Ex/SC/PHY/UG/CORE/TH/03/2023

B. Sc. Physics (Honours) Examination, 2023

(1st Year, 2nd Semester)

Electricity and Magnetism

Paper – CORE - 3

Time : Two hours Full Marks : 40

Use separate answer script for each Group

GROUP-A: Answer **ANY TWO** questions(2x10=20 Marks).

1. (a) Write down the Maxwell's equations. From these equations state the fundamental laws of electrostatics. Discuss its solutions when potential vanishes at infinity.
(b) Prove the uniqueness of the solution.
(c) Show that $\nabla^2 \frac{1}{|\vec{x}-\vec{x_0}|} = -4\pi\delta^3(\vec{x}-\vec{x_0})$ where $\vec{x}$ is a position vector. [4+3+3]

2. A conducting sphere of radius a carries a charge q, is placed in a homogeneous isotropic dielectric medium of dielectric constant K. Determine $\vec{D}$, $\vec{E}$ and $\vec{P}$ inside the dielectric. Hence determine the volume and surface densities of polarization charges.
(b) A coil having a resistance of 7ohm and inductance of 31.8mH is connected to 230V, 50Hz supply. Calculate (a) the circuit current (b) Phase angle, (c) Power factor (d) Power consumed. [6+4]

3.(a) A point charge q is placed in front of a grounded conducting sphere of radius a at a distance d from its center. Take it as a boundary value problem and find the solution of the potential $\Phi(r,\theta)$ for the external points(r,θ) when $r/d << 1$. Show that potential at any external point due to the induced charge on the sphere may be considered as due to an imaginary image point charge $-qa/d$ located at the inverse point a^2/d from the center.
(b) A spherical shell of radius R, which carries a surface charge density $kcos\theta$, calculate the dipole moment of this charge distribution. [7+3]

Group - B

Answer any **four** questions

1. Write down Biot-Savart law in vector form. Describe the steps required to use this law to find magnetic field due to a current carrying conductor. Follow these steps to find magnetic field due to a circular current carrying loop at an axial point.

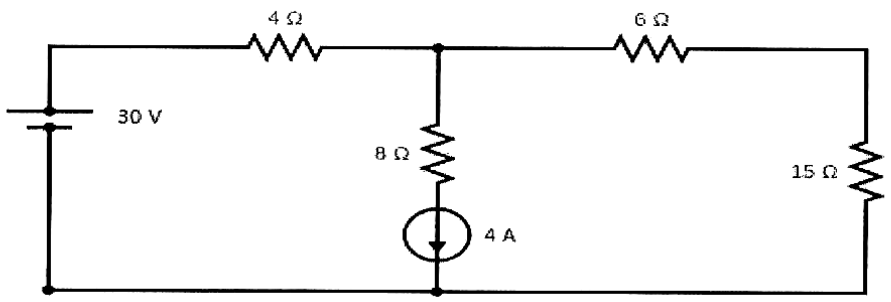
[1+1+3]

2. Find the magnetic vector potential $\vec{A}$ for a straight current carrying conductor. Hence calculate the magnetic field.

[3+2]

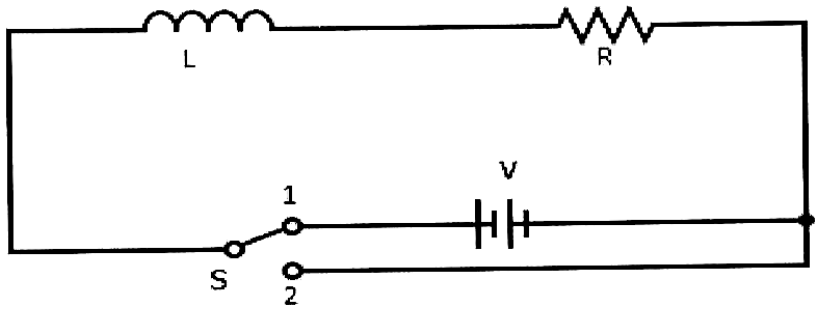
3. (a) What do you mean by ideal constant-voltage source and ideal constant current-source ?

   (b) Use Norton's theorem to calculate the current flowing through the 15Ω load resistance in the given circuit.



[2+3]

4. Suppose that the given circuit has been switch 'on' for a long time. Then suddenly, at time t=0 , the switch S is thrown to the point 2 from 1.



(a) Derive an expression for the current at any subsequent time $t > 0$.

(b) Show that the total energy delivered to the resistor R is equal to the energy originally stored in the inductor L.

[2+3]

5. (a) Discuss domain theory of ferromagnetism.

(b) What is meant by hysteresis? Find an expression for the work done due to hysteresis.

[2+3]

6. (a) Describe the essential features in constructing a moving coil ballistic galvanometer.

(b) Establish a relation between the throw and the charge flowing through a moving coil ballistic galvanometer.

[2+3]