UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	:	APPLIED ELECTROMAGNETICS
COURSE CODE	:	BEE 3223
PROGRAMME	:	BEE
EXAMINATION DATE	:	APRIL / MEI 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR** QUESTIONS ONLY

THIS PAPER CONSISTS OF NINE (9) PAGES

Q1 (a) Define lossless transmission lines together with the line parameters.

(1 mark)

(b) Explain the concept of skin depth supported with a proper figure.

(1 mark)

(c) Illustrate quarter-wavelength transformer matching technique with the help of a proper figure and interpret its drawback.

(3 marks)

(d) A section of lossless transmission line is shunted across the main line as can be seen in Figure Q1(d).

If $\ell_1 = \frac{\lambda}{4}, \ell_2 = \frac{\lambda}{8}$ and $\ell_3 = \frac{7\lambda}{8}$, use Smith Chart to determine:

(i) Input admittance at Line 1, Y_{in1}
(ii) Input admittance at Line 2, Y_{in2}
(iii) Input admittance at Line 3, Y_{in3}

You are given $Z_O = 100\Omega$ and $Z_L = 200 + j150\Omega$.

(10 marks)

(e) For the lossless transmission line circuit shown in the Figure Q1(e), propose the equivalent series lumped-element (R and L) circuit at 400 MHz at the input to the line. The insulating layer has relative permittivity, $\varepsilon_r = 2.25$ and the line has characteristic impedance, $Z_o = 50\ \Omega$.

(10 marks)

Q2 (a) Explain TWO main roles of a metallic cavity resonator in Microwave Engineering.

(2 marks)

(b) What is the Quality Factor, Q of the cavity? Evaluate Q if the cavity is lossless.

(2 marks)

(c) A rectangular cavity is connected to Waveguide-1 and Waveguide-2 and can send electromagnetic energy to these waveguides by two small holes at each side. The cavity itself is fed by a generator which can produce electromagnetic fields for continuous frequencies of 2 GHz – 5.2 GHz as can be seen in Figure Q2(c). Cavity and Waveguide-1 are air-filled but Waveguide-2 is filled with dielectric with relative permittivity, $\varepsilon_r = 1.7$ and the dimensions are: a = 7.5 cm, b = 3 cm for the waveguides and cavity. In addition, c = 5 cm for the cavity.

(i) Calculate all the frequencies which can be supported in the cavity.

(3 marks)

(ii) Propose the propagation modes in Waveguide-1 and evaluate the group velocity, v_g of every mode.

(4 marks)

(iii) Propose the propagation modes in Waveguide-2 and evaluate the wave impedance, η of every mode.

(8 marks)

(iv) If at point A inside Waveguide-1: |E| = 10V/m for its dominant propagation-mode, estimate |E| at points B, C and D. Deduce the direction of electric field intensity, $\vec{E}$ at all these points.

(6 marks)

Q3 (a) With the aid of relevant equations or diagrams, briefly explain the following terms:

(i) Gain, G_R for a receive antenna
(ii) Radiation Efficiency, η_r.
(iii) Polarization
(iv) Half-Power Beam Width

(2 marks)

(b) A dipole antenna of length 0.35λ operating at 3 GHz is constructed by using copper $\left(\sigma = 5.8\times10^7\ \text{S/m}\right)$ with 2.5 mm in diameter.

(i) Determine the radiation efficiency, η_r of the antenna.

(6 marks)

(ii) Calculate the directivity, D of the antenna if maximum radiation intensity, U_{max} of 0.75W/sr and input power, P_{in} of 0.25 W are employed respectively.

(4 marks)

(iii) Four half-wave dipoles are arranged in a square lattice, spaced in a straight line by a distance of one half-wavelength along a line. Illustrate the element pattern in both E and H planes and predict the boresight gain in case that all elements are fed with equal amplitudes which are in phase.

(5 marks)

(c) Given transmit antenna efficiency, η_r is 65%, design a parabolic reflector operating at 8.52 GHz with 15 W of power radiated by the systems. In your consideration, plan the design of the reflector by taking into account the beam width, θ; transmit power gain, G_{PT} in dB; receive power gain, G_{PR} in dB; and Effective Isotropic Radiated Power, *EIRP* in dBm.

(8 marks)

Diameter of antenna is 2 m.

Q4 (a) Define Clearance Zone and state the significant of this zone to radio wave propagation.

(2 marks)

(b) Interpret the concept of diffraction from TWO different conditions.

(3 marks)

(c) The Royal Armed Forces wishes to set up a line of sight communication between Kuala Lumpur and Kuantan. The distance between the two cities is approximately 200 km. They plan to use antennas with power gain, G_p of 13 dB for the link for both transmitting and receiving station. The transmitting antenna will be fed with 5W of power at a carrier frequency of 300 MHz. Calculate:

(i) Effective Isotropic Radiated Power, *EIRP* in dBW.
(ii) Free Space Loss, L_F in dB.
(iii) Power density at the receiver antenna, P_d.
(iv) Power received at the receiving antenna, P_R in dBW. Assume no other losses.

(10 marks)

(d) After conducting site survey, it is found that the 800-meter Batang Kali hill in Pahang located at 50 km from the transmitter in Kuala Lumpur will become a major obstruction to the line-of-sight system planned in Q4(c). Predict:

(i) Knife-edge loss, L_{ke} in dB, caused by the hill if both transmitter and receiver are 30 meters above the sea level.
(ii) Path loss, L in dB.
(iii) Power received, P_R in dBW, at the receiving antenna. Assume no other losses.

(10 marks)

Q5 (a) Differentiate between Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI)

(2 marks)

(b) Describe the condition(s) when a system is considered as Electromagnetically Compatible.

(2 marks)

(c) Figure Q5(c) shows an electrical system that fails some EMC tests due to some EMI issues with arrows showing some types of emission.

(i) Relate to the EMC tests involved

(ii) Propose and elaborate some methods that you can used to minimise the emissions as shown in the Figure Q5(c).

(10 marks)

(d) In EMC measurement setups, many environments such as listed below are involved:

- Open Area Test Site (OATS)
- Screened Room (SR)
- GigaHertz Transverse Electromagnetic Cell (GTEM)
- Semi Anechoic Room (SAR)
- Reverberation Chamber (RC)

(i) Explain the term environment in the aspect of EMC testing.

(ii) From the environments listed above, compare these environments in terms of their advantages and disadvantages.

(11 marks)

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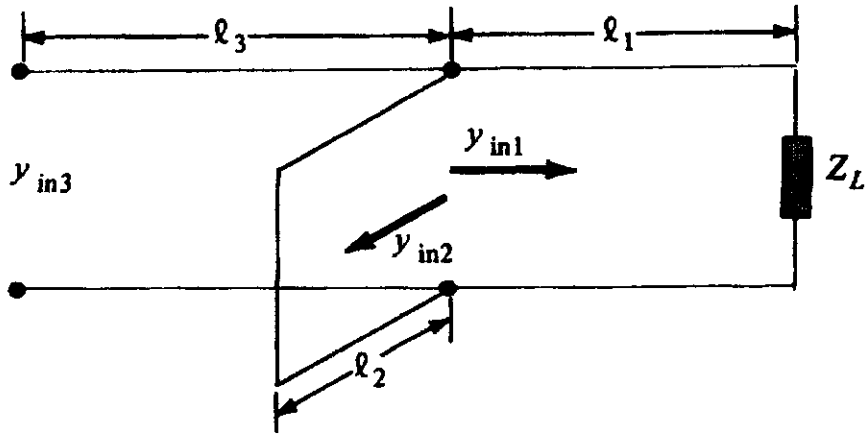

FIGURE Q1(d)

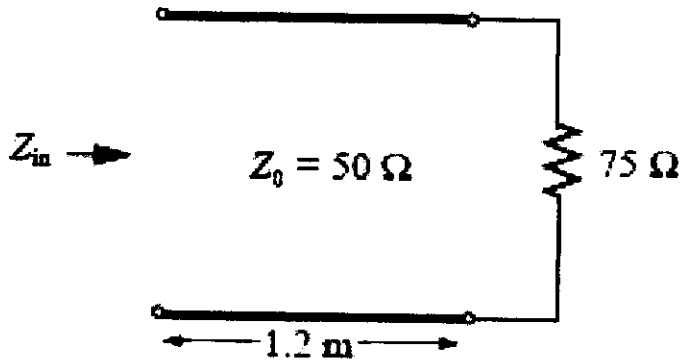

FIGURE Q1(e)

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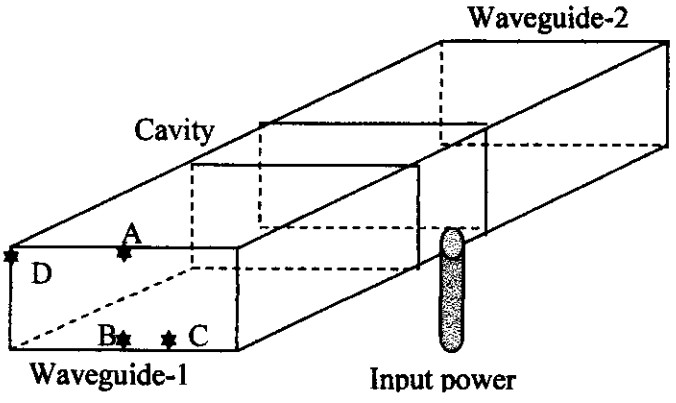

FIGURE Q2(c)

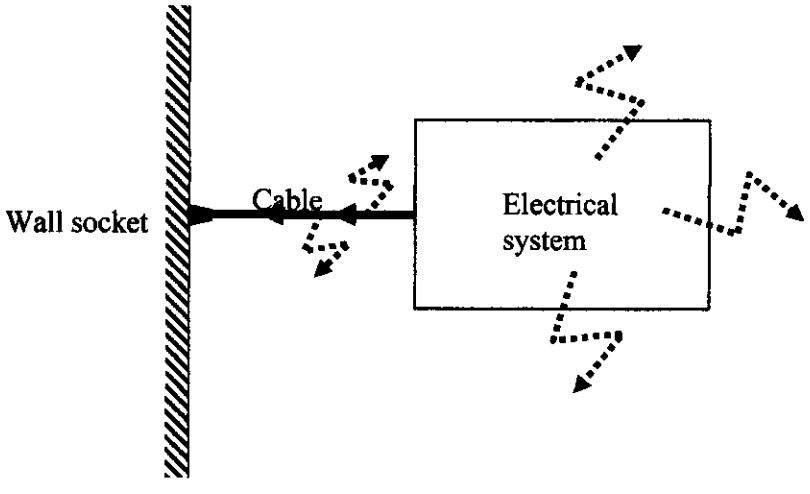

FIGURE Q5(c)

The Complete Smith Chart

Black Magic Design