marks: 100

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

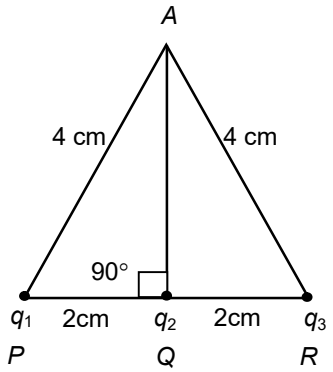
PART A

1. a) Determine the direction in which the scalar field $f(x,y) = 2x^2 - y^2 + xy$ increases most rapidly at the point (1, 1). (5)

   b) Calculate the work done by a force $\vec{\mathbf{F}} = 3x\hat{\mathbf{i}} + 2y\,\hat{\mathbf{j}}$ in moving a particle once counter-clockwise along the ellipse $\frac{x^2}{4} + \frac{y^2}{9} = 1$. (10)

   c) Use the divergence theorem to calculate the flux of a vector field $\vec{\mathbf{A}} = 2x\,\hat{\mathbf{i}} - y\,\hat{\mathbf{j}} + 3z\ \hat{\mathbf{k}}$ over a cube of side 2*a* which has its vertices at $(\pm a, \pm a, \pm a)$. (10)

2. a) Consider the figure given below. Charges q_1, q_2 and q_3 are placed at *P*, *Q* and *R*, respectively, and $q_1 = q_2 = -q_3 = 2\mu\text{C}$. Determine the magnitude and the direction of the electric field at point *A*. (10)



   b) Determine the electric field of a uniformly charged infinite solid cylinder of radius *R* at a point (i) outside the cylinder, and (ii) inside the cylinder. (10)

   c) Obtain an expression for electric potential due to an electric dipole at an off axis point at a distance *r* from the midpoint of the dipole. (5)

PART B

3. a) The separation between the plates of a parallel plate capacitor is 3 mm and the cross-sectional area of the plates is 5.5 x 10^{-4} m^{-2}. A dielectric material of dielectric constant 5.0 is filled between the plates of the capacitor and a voltage of 80 V is applied across the plates. Calculate (i) the capacitance of the capacitor, (ii) charge stored on each plate, (iii) displacement *D*, and (iv) polarization *P*. (10)

b) Explain the concept of current density and derive continuity equation. What form does the continuity equation takes for steady currents? (10)

c) A toroid has 500 turns and it carries a current of 8 A. Calculate the magnetic field within the toroid at a point which is at a distance of 15 cm from its centre. (5)

4. a) A typical ignition coil made up of two coils draws a current of 4.0 A and supplies an emf of 25 kV to the spark plugs. If the current in the two coils is interrupted every 0.15 ms, calculate their mutual inductance. (5)

b) Explain the physical significance of the Maxwell's equation $\nabla \times \vec{\mathbf{B}} = \mu_0 \left(\vec{\mathbf{J}} + \varepsilon_0 \frac{\partial \vec{\mathbf{E}}}{\partial t} \right)$.

Derive the wave equation for the electric field of an electromagnetic wave. (5+5)

c) Consider an electromagnetic wave in vacuum whose electric field is given by

$$\vec{\mathbf{E}} = (800\ \mathrm{Vm}^{-1})\,\hat{\mathbf{y}} \cos(50\,x - \omega t)$$

Determine the direction of propagation, the wave number, the frequency and the magnetic field of the wave. (10)

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