BPHCT-133

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME
(B.SC.G)

ELECTRICITY AND MAGNETISM

Valid from 1st January, 2022 to 31st December, 2022

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2022)

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, 2022 to 31st December, 2022**. If you have failed in this assignment or fail to submit it by 31st December, 2022, then you need to get the assignment for the year 2023, 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, vijayashri@ignou.ac.in. We wish you good luck.

Tutor Marked Assignment
ELECTRICITY AND MAGNETISM

Course Code: BPHCT-133
Assignment Code: BPHCT-133/TMA/2022
Max. Marks: 100

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

PART A

1. a) Determine the value of the constant *a* for which the vector field $\vec{\mathbf{F}} = (2x^2y + z^2)\hat{\mathbf{i}} + (xy^2 - x^2z)\hat{\mathbf{j}} + (axyz - 2x^2y^2)\hat{\mathbf{k}}$ is solenoidal. (5)

   b) Calculate the work done by a force $\vec{\mathbf{F}} = (x - y)\hat{\mathbf{i}} + xy\,\hat{\mathbf{j}}$ in moving a particle counterclockwise along the circle $x^2 + y^2 = 4$ from the point (2,0) to the point (0, –2). (10)

   c) Using Stoke's Theorem evaluate the line integral $\int_c \vec{\mathbf{F}}.d\bar{\mathbf{l}}$ where *C* is the ellipse $\frac{x^2}{4} + \frac{y^2}{16} = 1$ in the *xy* - plane and $\vec{\mathbf{F}} = 2x^2\hat{\mathbf{i}} + 4x\,\hat{\mathbf{j}} + 2z^2\,\hat{\mathbf{k}}$. (10)

2. a) Two electric charges 2 μC and –1 μC are placed at a distance of 20 cm from each other in vacuum. Locate the point on the line joining these two charges outside the region between them at which the electric potential is zero with reference to the positive charge. (5)

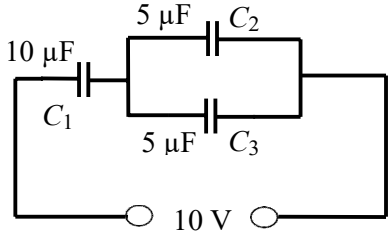
   b) A sphere of radius *R* carries a charge of volume charge density ρ= *ar*, where *a* is a constant and *r* denotes the distance from the centre of the sphere. Calculate the total charge enclosed by the sphere and the electric field at points lying inside and outside the sphere. (10)

   c) Derive the expression for electric potential of a line charge. (10)

PART B

3. a) A dielectric object is placed in an electric field. The object becomes polarised and a large number of atomic/molecular dipoles in the object align in the direction of the applied electric field. Derive an expression for the electric potential due to this polarised dielectric at a point outside the dielectric. (10)

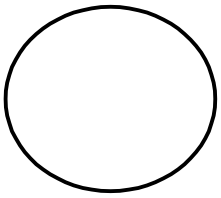
   b) Three capacitors are connected to a 10 V potential difference as shown in the figure below:



   Calculate the charge on each plate and the potential difference across each capacitor when fully charged. (5+5)

c) In the Bohr model of hydrogen atom, the electron follows a circular orbit centred on the nucleus containing a proton. The motion of the electron along the circular orbit constitutes a current. Calculate the magnetic field produced by the orbiting electron at the site of the proton. (5)

4. a) A time varying magnetic field $\mathbf{B}(t) = \mathbf{B}_0 \cos\omega t$ pointing out of the page fills the region enclosed by a circle of radius *a* shown in the figure below. Determine the induced electric field. (5)



b) Do the following fields satisfy all four Maxwell's equations?

$\mathbf{E}(t) = \mathbf{E}_0 \sin x \sin t$

$\mathbf{B}(t) = \mathbf{B}_0 \cos x \cos t$ (10)

c) Discuss Maxwell's generalisation of Ampere's law. (5)

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

$$\vec{\mathbf{E}} = (200\,\mathrm{Vm}^{-1})\,\hat{\mathbf{x}} \sin(2\pi \times 10^8 t - ky)$$

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

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