MANSOURA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRONICS
& ELECTRICAL COMMUNICATIONS

ELECTROMAGNETIC WAVES
EXAM
JUNE 2013

Attempt the following questions. Full Mark 100 Time: 3 Hours

1- For TEM waves on a coaxial transmission line, define the following terms and give illustrative equations where necessary: Characteristic Impedance; Reflection Coefficient; Return Loss; and Voltage Standing Wave Ratio (VSWR).
A 75 Ω line has a length of 0.27 m and connects a 10 V source of internal resistance 75 Ω to a load impedance 75 + j25 Ω. The dielectric constant of the line is 2.25 and the frequency is 3 GHz. Find
a) The phase velocity, the wave impedance, the phase shift constant, and the wavelength on the line.
b) The reflection coefficient at the load and at the input, and the VSWR.
c) The power delivered to the load. 20 Marks

2- For electromagnetic wave reflection at a plane boundary between two dielectric media, state the conditions for: i- total internal reflection ii- total transmission.
A vertically polarized uniform plane wave is incident from sea water ($\sigma = 0$, $\varepsilon_r = 81$) onto the water –air interface. The amplitude of the incident electric field is 1 V/m. Find the amplitude of the reflected and transmitted electric fields and the reflected power density in each of the following cases: i- the angle of incidence $\theta_i = 0^o$ (normal incidence) ii- $\theta_i = 60^o$ (oblique incidence) 20 Marks

3- Why are microwave waveguides usually designed to support only a single mode?
The inside dimensions of an air-filled waveguide are a = 10.7mm and b = 4.3 mm.
a-Determine the cut-off frequencies of the first two propagating modes, hence suggest, giving reasons, which range of frequencies would be most appropriately covered by this guide.
b- For the TE_{10} mode at 20 GHz, determine the phase shift constant, the wavelength, the phase and group velocities, and the wave impedance inside the guide.
c- A section of length d = 10.7mm of the guide is short circuited at both ends and used as a rectangular cavity resonator. Determine the resonant frequency for the TE_{101} mode.
25 Marks

4- Consider matching a load impedance $Z_L = 60 - j25\ \Omega$ to a 50 Ω coaxial line using a shunt 50 Ω short circuited stub.
a- Determine the length and the location, nearest to the load, of the stub.
b- What will be the reflection coefficients: on the stub, on the line section near the load, and on the line section on the other side of the stub?
c- Why is it recommended to connect the stub as ear to the load as possible?
15 Marks

5- Derive expressions for the attenuation factor α and the phase shift constant β for a low-loss transmission line in terms of the line parameters L, C, R, and G.
A transmission line has the following parameters: L = 0.25 μH/m, C = 250 pF/m, R = 5 Ω/m, G = 0.01 S/m.
a- Calculate the propagation constant ($\gamma = \alpha + j\beta$) and the characteristic impedance of the line at 600 MHz.
b- If a half wavelength short-circuited section of this line is used as a UHF resonator find Q of this resonator. 20 Marks

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