U.G. 2nd Semester Examination - 2020

PHYSICS

[HONOURS]

Course Code : PHSH/CC-T-03

Full Marks : 40 Time : $2\frac{1}{2}$ 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.

GROUP–A

1. Answer any **five** questions: 2×5=10

a) What do you mean by polarization in a dielectric? What is dielectric constant of a material?

b) Justify if energy density of electric field obeys superposition principle or not.

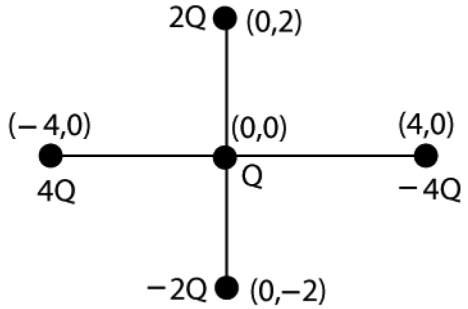
c) Obtain the electric field within a parallel plate capacitor. Under what condition the inter-plate separation is a constant field region?

d) Can the vector $k(x\hat{i} + y\hat{j})$ be treated as an electric field or a magnetic field or neither? (k is a constant)

e) What is displacement current? What is conduction current? In what respect do they differ?

f) What is a constant voltage source and constant current source? Give examples.

g) Find electric dipole moment of the distribution shown. (Q is charge)



h) What is an electrical image? Justify when would you use the method of electrical images?

GROUP–B

2. Answer any **two** questions: 5×2=10

a) i) Obtain expression for the energy density in an electrostatic field. 3

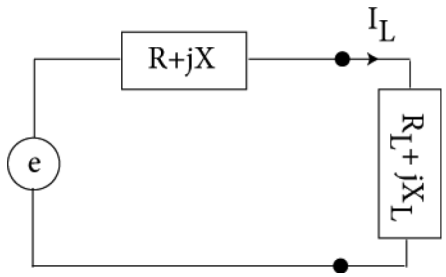
ii) Show using Gauss law of electrostatics that any volume completely inside a

charged conductor is electrically neutral. 2

b) i) What is the significance of equation of continuity? 1

ii) What reciprocal relation is stated in reciprocity theorem on networks? 1

iii) Using maximum power transfer theorem show that the maximum power dissipated to load R_L is $\frac{e^2}{4R_L}$. Also give a plot of power delivered to load as a function of load. 3



c) i) The potential due to excess electrons at a point inside a crystal is given by $\phi = 3\times10^6 z^2$ volt. Find the number density of excess electrons. 2

ii) Prove that the solution of the Laplace's equation in some region is uniquely determined if value of the potential is a specified function on all boundaries of that region. 3

d) i) What is self energy? What will be the self energy of a uniformly charged sphere of radius R? $2\frac{1}{2}$

ii) Show that Ampere's law of interaction between two current loops is consistent with Newton's third law of motion. How is Newton's third law preserved in case of interaction between two current elements? $2\frac{1}{2}$

GROUP-C

3. Answer any **two** questions: $10\times2=20$

a) i) Starting from the expression $\vec{B}=\frac{\mu_0}{4\pi} i\int_C \frac{d\vec{r}\times\hat{R}}{R^2}$ prove that $\vec{\nabla}\times\vec{B}=\mu_0\vec{J}$ and $\vec{\nabla}.\vec{B}=0$. (symbols as usual) 4

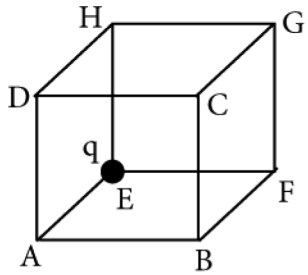
ii) Show that at the boundary of two magnetic media the normal component of $\vec{B}$ is continuous while the tangential

component of $\vec{H}$ is discontinuous by an amount equal to free surface current density. 4

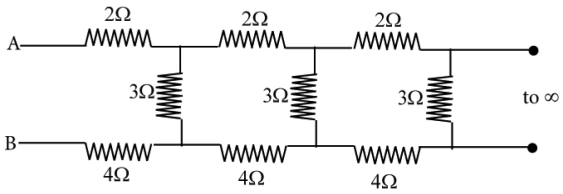
iii) Show that an alternating current can be produced by rotating a coil in a stationary magnetic field. Mention the principle on which such phenomena is based. 2

b) i) A cube is formed by joining equal wires each of resistance R and a battery is connected to two opposite corners of a face of the cube. Find out the effective resistance between these points. 3

ii) A point charge q is placed at a corner of a cube. What is the flux of the electric field through the surfaces ABCD and ABFE? 3



iii) Explain the B-H curve of a ferromagnetic specimen from domain theory. State Curie Weiss law. 4

c) i) 

Find the equivalent resistance between the points A and B for the above network. 3

ii) Obtain multipole expansion of the magnetic vector potential and show that the lowest non vanishing term is the dipole term. 3

iii) What is a toroid? Apply Ampere's circuital law to determine the magnetic induction inside a toroid. 3

iv) Obtain the dimension of time constant used in physics and engineering? 1

d) i) Show using Maxwell's equations of electrodynamics that the electric field $\vec{E}$ and magnetic induction $\vec{B}$ does not change if the potentials are shifted from $(\vec{A}, \phi)$

to $(\vec{A}+\nabla\lambda, \phi-\frac{\partial\lambda}{\partial t})$ where λ is a scalar function of space and time. 2

ii) Find the mutual inductance of 2 circular planar coaxial coils –one loop being very small in comparison to the other. 2

iii) A steady current I_0 is superimposed on an alternating current $I\ coswt$. Prove that the r.m.s current is $\sqrt{I_0^2+\frac{1}{2}I^2}$. 2

iv) In a series LCR circuit what is meant by half power frequency? Find the current in the circuit at half power frequency. What is power factor in an LCR series circuit at resonance and at offresonance? 4

———————