RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [2018-21]

B.A./B.Sc. THIRD SEMESTER (July – December) 2019

Mid-Semester Examination, September 2019

Date : 16/09/2019 **PHYSICS (Honours)**

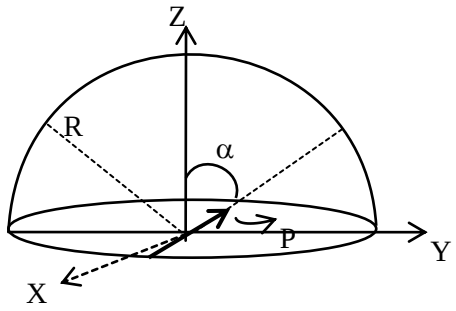
Time : 1 pm – 3 pm **Paper : III** Full Marks : 50

Group – A

Unit – I

(*Answer <u>any two</u> questions)* [2×5]

1. Suppose there is a circular hole of radius *a* at the centre of an infinite plane having a uniform charge density σ. Find the potential at an axial distance *x* from the centre of the hole. [5]
2. A dipole $\vec{P}$ kept at the origin makes an angle α with the z-axis as shown in figure. Calculate the electric flux through the upper hemisphere of a spherical surface of radius R centred at the origin. [5]



3. A charge system consists of point charges $+q,-q,+q,-q$ at points $\left(a\sqrt{2},0,0\right)$, $\left(0,a\sqrt{2},0\right)$, $\left(-a\sqrt{2},0,0\right)$ and $\left(0,-a\sqrt{2},0\right)$ respectively. Find out the quadrupole moment tensor for this system. Also find out the potential due to the quadrupole. [5]
4. a) Define electric dipole? Determine the electric potential and field at $P\left(r,\theta\right)$ due to electric dipole. [4]
   b) Also find out the polar equation of the equipotential surface of the dipole. [1]

Unit – II

(*Answer <u>any six</u> questions)* [6×5]

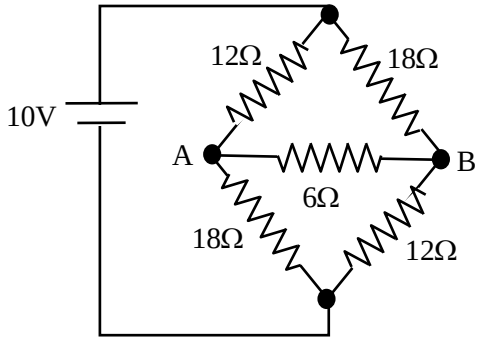
5. An infinitely large current sheet of thickness *t* lying in the *xy* plane with current density $J\hat{x}$. Find the magnetic field $\vec{B}$ (i) outside and (ii) inside of the sheet. [5]
6. Show that $\left(\vec{H}_1-\vec{H}_2\right)\times\hat{n}_{12}=\vec{K}_c$ (symbols have their usual meaning). [5]
7. Find and expression for magnetic field $\vec{B}$ at a distance *z* along the axis of a circular coil carrying current I. [5]
8. a) What is Ampere's circuital law? Deduce Ampere's circuital law in differential form.
   b) In free space the magnetic field $\vec{B}=xy\hat{z}+yz\hat{x}+zx\hat{y}$. Find current density J. [1+2+2]
9. a) Establish the relation between magnetization (M) and equivalent surface current density in Rowland ring of uniform magnetization.
   b) An infinitely long circular cylinder carries a uniform magnetization $\vec{M}=M\hat{z}$. Find the magnetization current densities. [3+2]
10. Find the magnetic vector potential $\vec{A}$ due to a small filamentary circular current loop of radius *a*. [5]

11. The magnetic scalar potential V_m due to uniform magnetic sphere satisfies the Laplace's equation, $\nabla^2 V_m = 0$. Find the magnetic scalar potential at a point $P(r, \theta, \phi)$ outside of the sphere. [5]

12. a) Establish the continuity equation relating the charge density and current density at a point in a medium. [3]

    b) A coaxial cable of length *l* consists of a solid cylindrical inner conductor of radius r_1, the inner radius of the hollow outer conductor being r_2. The space between the cylinder is filled with an imperfect dielectric of conductivity σ. Find the resistance offered by the dielectric. [2]

13. State Theremin's theorem and use it to calculate the current through the 6Ω resistor in the following circuit. [5]



14. a) What are phasors? [1]

    b) Discuss the energy conservation through pure inductive circuit, if an alternating power supply is given to it. [4]

Group – B

(*Answer any two questions)* [2×5]

14. a) Describe how depletion region is formed at the junction of a PN diode. [2]

    b) Define Barrier Field with explanation and give a schematic showing variation of the same with the dimension of the diode. [3]

15. a) Differentiate between various breakdown mechanisms with proper explanation. [2]

    b) State how a breakdown diode is used as a regulator. [3]

16. a) Define DC load current, Ripple Factor and Rectification Efficiency. [1.5]

    b) Obtain above mentioned parameters for a full-wave rectifier with two diodes. [3.5]

17. a) Show various current components of a PNP transistor with suitable explanation. [3]

    b) Draw the CE input and output characteristics and show different regions of operation of the transistor. [2]

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