RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [2017-20]

B.A./B.Sc. THIRD SEMESTER (July – December) 2018

Mid-Semester Examination, September 2018

Date : 24/09/2018 **PHYSICS (Honours)**

Time : 11 am – 1 pm Paper : III Full Marks : 50

Group – A
Part – 1
(*Answer <u>any two</u> questions)* [2×5]

1. A sphere centred at the origin carries a charge density $\rho(r,\theta) = K\frac{a}{r^2}(a-2r)\sin\theta$ where *a* is the radius of the sphere and K is a constant. Find the approximate potential i.e. potential due to monopole, dipole and quadruple moment, at a point on the Z-axis far from the sphere. [5]

2. What do you mean by an electric dipole ? Determine the potential and field at an arbitrary point (r,θ) due to a dipole. [1+2+2]

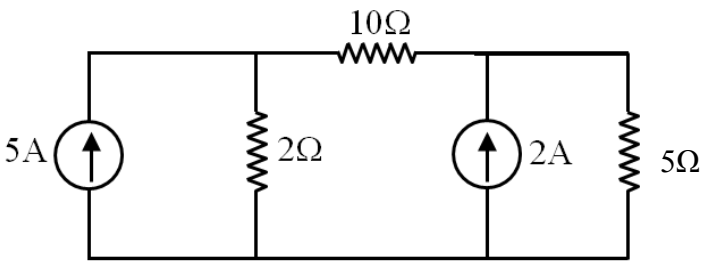
3. Derive an expression of energy for continuous change distribution. Then Calculate the energy of a conducting sphere of radius R with total charge q on it. [3+2]

4. a) What is Gauss's law in electrostatics ? Comments on the validity of Gauss's law. [1+2]
   b) Two uniform infinite sheets of electric charge densities $+\sigma$ and $-\sigma$ intersect at right angles. Find the magnitude and direction of the electric field everywhere and sketch the lines of electric field. [2]

Group – A
Part – 2
(*Answer <u>any six</u> questions)* [6×5]

5. a) What do you understand by ideal voltage source and ideal current source ? [2]
   b) Current is flowing radially from inner to outer spherical surface of two concentric spherical surfaces of inner and outer radii a and b respectively . The current density at a distance r(a>r>b) is given by $\vec{J}(r) = J_0\left(\frac{r^2}{a^2}\right)e^{-\alpha t}\hat{r}$,where J_0 and α are constant. Find the charge density at distance r and time t. [3]

6. State Thevenin's theorem. Determine the current through the 5Ω register in the circuit given below using Thevenin's theorem. [5]



7. Show that $\vec{\nabla}\times\vec{B} = \mu_0\vec{J}$ (symbols have their usual meanings). [5]

8. A rectangular current loop is placed in a uniform magnetic field B. Find the expression for torque acting on the coil. [5]
9. Find the vector potential inside and outside of an infinite solenoid of radius *a*, current *I* with n turns per unit length. [5]

10. (a) Deduced the fundamental equation of a magnetic circuit. [3]
    (b) A solid toroid of iron of cross-sectional area $\pi \times 10^{-4} m^2$ and mean radius 10 cm. The relative permeability of the materials is $\mu_r = 5000$, If winding of 400 turns around the toriod carries a steady current of 1*A*. Calculate the flux produced in the ring. [2]

11. The region 1, described by $3x+4y \geq 10$, is free space, where as region 2, described by $3x+4y \leq 10$ is a magnetic material for which $\mu_r = 10\ \mu_0$. Assuming that the boundary between the material and free space is current free, find B_2 if $\vec{B}_1 = 0.1\hat{x} + 0.4\hat{y} + 0.2\hat{z}\ Wb/m^2$. [5]

12. What is meant by Hysteresis ? Find an expression for the work done due to Hysteresis. [1+4]

13. In a magnetic material for which $\mu=3\mu_0$ and $\vec{H} = 1\hat{x} + 5\hat{y} - 2\hat{A}/m$. Find (i) the bound current density J_b and (ii) the surface current density . [5]

Group – B

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

14. (a) The barrier potential across the junction of a pn diode cannot be measured by placing a voltmeter across the diode terminals. Explain why ? [2]
    (b) What is a breakdown diode ? Discuss the origin of breakdown of a junction diode. [3]

15. (a) Compare and explain the energy band diagram for an unbiased, forward biased and reverse biased pn junction diode. [3]
    (b) The current flowing through a pn junction Si diode is 50 mA for a forward bias of 0.8V at room temperature. Determine the static and dynamic resistance of the diode. [2]

16. (a) Define ripple factor. Compare ripple factor for a half wave rectifier with that of a full wave rectifier. [1+2]
    (b) Explain how a single capacitor can be used to improve the dc output of a full wave rectifier. [2]

17. (a) Draw the CE output characteristics of a BJT. Explain the various regions of operation. [4]
    (b) What is Early effect ? [1]

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