BPHCT-133

# ASSIGNMENT BOOKLET

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

## ELECTRICITY AND MAGNETISM

**Valid from 1st January, 2021 to 31st December, 2021**

**School of Sciences**
**Indira Gandhi National Open University**
**Maidan Garhi, New Delhi-110068**
**(2021)**

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:

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**ROLL NO.:** ……

**NAME:** ……

**ADDRESS:** ……

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**COURSE CODE:**…….

**COURSE TITLE:** ……

**ASSIGNMENT CODE:** ……..

**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.
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, 2021 to 31st December, 2021**. If you have failed in this assignment or fail to submit it by 31st December, 2021, then you need to get the assignment for the year 2022, 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/2021**
**Max. Marks: 100**

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

## PART A

1. a) 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)

   b) 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)

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

2. a) Two positively charged particles each having charge 20 μC, are kept at a distance of 2.0 m from each other. Determine the electric field due to each charge. Show the electric field vectors on an appropriate diagram. (5)

   b) A non-conducting solid sphere of radius 2.0 m carrying net positive charge 20 nC is enclosed by a concentric non-conducting thin spherical shell of radius 4.0 m carrying net negative charge 25 nC. Determine the electric fields at the distances of 1.0 m, 3.0 m, and 10.0 m, respectively, from the centre of the sphere. (2+4+4)

   c) Derive the expression for electric potential due to a uniformly charged spherical shell at a point inside the shell. (10)

## PART B

3. a) Define electric displacement vector $\vec{\mathbf{D}}$ and deduce Gauss's law for dielectrics. (5)

   b) A dielectric of dielectric constant 5.0 is filled in the gap between the plates of a capacitor. Calculate the factor by which the capacitance is increased, if the dielectric is only sufficient to fill up 1/5 of the gap. (5)

   c) A 1.0 m length of current-carrying wire kept perpendicular to a magnetic field of magnitude 400 mT experiences a force of 3.0 mN. Determine the current flowing in the wire. (5)

   d) A long, straight wire of diameter 2.0 mm carries a uniformly distributed current of 10 A. At what distance from the axis of the wire will the magnitude of $\vec{\mathbf{B}}$ be maximum? Justify your answer. (5)

   e) Calculate the magnitudes of magnetic intensity $\vec{\mathbf{H}}$ and magnetic field $\vec{\mathbf{B}}$ at the centre of a 2500-turn solenoid which is 0.50 m long and carries a current of 1.0 A. ($\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H\,m^{-1}}$). (5)

4. a) A wire loop of resistance 20 $\Omega$ and radius 5.0 cm is kept in the plane of this paper in a changing uniform magnetic field $\vec{\mathbf{B}}$. The direction of $\vec{\mathbf{B}}$ is perpendicular to the plane of the page and points out of it. If the magnitude of the induced current in the loop is 3.0 mA, determine the rate of change of the magnitude of the magnetic field $\vec{\mathbf{B}}$. (5)

b) The diameter of a 3.0 m long solenoid is 0.80 m. The magnetic field at its centre is 0.80 T. Estimate the energy stored in the magnetic field of the solenoid. (5)

c) Using Maxwell's equations in vacuum, derive the wave equation for the *x*-component of the electric field vector associated with an electromagnetic wave. (10)

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

$$\vec{\mathbf{E}} = (1000\ \mathrm{V m^{-1}})\ \hat{\mathbf{z}} \sin(2\pi \times 10^8 t + kx)$$

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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