BPHCT-133

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG/BSCM)

ELECTRICITY AND MAGNETISM

Valid from 1st January, 2025 to 31st December, 2025

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2025)

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, 2025 to 31st December, 2025**. If you have failed in this assignment or fail to submit it by 31st December, 2025, then you need to get the assignment for the year 2026, 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, slamba@ignou.ac.in,

We wish you good luck.

Tutor Marked Assignment
ELECTRICITY AND MAGNETISM

Course Code: BPHCT-133
Assignment Code: BPHCT-133/TMA/2025

Max. Marks: 100

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

PART A

1. a) If $\vec{\mathbf{u}}$ is a constant vector show that $\vec{\nabla}\times(\vec{\mathbf{u}}\times\vec{\mathbf{r}}) = 2\vec{\mathbf{u}}$. (5)

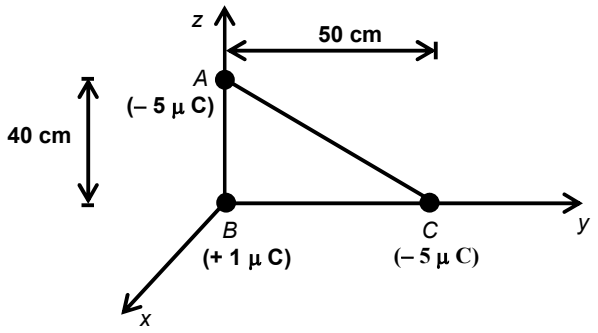
b) Determine the work done by a force $\vec{\mathbf{F}} = (x+2y)\hat{\mathbf{i}} + (x-y)\hat{\mathbf{j}}$ in taking a particle along the curve $x(t) = 2\cos t; y(t) = 4\sin t$ from $t = 0$ to $t = \frac{\pi}{4}$. (10)

c) Using Stokes' theorem, prove that curl of a conservative force field is zero everywhere. (5)

d) Determine the directional derivative of the scalar field $\phi = \ln(x^2 + y^2 + z^2)$ in the direction $(\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}})$ at the point (1,-1, 2). (5)

2. a) Explain with the help of diagrams what spherically and cylindrically symmetric charge distributions are. What is the electric field at a point inside a hollow metallic sphere of radius *R* having volume charge density ρ? (8+2)

b) Determine the electrostatic force and electrostatic field on a charged particle located at *A* in the Figure given below due to the charged particles situated at *B* and *C*. The value of the charge on each of these particles is indicated in the Figure.



Express your result both in the unit vector notation and as magnitude. (10)

c) Two particles carrying 4C and − 2C charges are placed on a 1 m long straight wire. Determine the point on the line joining these particles where the electric potential is zero with reference to the positively charged particle. (5)

PART B

3. a) Explain the phenomenon of polarisation of a dielectric. Show that, when a dielectric material is filled between the plates of a capacitor, the value of capacitance increases by factor of *K*, the dielectric constant of the material. (5+10)

   b) The energy of a capacitor is 4.0 μJ after it has been charged by a 1.5 V battery. Calculate its energy when it is charged by a 6.0 V battery. (5)

   c) A horizontal, straight wire carrying 12.0 A current from west to east is in the earth's magnetic field **B**. At this place, **B** is parallel to the surface of the earth, points to the north and its magnitude is 0.04 mT. Determine the magnetic force on 1 m length of the wire. If mass of this length of wire is 50 g, calculate the value of current in the wire so that its weight is balanced by the magnetic force. (5+5)

4. a) A current is flowing in an infinitely long straight wire. Using Biot-Savart law, show that the resultant magnetic field at a point along a line perpendicular to the wire is inversely proportional to the distance of the point from the wire. (5)

   b) Using Maxwell's equations in free space, derive the wave equation for the electric and magnetic field vectors. (5+5)

   c) The expression of the electric field associated with an electromagnetic wave in vacuum is given by

   $$\vec{\mathbf{E}} = (800\ \mathrm{Vm}^{-1})\ \hat{\mathbf{x}} \sin(2\pi \times 10^{8} t + kz)$$

   Determine the wave number, frequency, the direction of propagation and the magnitude and direction of the magnetic field associated with the wave. (1×5)

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