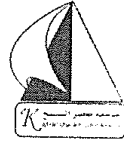


Kaferelsheikh University
Department of Electrical Engineering

Subject: Electromagnetic waves

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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, $\sigma = 4 \text{ s/m}$, $\epsilon_r = 80$, $\mu_r = 1$ and $f = 100 \text{ MHz}$. 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 $C = 20\mu F/km$. 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_0 ,
- iv) A stub of length 0.12λ is used to match a 60Ω 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 wave 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,

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

- (a) the mode of operation, (b) the cutoff frequency, (c) the intrinsic impedance
(d) H_x
- v) An air filled resonant cavity with dimensions $a=5$ cm, $b=4$ cm and $c=10$ cm is made of copper. Find the resonant frequency for the dominant mode.

Best Wishes

Dr. Shamia Ghamry

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