B.Sc.(Honours) Examination, 2019

Semester-II (CBCS)
Physics (Honours)
Core Course: CC-3
(Electricity & Magnetism)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer ***any four*** questions.

1. a) State Gauss's theorem in electrostatics.
   b) Using Gauss's theorem, find the expressions for electric field due to a uniformly charged infinitely long solid cylinder at points inside and outside the cylinder.
   c) A spherical charge distribution is given by $\rho(r) = \rho_0(1-r/a)$ for $r \leq a$; and $\rho(r) = 0$ for $r \geq a$. For what value of r inside the sphere, the electric field will be maximum? ρ and a are the volume charge density and radius of the spherical charge distribution, respectively while r is the distance from the centre. 2+4+4=10

2. a) What are dielectric polarization and bound charge?
   b) Obtain Gauss's law for dielectrics.
   c) A point charge q is placed at the origin of a spherical polar coordinate system in a dielectric medium whose permittivity ε changes with the distance r from q as $\varepsilon=\varepsilon_0(1+\beta/r)$, where β is a constant independent of r. Show that the potential is given by $\phi = \frac{q}{4\pi\beta\epsilon_0}\ln(1+\beta/r)$. 3½+3½+3=10

3. a) Find the capacitance of a spherical capacitor. Can an isolated conducting sphere act as capacitor?
   b)Two long coaxial hollow cylinders of radii a and b, $(a < b)$ are charged to potentials V_a and V_b, respectively. Using Laplace's law, show that the potential at any point between the cylinders at a distance r from the axis is given by
   $$V(r) = V_a - (V_a - V_b)\frac{\ln(\frac{r}{a})}{\ln(\frac{b}{a})}.$$
   c) Discuss the principle of electromagnetic shielding? (3+1)+4+2=10

4. a) Establish Ampere's circuital law. With the help of this law, find the variation of magnetic field due to a long straight current-carrying conductor as a function of distance from it's axis.
   b) Establish $\vec{\nabla} \times \vec{M} = \vec{j}_m$ where $\vec{M}$ and $\vec{j}_m$ are the magnetization and magnetization current density vectors, respectively. (2+4)+4=10

5. a) Starting with Biot-Savart law, explain clearly how a uniform magnetic field is produced in a Helmholtz type galvanometer.
   b) Find the expression of admittance for a parallel LCR circuit under a sinusoidal voltage. Show that for parallel resonance, $R < (L/C)^{1/2}$.

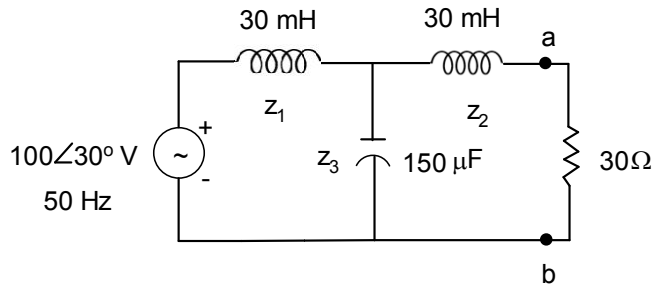
P.T.O.

c) A parallel LC combination is connected in series with a resistance R. If a sinusoidal voltage $V_0 \sin\omega t$ is applied to this circuit, calculate the output voltage across the LC combination. What is the frequency of resonance for this circuit?

5+3+2=10

6. Describe a ballistic galvanometer of the suspended-coil type. What is damping in this type of galvanometer? Give the theory of working of this galvanometer for measuring charge assuming damping to be small. 2+2+6=10

7. a) State and prove the maximum power transfer theorem for ac circuits.
   b) Calculate the Thevenin voltage and Thevenin impedance for the load terminals **a,b** in the network drawn below. Also find the load current.



c) Prove $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ where the symbols have their usual meaning.

(2+3)+3+2=10