INDIAN INSTITUTE OF TECHNOLOGY

Date : Time : 3 Hrs. Full Marks 100 Dept. of E & ECE

No. of Students – 120 Spring Semester : 2011-12

Sub. No. EC21006 Sub.: Electromagnetic Engineering

Instructions : 1) ATTEMPT ALL THE QUESTIONS
2) MAKE NECESSARY ASSUMPTIONS WITH JUSTIFICATIONS, IF NECESSARY
3) ATTEMPT ALL THE PARTS OF A QUESTIION AT ONE PLACE

1. The boundary surface between two regions I and II in a magnetic field is on the z = 0 plane. The magnetic field intensity at the interface in Medium I ($z < 0$) is $\vec{H}_1 = 25\,\hat{a}_x + 30\hat{a}_y\ A/m$. The relative permeability of medium I is 12.0 and that of medium II is 15.0. Find **10**

a) the magnetic field intensity at the interface in medium II if the interface has no surface current

and b) the same quantity if the interface has a current sheet defined by $\vec{K} = 6.00\,\hat{a}_y\ A/width$

2. **20**

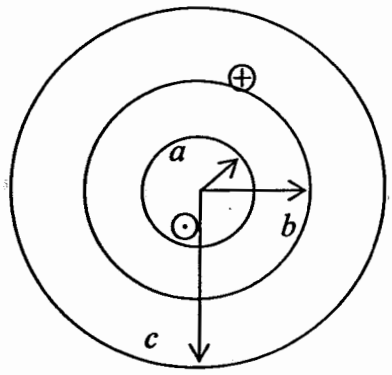

Figure – 1

The cross sectional view of a coaxial transmission line is shown in Figure 1. The current density is flowing through both inner and outer conductors and their directions are as shown. The inner conductor is a solid one and the region between the two conductors is filled by a dielectric. Find

a) internal inductance of the inner conductor
b) inductance due to linkage of flux in the dielectric region
c) inductance due to linkage of flux within the outer conductor.

3. At frequency $f = 150$ MHz, the propagation constant and intrinsic impedance of a medium are $0.01 + j12\ m^{-1}$ and $110 + j1.2\ \Omega$ respectively. The amplitude of the magnetic field intensity of an uniform plane electromagnetic wave travelling along positive z direction in the medium at $z = t = 0$ is $0.9 < 0\ A/m$. **10**

a) Write expressions for the instantaneous electric field intensity and instantaneous magnetic field intensity
b) Calculate the average power flow per unit area along the direction of propagation of the wave at $z = 0$ and also at $z = 10\ m$.

4. A y-polarised uniform plane wave travelling in free space is incident obliquely on a perfect plane conductor. The surface of the conductor is at $z = 0$ and the x - z plane is the plane of incidence. The angle of incidence is 30^0, the amplitude of electric field intensity of the incident wave is 15 V/m and frequency of the wave is 125 MHz. **20**

a) Express the electric field and magnetic field intensity vectors of the incident and reflected waves in phasor form.

b) Find the complex Poynting vectors of the incident wave, reflected wave and the sum of the complex Poynting vectors of the incident and reflected waves.

c) What conclusion you can draw from the value of the sum of the complex Poynting vectors of the incident and reflected wave?

5. The radii of the inner and outer conductors of a coaxial transmission line are 2 mm and 4 mm respectively. The conductivity of the conductors is $5.8 \times 10^7\ S/m$. The relative permittivity, relative permeability and conductivity of the insulation between the conductors are 3.5 , 1.0 and $6.0 \times 10^{-8}\ S/m$ respectively. **20**

a) Find per unit length resistance, inductance, capacitance and conductance of the line at a frequency of 150 KHz.

b) If a 7 m length line is terminated by a load impedance of 150Ω and is driven by a source having $\tilde{V}_s = 10 < 0^0\ V$ and $\tilde{Z}_s = (75 + j0)\Omega$, determine the time-average power delivered to the line and also to the load.

c) Repeat these calculations if the line is terminated by its characteristic impedance.

6. A pulse generator having a source impedance of 50Ω is attached to a 50Ω coaxial cable having some unknown length and load resistance. The dielectric of the cable is Teflon $(\epsilon_r = 2.1)$. The open circuit voltage waveform of the pulse generator is a pulse of duration $10\mu s$. If the recorded voltage at the input to the line is as shown in Figure 2, determine **10**

a) the length of the line

and b) the unknown load resistance.

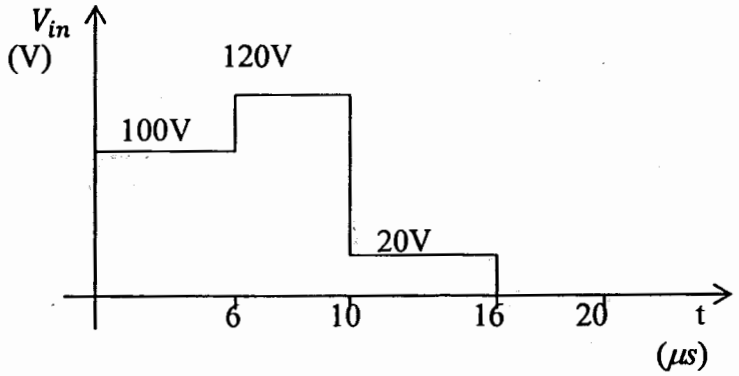

Figure – 2

7. A z-directed current element $I_z\ dl$ and another x-directed current element $I_x\ dl$ have the same angular frequency ω. **10**

a) Find the expressions for the far-fields of the z-directed antenna. Also, write the expression for the far-fields of the x-directed current element.

b) If I_z leads I_x by 90^0, show that on the y-axis in the far-field, the field is right-handed circularly polarised.