BPHCT-133

ASSIGNMENT BOOKLET

BACHELOR'S DEGREE PROGRAMME

(BSCG)

ELECTRICITY AND MAGNETISM

Valid from 1st January, 2020 to 31st December, 2020

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2020)

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: ……

……

……

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, 2020 to 31st December, 2020**. If you have failed in this assignment or fail to submit it by 31st December, 2020, then you need to get the assignment for the year 2021, 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/2020
Max. Marks: 100

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

PART A

1. a) Determine whether the following force field $\vec{\mathbf{F}}$ is conservative:

$$\vec{\mathbf{F}} = x\hat{\mathbf{i}} - y\,\hat{\mathbf{j}} + z\,\hat{\mathbf{k}} \qquad (5)$$

b) Obtain the directional derivative for a scalar field $\phi(x,y,z) = 3x^2y - y^3z^2$ at the point (1, –2, –1) in the direction $\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$. (5)

2. a) Determine the work done by the force $\vec{\mathbf{F}} = (xy + 3z)\,\hat{\mathbf{i}} + (2y^2 - x^2)\hat{\mathbf{j}} + (z - 2y)\hat{\mathbf{k}}$ in taking a particle from $x = 0$ to $x = 1$ along a curve defined by the equations:

$$x^2 = 2y; \quad 2x^3 = 3z \qquad (10)$$

b) Using Gauss's theorem, calculate the flux of the vector field $\vec{\mathbf{F}} = x\hat{\mathbf{i}} + y\,\hat{\mathbf{j}} + z\hat{\mathbf{k}}$ through the surface of a cylinder of radius *A* and height *H*, which has its axis along the *z*-axis. The base of the cylinder is on the *xy* plane. (5)

3. a) The electric field due to a charged particle at a point 1.0 m away from it has magnitude $81\,\mathrm{NC}^{-1}$. What is the magnitude of the electric charge on the particle? What is the magnitude of the electrostatic force on a particle having the same charge kept at a distance of 2.0 m from it? (2+3)

b) A non-conducting sphere of radius 1.0 m carrying net positive charge $18\,\mathrm{nC}$ is enclosed by a concentric non-conducting thin spherical shell of radius 2.0 m carrying net negative charge $20\,\mathrm{nC}$. Determine the electric fields at the distances of 0.5 m, 1.5 m, and 2.5 m, respectively, from the centre of the sphere. (2+4+4)

4. a) The electric potential at a point is given by $V = z(z^2 - 4x^2)$. Calculate the electric field $\vec{\mathbf{E}}$ at that point. (5)

b) Derive the expression for electric potential due a uniformly charged spherical shell at a point outside the shell. (5)

PART B

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

b) A dielectric of dielectric constant 2.5 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 one-fourth of the gap. (5)

6. A 0.5 m length of current-carrying wire kept perpendicular to a magnetic field of magnitude 200 mT experiences a force of 1.5 mN. What is the current flowing in the wire? (5)

7. a) A long, straight wire of diameter 5.0 mm carries a uniformly distributed current of 15 A. At what distance from the axis of the wire will the magnitude of $\vec{\mathbf{B}}$ be maximum? Justify your answer. (5)

   b) Calculate the magnitudes of magnetic intensity $\vec{\mathbf{H}}$ and the magnetic field $\vec{\mathbf{B}}$ at the centre of a 1500-turn solenoid which is 0.22 m long and carries a current of 1.5 A. ($\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H\,m^{-1}}$). (5)

8. a) A wire loop of resistance $10\,\Omega$ and radius 10 cm is kept in the plane of this paper in a 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 and its magnitude is increasing at the rate of $0.50\,\mathrm{T\,s^{-1}}$. Determine the magnitude and direction of the induced current in the loop. (5)

   b) What rate of change of current in a solenoid having self-inductance 19.4 mH produces a self-induced emf of 100 mV in it? (5)

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

10. The expression of the magnetic field associated with an electromagnetic wave in vacuum is given by

$$\vec{\mathbf{B}} = (100\,\mathrm{T})\,\hat{\mathbf{y}} \sin(2\pi \times 10^8 t + kz)$$

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

****