B.Sc. 2nd Semester (Honours) Internal Examination, 2019-20

PHYSICS

Course ID: **Course Code: SH/PHS/201/C/3**

Course Title: Electricity and Magnetism

Time: 1Hour 15 Minutes Full Marks: 20

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words
As far as practicable

1. Choose the correct from any **five** of the followings: $1\times5=5$

i) A cube consisting a charge of +QC at its center. Find the flux through any one face

a. +Q/ ε_0 b. +6Q/ ε_0 c. +Q/6 ε_0 d. –Q/ ε_0

ii) The equation containing the fact of non-existence of magnetic monopole is:

a. $\vec{\nabla}\cdot\vec{B}=0$ b. $\vec{\nabla}\times\vec{B}=0$ c. $\nabla^2\vec{B}=0$ d. $\vec{\nabla}\times\vec{B}=\mu_0\vec{j}$

iii) For steady current region:

a. $\vec{\nabla}\cdot\vec{j}=0$ b. $\vec{\nabla}\times\vec{j}=1$ c. $\vec{\nabla}\cdot\vec{j}\neq0$ d. $\vec{\nabla}\cdot\vec{j}=1$

iv) Unit of Magnetic flux may be:

a. maxwell b. newton c. rydberg d. farad

v) Torque on a magnetic dipole in magnetic field is

a. $\vec{p}_m\times\vec{B}$ b. $\vec{p}_m\cdot\vec{B}$ c. $-(\vec{p}_m\times\vec{B})\ \varepsilon_0$ d. $-\vec{p}_m\cdot\vec{B}$

vi) Potential energy of a magnetic dipole in magnetic field is

a. $\vec{p}_m\times\vec{B}$ b. $\vec{p}_m\cdot\vec{B}$ c. $-(\vec{p}_m\times\vec{B})\ \varepsilon_0$ d. $-\vec{p}_m\cdot\vec{B}$

vii) Total solid angle formed by a closed surface in steradian is: a. 2π b. π c. 12π d. 4π

2. Answer any **one** question: $5\times1=5$

(a) Using Gauss's law find the electric field near a charged sheet having charge density +σ in free space. Hence find electric field inside a parallel plate capacitor (taking +σ and –σ as the existing surface charge densities on the two plates respectively)

(b) Show that magnetic field ($\vec{B}$) at a distance *'d '* from an infinitely long straight current carrying wire is inversely proportional to *'d'*. *(5)*

(c) Derive Coulomb's law from Gauss's law in electrostatics *(5)*

(d) Derive Gauss's law in Electrostatics. *(5)*

(e) Write down the differential form of Gauss's law. Suppose that electric field in some region is found to be $\vec{E}=\alpha r^3\hat{r}$ in spherical coordinates (α is a constant). Find the electric charge density. *(5)*

(f) Derive Laplace's equation for electrostatic field from Gauss's law. Write down the equation in Spherical coordinate system. *(5)*

(g) Express P(1,2,3) in cylindrical and spherical coordinate system. *(5)*

(h) Starting from the definition electric current and current density, derive the equation of continuity. Show that the potential distribution within a conducting medium satisfies Laplace's equation as long as the medium is homogeneous and the current distribution is time invariant or steady. *(5)*

(i) Find energy density of magnetic field inside a long solenoid. *(5)*

3. Answer any **one** question: $10\times1=10$

(a) Find the magnetic field $(\vec{B})$ due to a circular loop of radius *a* carrying current I on a point on the axis at a distance *x* from centre. Hence find $\vec{B}$ at a point on the axis of an infinitely long solenoid carrying current *I* with no. of turns per unit length being *n*. *(5+5)*

(b) Prove the following where symbols have their usual meanings:

i) $\vec{D}=\varepsilon_0\vec{E}+\vec{P}$

ii) $\vec{B}=\mu_0(\vec{H}+\vec{M})$ *(5+5)*

(c) i) Find the electrostatic potential energy for the system of charges q_1, q_2, q_3 and q_4

ii) Find the electrostatic potential energy of a uniformly charged sphere. *(5+5)*

(d) i) State Kirchhoff's current and voltage laws with proper circuit diagrams.

ii) Derive the resonance condition in a series LCR circuit. *(5+5)*