U.G. 2nd Semester Examination - 2021

PHYSICS

[HONOURS]

Course Code: BPHSCCHC 201

Course Title: Electricity and Magnetism

Full Marks : 30 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **ten** questions from the following: $1\times10=10$

a) A wire of resistance $10\,\Omega$ is bent to form a complete circle. Find the resistance between two diametrically opposite points.

b) If an electron moves in a circular path of radius 'r' with a constant speed 'v', calculate the magnetic moment of the electron.

c) If the magnetic vector potential is $\vec{A}=e^{-x}\sin y\hat{i}+(1+\cos y)\hat{j}$, calculate the magnetic induction.

d) Show that relative permeability μ_r is given by $\mu_r=1+\chi_m$, where χ_m is the magnetic susceptibility.

e) What is the significance of displacement current?

f) Current in a circuit falls from 5A to 0A in 0.1 sec. If an average *emf* of 200V is induced, give an estimate of the self inductance of the circuit.

g) What is the physical significance of the equation $\vec{\nabla}.\vec{B}=0$?

h) Why is electric flux zero across a closed surface with an electric dipole inside?

i) Two uniformly charged infinite planes of charge density $+\sigma$ and $-\sigma$ respectively intersect each other at right angles. Sketch the field lines.

j) What happens when a dielectric is polarised?

k) A point charge q = –1.2 C has a velocity $\vec{v}=\left(5\hat{i}+2\hat{j}-3\hat{k}\right)ms^{-1}$. Find the magnetic force exerted on the charge if the magnetic field intensity is $\vec{B}=\left(-4\hat{i}+4\hat{j}+3\hat{k}\right)T$.

l) Explain why electric field always decreases when a dielectric material is introduced between the two plates of a capacitor.

m) What is Helmholtz coil? What is its utility?

n) How does inductive reactance vary with frequency?

o) What are polar and non-polar materials? Give examples for each.

2. Answer any **five** of the following questions. $2\times5=10$

a) A particle of mass 'm' carrying a charge $-q_1$ is moving around a charge $+q_2$ along a circular path of radius 'r'. Prove that the period of revolution of charge $-q_1$ about $+q_2$ is given by, $T=\sqrt{\frac{16\pi^3 \in_0 mr^3}{q_1q_2}}$.

b) Write differential form of Gauss's law and hence establish Poisson's equation.

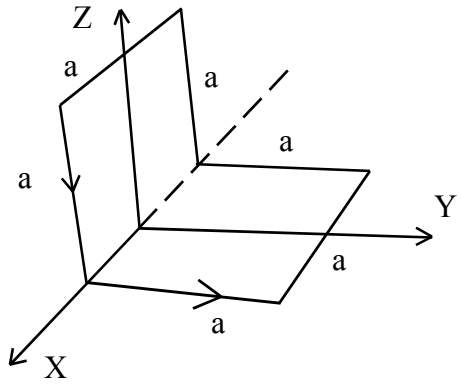
c) Calculate the electric potential at an axial point due to a thin uniformly charged ring of radius 'a'.

d) Find the capacitance of a system of three parallel plates, each of area A m^2, separated by d_1 and d_2 meters. The space between them is filled with dielectrics of dielectric constant K_1 and K_2.

e) Show that conductor is an equipotential surface.

f) An alternating emf $E=220\sin\pi t$ is applied to a circuit containing an inductance of $(1/\pi)$ Henry. Write the equation for instantaneous current through the circuit. What will be the reading of the ammeter in the circuit?

g) Find the magnetic dipole moment of the loop with all its sides 'a' and carrying current 'I' as shown in figure.



h) There is a long narrow air cored solenoid with N_1 turns. Over it, a short solenoid with N_2 is wound coaxially. Determine the mutual inductance of the system.

3. Answer any **two** of the following questions. $5\times2=10$

a) i) A point charge 'q' of mass 'm' is released from rest at a distance 'd' from an

infinite grounded conducting plane. How long will it take for the charge to hit the plane?

ii) Derive Ampere's circuital law from the concept of magnetic vector potential $\left(\vec{A}\right)$. 3+2=5

b) An a.c. supply of *emf* 50V r.m.s. at a frequency 1000 c/s is connected across an inductor of inductance 100 mH and a resistor of resistance $2000\,\Omega$ in series. Find the r.m.s. current in the circuit, potential drop across the inductor and potential drop across the resistor. Do these potential drops add up to the *emf* of the source? How do you explain the difference, if there is any? 3+1+1=5

c) Using Thevenin's theorem find the unbalanced current through the galvanometer of a Wheatstone bridge supplied with an ideal voltage source. Hence find the balance condition of the bridge. 4+1=5

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