THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

Faculty of Engineering and Technology

THIRD YEAR/SECOND SEMESTER EXAMINATIONS FOR THE DEGREE

OF BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 2314 TRANSMISSION LINES

MAY 2011 SERIES **TIME: 2 HOURS**

<u>INSTRUCTION TO CANDIDATES</u>

Answer question **ONE** and any other **TWO** questions.

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1. (a) A 2 meter length of RG179 B/U coaxial cable, with $Z_0 = 50\Omega$ and a capacitance of 64 pF/m, is used at a frequency of 1000MHz and is considered lossless.

(i) Explain why it possible for this cable to be considered lossless

(ii) Prove that the equation for the phase velocity of this lossless line is given by

$$v_p = 1/Z_0C\ ms^{-1}$$

(iii) If this 2m length of RG179 B/U coaxial cable is terminated with a load impedance of 50Ω, determine (analytically) the input impedance of the cable. (11 marks)

(b) A coaxial transmission with a characteristic impedance of $Z_0 = 75\Omega$ is 2cm long, and is terminated with a load impedance $Z_L = 75 + j37.5\Omega$. If the dielectric constant of the line is 2.56 and the frequency is 1.5 GHz, find using a Smith chart:

(i) The input impedance of this line

(ii) The VSWR on the line (11 marks)

(c) For each of the following engineering applications describe the technological challenges inherent in their implementation and how the adoption of transmission line theory has been able to either overcome or minimize such challenges:

(i) High speed digital interconnects

(ii) Fabrication of microwave circuit components

(iii) Antenna feed lines

(iv) Parallel transmission lines (8 marks)

2. (a) The transmission line circuit of figure (Qu.2b) has Vg = 15V_{RMS}; Z_0 =75Ω; Zg =50Ω; Z_L = 60 – j40 and the length *l* = 0.7λ. Compute the power delivered to the load using two different techniques:

(i) Find $|\Gamma|$ and compute $P_L = (\frac{V_g}{2})^2 \frac{1}{z_0}(1+|\Gamma|^2)$

(ii) Find Z_{in} and compute $P_L = \left|\frac{V_g}{Z_g + Z_{in}}\right|^2 \mathrm{Re}(Z_{in})$ (10 Marks)

(b) With the aid of a Smith chart design a quarter-wave transformer to match a load impedance $Z_L = 41.25 + j22.5\Omega$ to a transmission line with characteristic impedance $Z_0 = 75\Omega$, velocity factor of 0.9 and a frequency of 1GHz.

(10 marks)

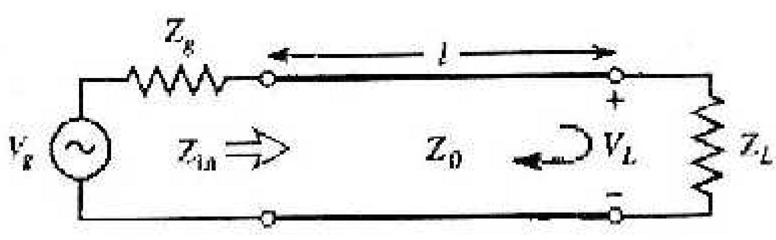

Figure Qu.(2b)

3. (a) (i) When a transmission line is used to transmit energy from a source to a load, the load impedance is normally chosen to match the characteristic impedance of the line. Why?

(ii) Describe what happens when a line is terminated in an impedance other than the characteristic impedance of the line and a single pulse of energy is injected into the line. (6 Marks)

(b) Prove mathematically that a short circuited transmission line behaves like an inductance and with the aid of suitable sketches show that the impedance varies at a distance of $\lambda/4$ alternating between 0 and ∞.

(14 marks)

4.(a) Compare and contrast key differences between circuit and transmission line theory. (4 marks)

(b) With the aid of a Smith chart design a parallel short-circuited stub to match a load impedance $Z_L = 22.5 - j41.25\Omega$ to a transmission line with characteristic impedance $Z_0 = 75\Omega$, a velocity factor of 0.9 and a frequency of 1GHz.

(10 marks)

(c) (i) How does the presence of standing waves affect voltage and current along a transmission line?

(ii) Describe the consequence of standing waves in the following situations:

- Transmitting applications
- Receiving applications
- Data transmission (6 Marks)

5.(a) A single short pulse is launched on a coaxial cable of unknown termination. The velocity factor of the coaxial cable is 0.9. The source can be assumed to be matched to the coaxial line. An oscilloscope shown in

Figure Qu.(5a) measures the following at the input to the coaxial line, where the source is connected:

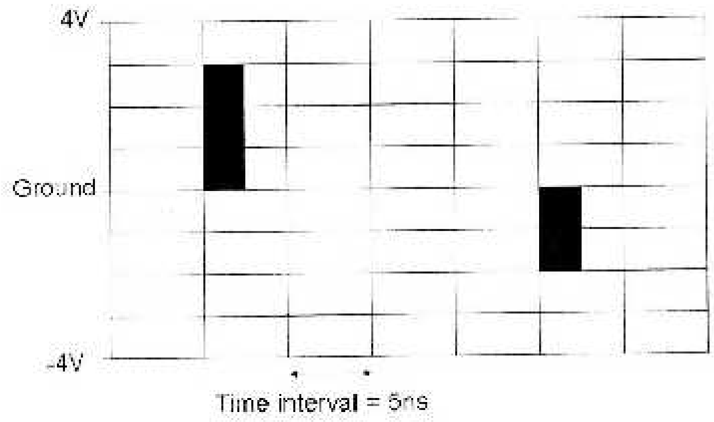

Figure Qu.(5a)

(i) The length of the line

(ii) The type of load termination that will cause this reflection

(iii) The attenuation of the cable in dB per metre

(9 Marks)

(b) (i) Prove that for a line that has a purely resistive characteristic Impedance which is terminated in a load that is purely resistive, the VSWR = R_0/R_L for $R_0>R_L$ and R_L/R_0 for $R_L>R_0$

(ii) A transmission line with a characteristic impedance of 300Ω is terminated in a purely resistive load. It is found by measurement that the minimum value of voltage upon it is 5μV and the maximum 7.5μV. Calculate the possible values of the load resistance.

(11 Marks)