Kaferelsheikh University
Department of Electrical Engineering
Subject: Electromagnetic waves
Subject: Electromagnetic waves
Full Mark: 90 marks Final Exam: 2 pages

Faculty of Engineering
Year: 3rd Electronics and Electrical Communication
Academic Number: EPM3130
Date: 23/1/2017 Time allowed: 3 h

Attempt the following questions:

[1] Question One: (20 Mark)

i) Write down short notes about:

a- Magnetic dipole sources in magnetic materials
b- Basic polarization mechanisms in dielectric materials
c- Polarization of plane waves

ii) Consider the case where the medium is a perfect insulator with no stored charges, μ and ε are constants, the field vary sinusoidal with time and ω is the angular frequency. Use this information and the expressions for D and B in terms of E and H to simplify Maxwell equations

iii) Find the ratio of the amplitude of the conduction current density and the displacement current density for the applied field $E = E_m \cos\omega t$. Assume $\mu = \mu_0$

[2] Question Two: (20 Mark)

i) In a certain medium, $E = 10\,e^{-0.1y}\cos(10^8 t - 3y)a_x$ V/m. what type of medium is it?

a- Free space b- perfect dielectric c- lossy dielectric d- perfect conductor

ii) Show that in a good conductor, the skin depth δ is always much shorter than the wavelength.

iii) Sea water plays a vital role in the study of sub marine communication. Assuming that for sea water, $\sigma = 4s/m, \varepsilon_r = 80, \mu_r = 1$ and f = 100MHz. calculate: (a) the phase velocity, (b) the wavelength, (c) the skin depth, (d) the intrinsic impedance.

iv) In a non magnetic medium, the electric field component $E = 4\sin(2\pi \times 10^7 t - 0.8z)a_x$ V/m

Determine: a- direction of propagation b- ω and λ
c- the magnetic field component d- the time average power in the wave

[3] Question three: (25 Mark)

i) write down the conditions required for (a) lossless transmission line (b) distortion less T.L..... Deduce the characteristic impedance in each case

ii) A telephone line has $R = 30\Omega/km$, L = 100mH/km, G = 0 and C = 20μ F/km. At frequency of 1kHz, find:

a- The characteristic impedance of the line b- the propagation constant

c- the phase velocity

iii) Derive an expression for the input impedance seen by the generator when it is connect to a load ,Z_L, through a T.L. of length, l, and characteristic impedance, Z_o,

iv) A stub of length 0.12λ is used to match a 60 Ω lossless line to a load. If the stub is located at 0.3λ from the load, use smith chart to calculate: (a) the load impedance (b) the length of an alternative stub and its location with respect to the load (d) the standing eave ratio between the stub and the load

v) With an unknown load connected to a slotted air line, S = 2 is recorded by a standing wave indicator and minima are found at 11 cm, 19 cm, . . . on the scale. When the load is replaced by a short circuit, the minima are at 16 cm, 24 cm. If $Z_0 = 50\Omega$, calculate the wave length and the load impedance. (use smith chart)

[4] Question four: (25 Mark)

i) Explain the effect of zigzag paths on the wave velocity in rectangular wave guides.

ii) show that the rectangular waveguide does not support TM_{10} and TM_{01} modes

iii) if a tunnel is 4 by 7 m in cross section, will a car in the tunnel receive an AM radio signal with frequency of 10MHz? justify your answer.

iv) In an air-filled rectangular waveguide, with a = 2.286 cm and b = 1.016 cm,

$$E_y = 5\sin(2\pi\ x/a)\cos(3\pi\ y/b)\sin(10\pi\times10^{10}\ t - \beta z)\ V/m$$

Determine

(a) the mode of operation, (b) the cutoff frequency, (c) the intrinsic impedance

(d) H_x

v) An air filled resonant cavity with dimensions a=5cm, b=4cm and c=10cm is made of copper. Find the resonant frequency for the dominant mode.

Best Wishes

Dr. Shamia Ghamry