THE ANSWERS MUST BE ATTEMPTED ON THE ANSWER SHEET PROVIDED

Q.1.   Answer the following short questions.   (15x2=30)

(i)- Is there a net force on an electric dipole placed in a non-uniform electric field?

(ii)- Is $\vec{E}$ necessarily zero inside a charged rubber balloon, which is spherical? Assume that charge is uniformly distributed over the surface.

(iii)- Why can an isolated atom not have a permanent electric dipole moment?

(iv)- How many electrons will be produced by charge of 1C?

(v)- A parallel plate capacitor is charged by using a battery which is then disconnected. A dielectric slab is slipped between the plates. Describe quantitatively what happens to charge, the electric field, the potential difference and capacitance?

(vi)- On what factors, the capacitance of a parallel plate capacitor depends upon?

(vii)- If positive and negative connections to terminals of an automobile battery were reversed, would you expect the automobile light to function?

(viii)- Differentiate between electric and magnetic dipoles.

(ix)- Discuss the difficulties of testing whether the filament of light bulb obeys Ohm's law?

(x)- Discuss similarities and difference between electrostatic and magnetic fields.

(xi)- Discuss the analogies and differences between Biot-Savart law and Coulomb's law.

(xii)- Describe briefly difference between self-induction and mutual induction.

(xiii)- Suppose that, in a series RLC circuit, the frequency of the applied voltage is changed continuously from a very low value to a very high value. How does the phase constant change?

(xiv)- Do pure semiconductors obey Ohm's law?

(xv)- What are bias conditions of base emitter and base collector junctions for a transistor to operate as an amplifier?

Answer the following questions.

Q. 2: (a)-What is linear charge density? Derive an expression for electric field due to an infinitely long uniformly charged straight wire using Coulomb's law.   (05 + 05)

(b)-Calculate capacitance of a capacitor consisting of two concentric spheres (spherical plate capacitor) of radii a & b respectively separated by air and a dielectric of dielectric constant k_e or relative permittivity ϵ_r.

Q. 3: (a)-State and explain Kirchhoff's rules. Apply the Kirchhoff's rules to find current in a single loop containing two resistances and two batteries.   (05 + 05)

(b)-Derive an expression for force acting on a small element placed in a uniform magnetic field. Hence find force on a long straight conductor carrying current and show that,

$$\vec{F} = \oint_{c} i\,\vec{dl} \times \vec{B}$$

What is value of force for a closed loop carrying current?

Q. 4: (a)-Calculate energy stored in an inductor. Show that energy stored in magnetic field per unit volume is,

$$u_B = \frac{B^2}{2\mu_0}$$

(b)-State Ampere's law. How Maxwell generalize it? Why modification was needed? (06 + 04)