C.O.E.P

ELECTROMAGNETIC FIELD THEORY [EE-208]

END SEMESTER EXAM-2012

Branch: Electrical **Total: 50 marks**

S.Y.B.Tech **Time: 3:00hr**

Note:- (i) Write the answers precisely and legibly.

(ii) All questions are compulsory.

(iii) All questions carry equal marks.

(iv) All graphical work must be neat

Q. 1 Define the inductance (self as well as mutual) in terms of both flux linkage as well as stored energy and field vectors. What are the advantages and draw-backs of these definitions.

Show that the internal self-inductance of a straight cylindrical conductor is independent of its radius.

Q.2 Show that in a system, if the entire region between any two electrodes is filled with an uniform isotropic medium of constant resistivity {or conductivity}, then the current distribution in and the resistance of the region between the electrodes can be derived from the solution of the corresponding electrostatic problem for the capacitance between the same two electrodes when the intervening region is filled with insulating dielectric of constant permittivity.

Q.3 A parallel plate capacitor with free space as its dielectric is made up of electrode plate of area A with the separation x between them. A battery connected to the electrodes maintains them at constant potential difference of V_0 volts. Evaluate the mechanical work required to treble the separation of the electrode {at constant potential difference}.

Solve the problem by considering the stored energy of the capacitor, and then check the answer by solving it from force considerations.

Q.4 There is a surface charge density ρ_S per unit area on the interface plane between the two dielectric media of permittivities $\varepsilon_1\{=\varepsilon_0\varepsilon_{r1}\}$ and $\varepsilon_2\{=\varepsilon_0\varepsilon_{r2}\}$, the electric field intensities on the two sides of the interface are $\underline{E_1}$ and $\underline{E_2}$ respectively making angles θ_1 and θ_2 respectively with the common normal. Show that

$$\varepsilon_{r2}\cot\theta_2 = \varepsilon_{r1}\cot\theta_1\{1-\frac{\rho_s}{\varepsilon_0\varepsilon_{r1}\underline{E_1}\cos\theta_1}\}$$

Hence evaluate $\underline{E_2}$.

2.5 An expanding rectangular loop is made up of sides $x = 0, y = 0$ and $y = l$ which are fixed in space, the terminals being on the side $x = 0$. The fourth side which is parallel to y-axis and of length l, moves in the x-direction with a velocity $\underline{v} = \underline{i}_x v$ there is a time-harmonic magnetic field in this region {i.e x-y plane} which is given by

$$\underline{B} = \underline{B}_z = \underline{i}_z B_m \cos \omega t$$

Using the Faraday's law of induction in the form

$$\xi_{12} = -\iint_S \frac{\partial \underline{B}}{\partial t}.\underline{dS} + \oint_C (\underline{v} \times \underline{B}).\underline{dl},$$

show that the two components of the induced e.m.f will be 90^0 out of time-phase with each other, and whilst the amplitude of one component is constant, that of the other component increases linearly with time, when the velocity $\underline{v}$ is a constant quantity. Evaluate the actual values and explain these points in your own words.

Next, the velocity $\underline{v}$, instead of being constant, changes exponentially with time such that

$$\underline{v} = \underline{i}_x f e^{gt} = \frac{dx}{dt}$$

Where f and g are constants, and at $x = 0$, the moving conductor starts from the y-axis and hence

$$x = \int_{t=0}^{t} f e^{gt}\, dt$$

Find all the corresponding quantities in this case and explain them.