# MACHAKOS UNIVERSITY

**University Examinations for 2019/2020Academic Year**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**
**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**THIRD YEAR SECOND SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING**

**EEE 313: TRANSMISSION LINES AND WAVEGUIDE**

**DATE: 30/11/2020** **TIME: 8.30-10.30 AM**

**INSTRUCTIONS**

1. This paper consists of **FIVE** questions.
2. Answer **QUESTION ONE** and **ANY OTHER TWO** questions.
3. All workings must be clearly shown
4. The Smith Chart page provided should be attached to the Answer Booklet after use.
5. Take the speed of light in free space to be

**QUESTION ONE (30 MARKS) COMPULSORY**

a) Define a Transmission Line and outline **THREE** broad categories of Transmission Lines. (4 marks)

b) A $30m$ long lossless transmission line with $Z_0 = 50\Omega$ operating at $2MHz$ is terminated with a load $Z_L = 60 + j40\ \Omega$. If $u = 0.6c$ on the line, where $c$ is the speed of light in a vacuum, find the parameters listed below both without using the Smith Chart and by using the Smith Chart and comment on the results. (10 marks)

i. The reflection coefficient Γ

ii. The standing wave ratio $s$

iii. The input Impedance $Z_{in}$

c) What do you understand by the following terms as used in Transmission Lines: (4 marks)

i. Phase

ii. Dispersion:

iii. Voltage Standing Wave Ratio

iv. Characteristic impedance

d) A hollow rectangular waveguide is to be used to transmit signals at a carrier frequency of 6GHz. Choose its dimension so that the cut-off frequency of the dominant TE mode is lower than the carrier by 25% and that the next mode is at least 25% higher than the carrier

(8 marks)

e) A generator with an open-circuit voltage $V_g(t) = 100\sin(8000\pi t)$ and internal impedance $Z_g = 40 + j30\ \Omega$ is connected to a $50\Omega$ distortionless line. The line has a resistance of, and its lossy dielectric medium has a loss tangent of $0.18\%$. The line is $50m$ $50m$ long and is terminated in a matched load. Find the instantaneous expressions for the voltage and current at an arbitrary location on the line. (4 marks)

**QUESTION TWO (20 MARKS)**

a) With practical examples, distinguish between wave propagation in bounded media and unbounded media. (4 marks)

b) Explain the meaning of transit time and use the concept to distinguish between Lumped and distributed parameters as used in transmission line modelling and analysis. (4marks)

c) With the aid of block diagrams and mathematical expressions, distinguish between ABCD −Parameters and $S$-parameters as used in two-port networks analysis of transmission lines. Hence, show that for the case where a 2-port network is created by cascading two networks having transmission matrices defined as $T_A$ and $T_B$, respectively, the total transmission $T$ is given by$T = T_A T_B$.

(7 marks)

d) A lossless transmission line is 80cm long and operates at a frequency of $600MHz$. The line parameters are and. Find: (5 marks)

i) the characteristic impedance of the line

ii) the phase constant

iii) the velocity on the line

iv) the input impedance for $Z_L = 100\Omega$.

**QUESTION THREE (20 MARKS)**

a) List **FOUR** differences between a transmission line and waveguide. (4 marks)

b) Using the circuit of Fig. Q3 b) of a finite transmission line connected to a load, show that the input impedance is given by $Z_i = (Z)_{\substack{z=0 \\ z'=l}} = Z_0(\frac{Z_L + Z_0 \tanh \gamma l}{Z_0 + Z_L \tanh \gamma l})$

(6 marks)

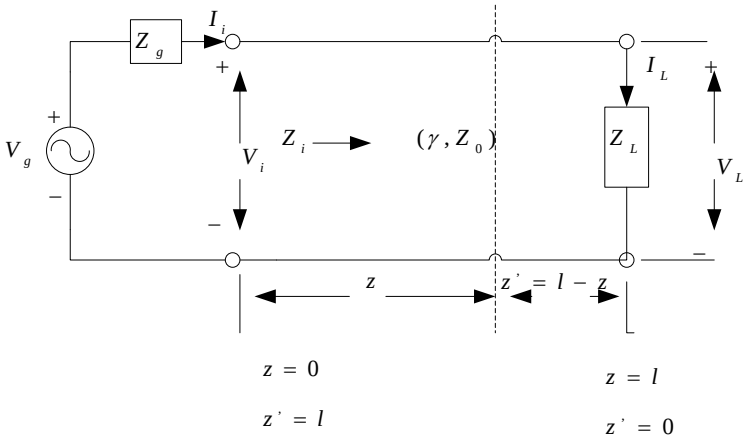


Fig. Q3 b) Finite Transmission Line Connected to Load

c) A certain transmission line operating at has $\alpha$ = 8 dB/m,, and $Z_0 = 60 + j40\Omega$, and is $2m$ long. If the line is connected to a source of $10 < 0^0 V$, $Z_g = 40\Omega$ and terminated by a load of $20 + j50\Omega$, determine: (10 marks)

i. The input impedance

ii. The sending-end current

iii. The current at the middle of the line

**QUESTION FOUR (20 MARKS)**

a) With aid of examples and block diagrams, explain the difference between balanced and unbalanced transmission lines or systems. (4 marks)

b) Discuss the meaning of Resonant Line and Anti-resonant Line as used in transmission lines. (4 marks)

c) Prove that a maximum power is transferred from a voltage source with an internal impedance $Z_g$ to a load impedance $Z_L$ over a lossless transmission line when $Z_i = Z_g^*$ where $Z_i$ is the impedance looking into the loaded line. What is the maximum power transfer efficiency?

(4 marks)

d) Waveguide, with dimensions a = 1 cm and b = 0.7 cm, is to be used at 20 GHz. Determine the wave impedance for the dominant mode when (8 marks)

i) the guide is empty,

ii) the guide is filled with polyethylene (whose εr = 2.25).

**QUESTION FIVE (20MARKS)**

a) In the analysis of transmission lines there are **TWO** main approaches which can be adopted. Give these approaches and justify the selection made between them in this unit. (3 marks)

b) A distortionless line has $Z_0 = 60\Omega,\ u = 0.6c$, where $c$ is the speed of light in a vacuum. Determine $R,\ L,\ G,\ C$ and $\lambda$ for the line at $100MHz$. (5 marks)

c) Explain **ONE** Advantage and **ONE** Disadvantage of single-stub matching technique of transmission lines as compared to the quarter wavelength transformer. (4 marks)

d) A 50Ω transmission line is connected to a load impedance $Z_L = 35 - j47.5\Omega$. Using Smith Chart, find the position and length of a short-circuited stub required to match the line (8 marks)