# RAMAKRISHNA MISSION VIDYAMANDIRA

**(Residential Autonomous College under University of Calcutta)**

**B.A./B.SC. THIRD SEMESTER EXAMINATION, DECEMBER 2013**

**SECOND YEAR**

Date : 18/12/2013 **PHYSICS (General)**

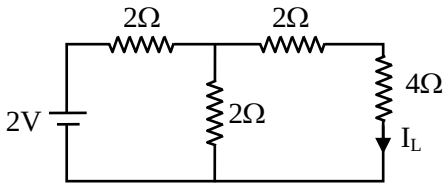
Time : 11 am – 1 pm Paper : III Full Marks : 50

Answer **any five** questions from the following :

1. a) Explain clearly what is meant by dielectric polarisation. [2]
   b) Deduce the relation between the electric displacement vector $(\vec{D})$ and the dielectric polarization $(\vec{P})$. [4]
   c) The potential function in a region is given as $V = a - b(x^2 + y^2) - c\ln(x^2 + y^2)$ where a, b and c are constants. Find the field $\vec{E}$ at (1,1,1). [4]

2. State and prove Coulomb's theorem. Show that the pressure developed on the surface of a charged conductor is $\frac{\sigma^2}{2\epsilon_0}$, where $\sigma$ is the charge density of the conductor and $\epsilon_0$ is the permittivity of free space. [1+4+5]

3. a) State and explain Thevenin's and Norton's theorem's for circuit analysis. [4]
   b) Draw the Thevenin and Norton equivalents of the following circuit and calculate the load current $I_L$ from both. [6]




4. a) State Ampere's circuital theorem. Using Ampere's circuital theorem, find the magnetic field due to a long straight conductor carrying a steady current. [2+4]
   b) An electron is revolving in a circular orbit of radius 5nm with a frequency $6{\cdot}8\times10^{15}$ Hz. Calculate the magnetic dipole moment at the centre of the orbit. Electronic charge = $1{\cdot}6\times10^{-19}$C. [4]

5. a) Define the coefficient of self inductence and mutual inductance. Derive an expression for the coefficient of self inductance per unit length of an infinite solenoid. [1+2+3]
   b) A particle with charge $1{\cdot}6\times10^{-19}$ coulomb is moving with a velocity $\vec{v} = 5\hat{x}\ m/s$ in an electric field of intensity $\vec{E} = 10\hat{y}$ volt/m and magnetic field $\vec{B} = 2\hat{k}$ tesla. Find the magnitude and direction of Lorentz force on the particle. [4]

6. a) Define magnetic permeability and magnetic susceptibility. Establish the relation between them. [2+3]
   b) What do you mean by quality factor of a series resonance circuit. Find an expression of it. Discuss its usefulness. [5]

7. a) Draw a B–H loop of a ferromagnetic substance and indicate retentivity, coercivity and magnetic saturation in that graph. What does the area of the graph signify? What will be the nature of B – H loop for a paramagnetic substance? [2+1+1+1+1]
   b) Show that the magnetic energy stored in establishing a steady current I in a coil of self inductance L is $\frac{1}{2}LI^2$. [4]

8. a) The thermo emf 'e' corresponding to a thermocouple is given by $e = a\theta + b\theta^2$, 'θ' being the temperature difference between the junctions. Calculate neutral temperature, Peltier coefficient and Thomson coefficient. [2+2+2]

b) A capacitor of capacitance $5\mu F$ and leakage resistance $1M\Omega$ is charged to a certain voltages and then disconnected. Find the time constant of the leaky capacitor. Derive the formula you use. [4]

9. A voltage $V_0 \sin \omega t$ is applied to a series LCR circuit. Find an expression for the instantaneous current. Plot the variation of impedance, current and power dissipation by the circuit with $\omega$. [4+2+2+2]