This question paper contains 4 printed pages]

Roll No.

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all. Question No. **1** is compulsory.

All questions carry equal marks.

1.   Attempt any *five* of the following :

   (*a*)   Show that the electrostatic field is conservative in nature.

   (*b*)   The electric potential in a given space is represented by $V = 3x + 5y - 6z$.
   Show that the electric field intensity is uniform everywhere in the given space.

   (*c*)   Prove that the electrostatic energy of a capacitor of capacitance C charged to
   a potential V is given by $(\frac{1}{2})CV^2$.

   (*d*)   What are the conditions for a moving coil galvanometer to be ballistic ?

P.T.O.

(e) What is Lenz's law ? Show that it is in accordance with the law of conservation of energy.

(f) What is the physical significance of solenoidal nature of magnetic field ?

(g) Why a parallel resonance circuit is called a rejecter circuit ?　　　$5\times3=15$

2. (a) An alternating emf is applied to a circuit having an inductor, capacitor and resistor in series. Obtain the expression for impedance and instantaneous current in the circuit. Discuss graphically the variation of current with frequency for different values of resistance. What is the utility of such a circuit ?　　　10

(b) State and explain Thevenin's Theorem with the help of relevant circuit diagrams. 5

3. (a) State and prove Gauss's flux law in electrostatics. Obtain its differential form. 10

(b) A spherical charge distribution is given by $\rho(r) = \rho(0)\left(1 - \dfrac{r}{R}\right)$ for $r < R$ and $\rho(r) = 0$ for $r > R$. Here $\rho(r)$ is the volume charge density and $\rho(0)$ is constant. R is the radius of the sphere and r is the distance from the centre of the sphere. Obtain an expression for the electric field intensity E at a point inside the sphere.　　　5

4. (*a*) What is meant by polarization of a dielectric ? Explain with reference to the case when a dielectric slab is introduced between the plates of a parallel plate capacitor. 5

(*b*) Show that $q' = q\left(1 - \dfrac{1}{k}\right)$, where the symbols have their usual meaning. 5

(*c*) Define the terms electric susceptibility and relative permittivity. Obtain the relation between them. 5

5. (*a*) State and explain Biot-Savart's law. Obtain an expression for the magnetic flux density at a point due to an infinitely long straight current carrying conductor. 10

(*b*) An electron circulates around a nucleus in an orbit of radius 5.1×10^{-11}m at a frequency of 6.8×10^{15} revolutions per second. Calculate B at the centre of the orbit. 5

6. (*a*) Show that the Ampere's circuital law is modified in the presence of a material. Obtain the relation between **B**, **M** and **H** where the symbols have their usual meaning. 10

(b) A solenoid 2 m long with a mean diameter of 0.05 m has four layers of 1000 turns of wire each. Calculate the magnetic flux density at its centre when a current of 2.5 A flows through it. Also calculate the magnetic flux at centre. ($\mu = 4\pi \times 10^{-7}$ H/m). 5

7. (a) Show that the charge passing through a ballistic galvanometer is given by

$$Q = K\left(\frac{T}{2\pi}\right)\theta$$

where the symbols have their usual meaning. 10

(b) Find an expression for the self inductance of a solenoid. 5