PAPER 1

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION 2023/2024

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 4401 TRANSMISSION LINES

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: April 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt **Question ONE and ANY other TWO questions.**

1. $\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9} F/m ; \mu_0 = 4\pi \times 10^{-7} H/m$

Question ONE (Compulsory 30 marks)

(a) Consider a pair of lines 5 cm in length etched on a glass-epoxy board (Fig. Qu. (1a)).

(i) Determine the delay and phase shift digital signals propagating along the lines will experience. Assume the signal is propagating in the conductor only.

(ii) Explain the consequence of this delay with regard to signal integrity. (10 marks)

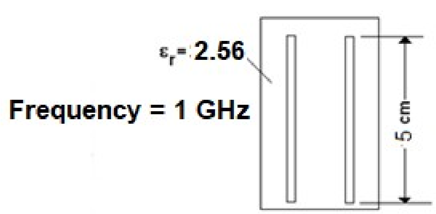

Fig. Qu. (1a)

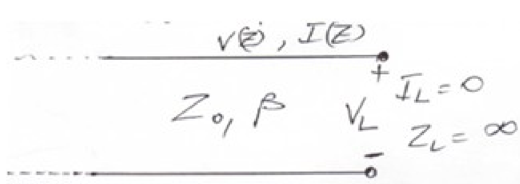

Fig. Qu. (1c)

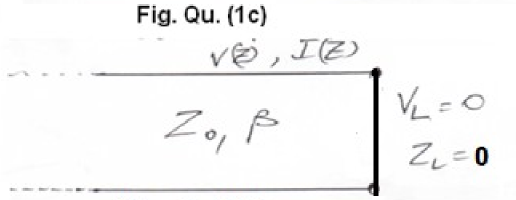

Fig. Qu.(1c)

(b) At the load end of a terminated transmission line having a characteristic impedance of $100\,\Omega$, the reflection coefficient $\Gamma_L = 0.560 + j0.215$. Determine the load impedance using:

(i) Analytical method (ii) A Smith chart. (10 Marks)

(c) Consider the open-circuited & short-circuited lines shown in Fig. Qu. (1c). Show that a section of an open-circuited transmission line behaves like a capacitor and a section of a short-circuited transmission line behaves like an inductor and determine the values for each given a frequency of $2\,GHz$. (10 marks)

(d) A correctly terminated transmission line of length 20 km has an input of 8 V_{RMS} at 3 kHz and produces an output across the terminating load of 2 V_{RMS} lagging by 100^0.and a velocity factor of 0.9. Determine the following:

(i) Attenuation coefficient (α) (ii) Phase angle coefficient (β) (4 marks)

Question TWO

Consider the transmission line in figure (Qu.2a). Given: $Vg = 15\,V\,RMS$; $Z_0 = 50\,\Omega$; $Zg = 50\,\Omega$.
$Z\,L = 100 + J\,50$ and the length $l = 0.3\,\lambda$. Determine:

(i) Reflection coefficient at the load

(ii) Reflection coefficient along the line

(iii) Incident voltage $V_0^{+¿¿}$ (20 marks)

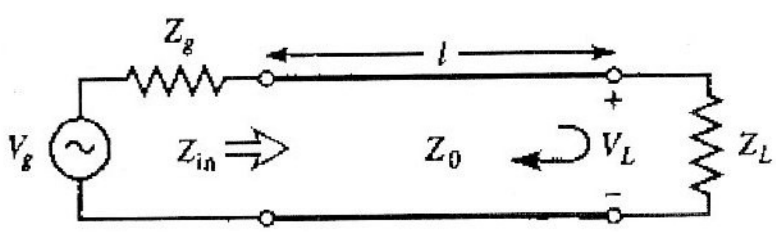

Figure (Qu.2a)

Question THREE

(a) (i) Describe how the presence of standing waves affect voltage and current along a transmission line.

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

I Transmitting applications

II Receiving applications

III Data transmission (7 marks)

(b) The transmission line circuit of figure (Qu.3b) has $Vg=15\,V\,RMS$; $Z_0=75\,\Omega$; $Zg=75\,\Omega$; $Z=100-j40$ and the length $l=0.7$. Compute the power delivered to the load using two different techniques:

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

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

(iii) Find V_L and compute $$P_L=\left|\frac{V_L}{Z_L}\right|^2\Re\left(Z_L\right)$$ (13 marks)

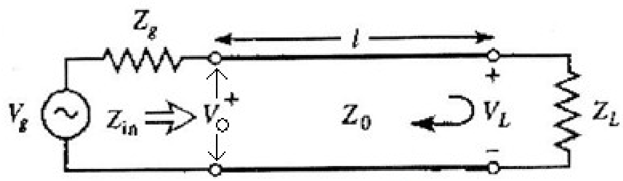

Figure Qu.(3b)

Question FOUR

(a) 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 $Z_0=75$, a velocity factor of 0.9 and a frequency of $1\,GHz$. (10 marks)

(b) Validate the solution in (a) analytically. (10 marks)

Question FIVE

(a) With the aid of a Smith chart design a quarter-wave transformer to match a load impedance $Z_L=22.5-j41.25\,\Omega$ to a transmission line with characteristic impedance $Z_0=75$, a velocity factor of 0.9 and a frequency of $1\,GHz$. (10 marks)

(b) Motivating all your steps derive the following transmission line equations:

$\hat{V}(Z)=V_0^{+¿e^{-\gamma z}+V_0^{-¿e^{\gamma z}¿}}$ $\hat{I}(Z)=I_0^{+¿e^{-\gamma z}-I_0^{-¿e^{\gamma z}¿}}$ (10 marks)