TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Electrical Engineering

EEE 2314: TRANSMISSION LINES

END OF SEMESTER EXAMINATION

SERIES: MAY 2016 EXAM

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-*Answer Booklet, examination pass and student ID*

-*Log/linear graph paper*

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

(a) Using suitable well labeled diagrams describe THREE types of transmission lines that are commonly in use.

[6 marks]

(b) Explain the following terms that are used to describe transmission lines:

(i) uniform

(ii) loss-less,

(iii) lossy,

(iv) distortionless. *[4marks]*

(c) (i) Draw a well labeled equivalent circuit of a section of transmission line of length *Δz* which has distributed parameters $R\,\Omega/m,\ L\,H/m,\ G\,mho/m,$ and $C\,F/m$.

(ii) Explain what each parameter represents in the physical line

[6 marks]

(d) Apply *Kirchhoff's* voltage and current laws to the equivalent circuit to derive the following equation:

$$\frac{\partial^2 V}{\partial z^2} = RGV + (RC + LG)\frac{\partial V}{\partial t} + LC\frac{\partial^2 V}{\partial t^2}.$$ *[8 marks]*

(e) Express the equation in (d) for the case of a loss-less line? *[3 marks]*

(f) Explain the nature of the solution of the equation obtained in part (e). *[3 marks]*

Question TWO

(a) The signal on a lossless transmission line travels as a wave in the *z*-direction with a phase velocity *v* and obeys the equation:

$$\frac{\partial^2 V}{\partial z^2} = \frac{1}{v^2}\cdot\frac{\partial^2 V}{\partial t^2}.$$

Verify that *V* is a function of either $(t - z/v)$ or $(t + z/v)$. *[4 marks]*

(b) A dc voltage V_o is suddenly applied at the time *t* = 0 to an ideal transmission line of infinite length. Explain and sketch the value of the voltage and current on the line at some other time *t* > 0.

[4 marks]

(c) A dc voltage V_o from a battery whose internal impedance is Z_g is suddenly applied at the time *t* = 0 to an ideal transmission line which is short-circuited at a point *z* = *l* from the sending end. The line has a characteristic impedance Z_c. If $Z_g = Z_c/2$ determine and sketch the value of the voltage at the input as a function of time.

[6marks]

(d) A lossless transmission line of length *l* is initially *charged* to a d-c potential V_o .with a resistor of resistance R connected across the input at time *t = 0*. If $R = Z_c$, determine and sketch the current flowing through the resistor as a function of time *t* > 0. *[6 marks]*

Question THREE

A telephone line has the following distributed parameters:

$R = 20\Omega/mi,\ L = 3\times10^{-3}\ H/mi,\ G = 10\times10^{-6}\ mho/mi,$ and $C = 60\times10^{-9}\ F/mi.$

(a) For a signal with an angular frequency of 5000 rad s^{-1}, calculate the following:

(i) the magnitude and phase of the characteristic impedance Z_c; *[3 marks]*

(ii) the propagation constant $\gamma = \alpha + j\beta$; *[3marks]*

(iii) the wavelength λ *[2 marks]*

(b) Estimate the magnitude of the characteristic impedance (i) at very low frequencies, and (ii) at very high frequencies.

[4marks]

(c) Explain carefully the difference between the units Nepers and Decibels (dB) used in describing attenuation in transmission lines. Express the attenuation constant obtained in part (a)(iii) in decibels.

[8 marks]

Question FOUR

(a) A transmission line with characteristic impedance Z_c and propagation constant γ is terminated with load impedance Z_L. Show that at a distance *l* from the load, ($z = -l$), the input impedance looking towards the load is given by:

$$Z_{in}(l) = Z_c \frac{Z_L + Z_c \tanh \gamma l}{Z_c + Z_L \tanh \gamma l}$$

[5marks]

(b) Deduce from part (a) the value of the input impedance of a *loss-less* line when (i) the line is open-circuited, and (ii) when the line is short-circuited.

[6 marks]

(c) A section of a coaxial cable is 1.1 m. long. It is found that an open-circuit measurement gives a capacitance of 60 *pF* and a short-circuit measurement gives an inductance of 0.38 *μH*, both measurements done at 1 kHz. Determine: (i) the characteristic impedance of the line, (ii) the phase velocity, and (iii) the phase constant.

[9marks]

Question FIVE

(a) Define the *Voltage Standing Wave Ratio (VSWR)* on a transmission line. *[2marks]*

(b) A transmission line with characteristic impedance Z_c is terminated with a load whose impedance $Z_L = 3Z_c$. Calculate and sketch the voltage and current standing wave patterns along the line.

[6marks]

(c) A transmission line is terminated with a load whose normalised admittance is $\overline{Y}_L = (0.17 + j0.20)\,mho$. A double-stub matching network consists of two line sections having the same characteristic impedance as the transmission line itself. The first stub is located at the position of the load, while the second is located a distance 0.211 λ from the load. Use a Smith Chart to determine the required susceptance values of the two stubs.

[6marks]

(d) Determine the shortest, and termination required of each stub to provide the susceptance values in part (c).

[6 marks]