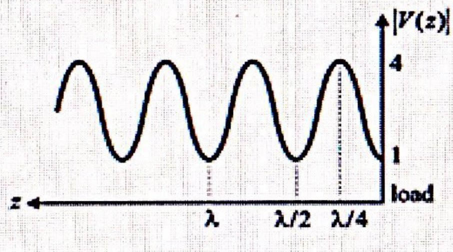
Department of Electrical Engineering
Assignment
Date: 17/04/2020

Course Details

Course Title:	Antennas & Wave Propagation	**Module:**	8TH
Instructor:	DR.NAEEM AHMAD JAN	**Total Marks:**	30

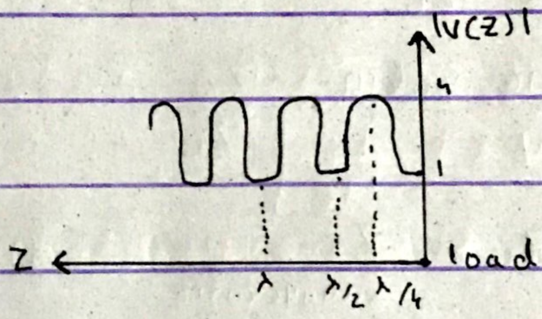
Student Details

Name:	LATIF UR REHMAN	**Student ID:**	13011

Q1.	(a)	**Voltage standing wave pattern in a lossless transmission line with characte[ristic] impedance 50 Ω and resistive load is shown in the figure.**  **Qu.** The value of the load resistance is (A) 50 Ω (B) 200 Ω (C) 12.5 Ω (D) 0	Marks 6 CLO 2
	(b)	Draw & Explain Equivalent circuit model of a Transmission line	Marks 4 CLO 1
Q2.	(a)	A microwave circuit consisting of lossless transmission lines T_1 and T_2 is shown in the figure. The plot shows the magnitude of the input reflection coefficient Γ as a function of frequency f.	Marks 6 CLO 2

QNO 1

(a) Voltage standing wave pattern in a lossless transmission line with characteristics impedance 50Ω and resistive load is shown in the figure.



Solution:.

Given Data

$Z_0 = 50\Omega$

$V_{max} = 4$

$V_{min} = 1$

Required Data:

$Z_L = ?$

S. wave. ratio = ?

As we know That

S = wave ratior $= \frac{V_{max}}{V_{min}}$ —— (1)

Put the value in Eq (1)

S. wave ratio $= \frac{4}{1}$

S. wave ratio $= 4$

Now find Z_L

S. wave ratio $= \frac{Z_0}{Z_L}$

$Z_L = \frac{Z_0}{\text{S. wave ratio}}$ —— (2)

Put value in Eq (2)

$Z_L = \frac{50}{4}$

$\boxed{Z_L = 12.5\,\Omega}$

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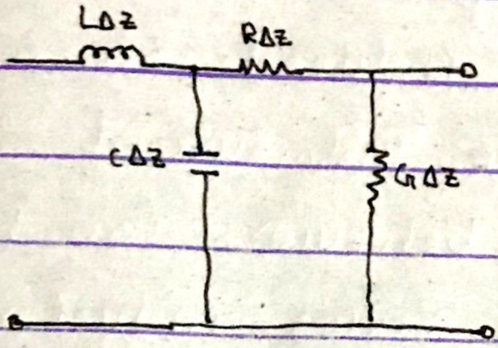
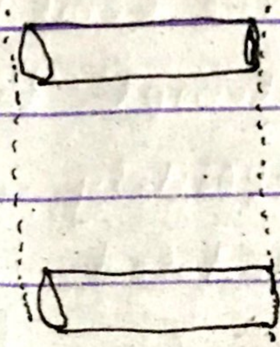
Part (b)

Draw and Explain Equivalent Circuit model of a transmission line





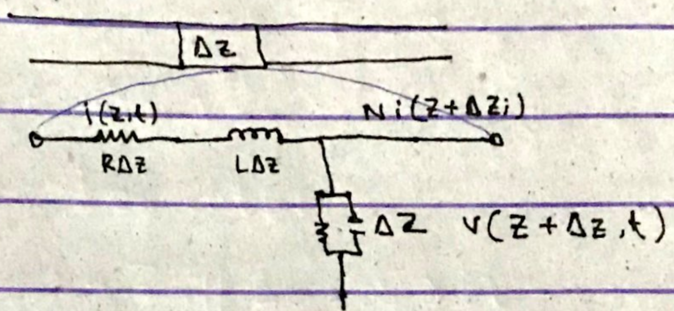
R, L, G, C are Primary line Constant.

Since The voltage and current of a transmission line vary with Position z (and time t). we have no characterize it by a "distributed" circuit model. Consider an infinitesimal line of length Δz, The current set up magnetic field between The Conductor (by Amper's law) causing magnetic flux. when current are time-varying. So The magnetic flux and a voltage variation along The conductor electromotive force (emf) is induced, in an attempt to drive The current oppositely. This behavior can be modeled by a Series inductor

$$\left[V = L \cdot \frac{di}{dt} \right]$$

mean while two seperated Conductor form a Capacitor. Since The upper and lower conductor of adjacent infinitesimal lines are connected respectively, The Capacitive behaviour of an infinitesimal lines can be modeled by a Shunt Capacitor. in The presence of imperfect conducting and imperfect insulating materials, voltage drop along The conducting line and leakage

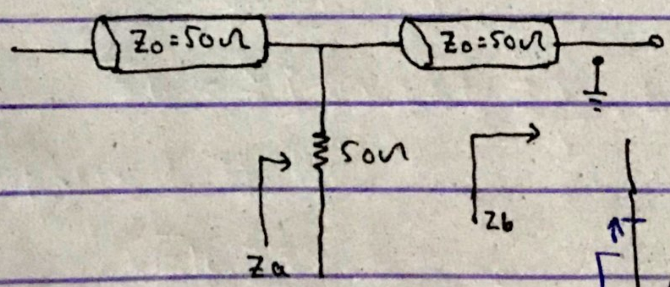
Current between Them exist, which can be modeled by a Series resistor and a Shunt conductor respectively.

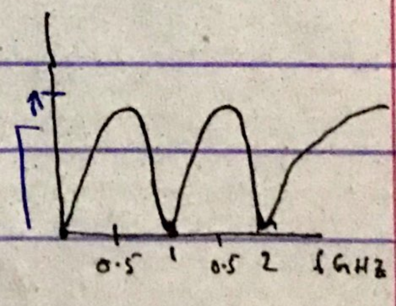


Equivalent circuit

QNO 2

Part(a) A microwave circuit Consisting of lossless transmission lines T_1 and T_2 is shown in figure.





Solution:

As we know That

$\Gamma = \frac{Z_L - Z_o}{Z_L + Z_o}$, $f = 1\,GHz$

in This case $\Gamma = 0$

$Z_a = 50\Omega$

$Z_b = jZ_o \cot \beta L$

$Z_{eq_L} = Z_a \| Z_b = 50\Omega$

Here

$Z_b = \alpha$

So

$Z_b = -jZ_o \cot \frac{2\pi}{\lambda} \cdot L$

Put values of Z_o

$Z_b = -j50 \cot \frac{2\pi}{\lambda} \cdot L$

if

$\cot \frac{2\pi}{\lambda} \cdot L = \alpha$

and if $L = \lambda/2$

So

$$\cot \frac{2\pi}{\lambda} \cdot \frac{\lambda}{2} = \alpha$$

Now

$$L = \lambda/2$$

$$V_p = 2 \times 10^8$$

$$V_p = \omega/\beta$$

$$\frac{\omega}{\beta} = 2 \times 10^8$$

$$= \frac{2\pi f}{2\pi} \times \lambda = 2 \times 10^8$$

At $f = 1\,GHz$

$$\lambda = \frac{2 \times 10^8}{1 \times 10^9}$$

$$\lambda = 0.2\,m$$

Now

$$L = \lambda/2$$

$$= \frac{0.2}{2}$$

$$L = 0.1\,m \text{ Ans}$$

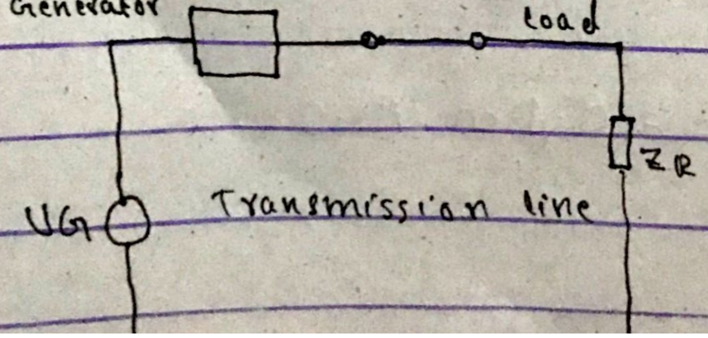
Part (b)

Derive transmission line Equation and describe what it say?

Ans:.

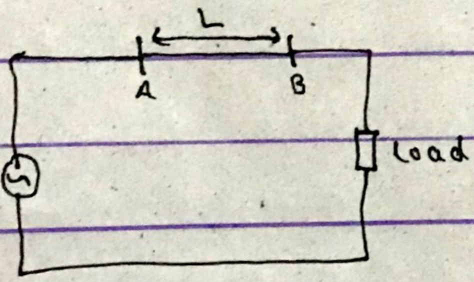
Transmission Line Equation:.

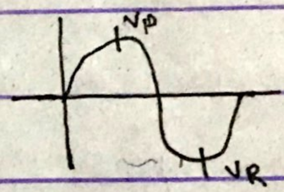
A typical engineering Problems involves The transmission of a Signal from a generator to a Load. A transmission line is The part of The circuit That provides The direct link between generator and load. transmission line can be realized in a number of ways. common Examples are Parallel-wire line and The Coaxial Cables.



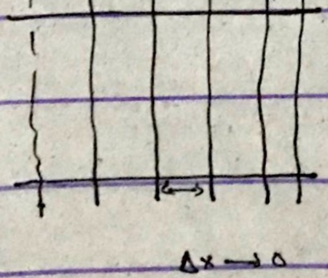
Transit time effect:

$T >> t_r$	$t_r = \frac{l}{v}$
$T >> l/v$	l = length
$1/f >> \frac{l}{v}$	v = velocity
$\frac{v}{f} >> l$	T = time period of signal
$\boxed{\lambda >> l}$	





Primary Constant of transmission line:

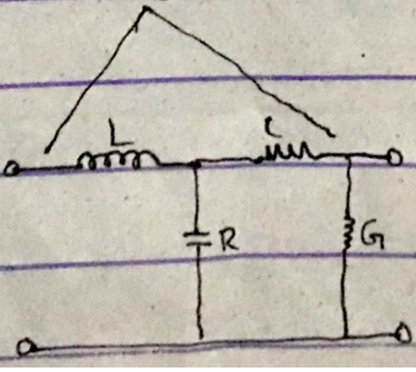


$L \rightarrow H/m$

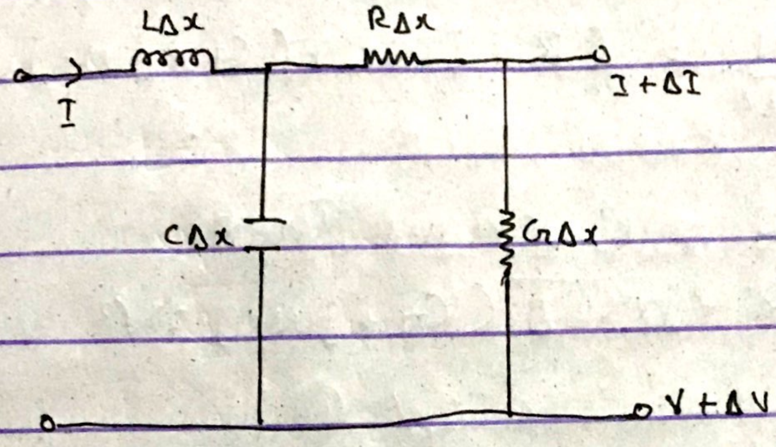
$C \rightarrow F/m$

$R \rightarrow \Omega/m$

$G \rightarrow \mho/m$



Transmission line Equation:-



Solution:

$$\Delta I = -(G\Delta x + j\omega C\Delta x)V$$

$$\lim_{x \to 0} \frac{\Delta I}{\Delta x} = -(G + j\omega C)V$$

$$\frac{dI}{dx} = -(G + j\omega C)V \text{ --- } (1)$$

$$\Delta V = -(R\Delta x + j\omega L\Delta x)I$$

$$\lim_{\Delta x \to 0} \frac{\Delta V}{\Delta x} = -(R + j\omega L)I$$

$$\frac{dV}{dx} = -(R + j\omega L)I \text{ --- } (2)$$

again derivative

$$\frac{d^2 v}{dx^2} = -(R + j\omega L)\frac{dI}{dx}$$

$$\frac{d^2 v}{dx^2} = (R + j\omega L)(G + j\omega C) \cdot v$$

As we know That

$(R + j\omega L)(G + j\omega C) = \gamma^2$

$$\boxed{\frac{d^2 v}{dx^2} = \gamma^2 v}$$

Now

$$v(x,t) = (V^+ e^{-\gamma x} + V^- e^{+\gamma x}) e^{j\omega t}$$

$$= V^+ e^{-j\beta x} e^{j\omega t} + V^- e^{j\beta x} e^{j\omega t}$$

$$= Ve^{+j(\omega t - \beta x)} + Ve^{-j(\omega t + \beta x)}$$

Now we know That

$\vec{E} = E_0 e^{-\alpha z} \cos(\omega t - \beta z)\hat{x}$

$\vec{E} = E_0 \cos(\omega t - \beta z)\hat{x}$ {loss less cond}

wave Equation

$V(x,t) = V^{+}\cos(\omega t - \beta x) + V^{-}\cos(\omega t + \beta x)$

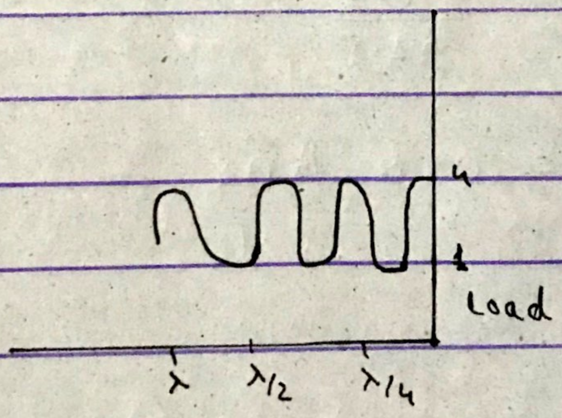
$V^{+}\cos(\omega t - \beta x)$: travelling $+x$ direction

$V^{-}\cos(\omega t + \beta x)$: ~~travelling $-x$~~ direction.

QNO3.

part (a)

Voltage standing wave pattern in a lossless transmission line with characteristics impedance 50Ω and resistive load is shown in figure.



Solutions:

Given Data

$Z_0 = 50\Omega$

$Z_L = 12.5\Omega$

Required = ?

Reflective = co-efficient = ?

So,

we know That

$$\Gamma = \frac{Z_L - Z_o}{Z_L + Z_o} \quad \text{--- (1)}$$

put value in Eq (1)

$$\Gamma = \frac{12.5 - 50}{12.5 + 50}$$

$$= \frac{-37.5}{62.5}$$

$$\Gamma = -0.6 \text{ Ans}$$

Part (b)

Explain two impedance matching techniques in detail?

impedance matching:

• impedance matching

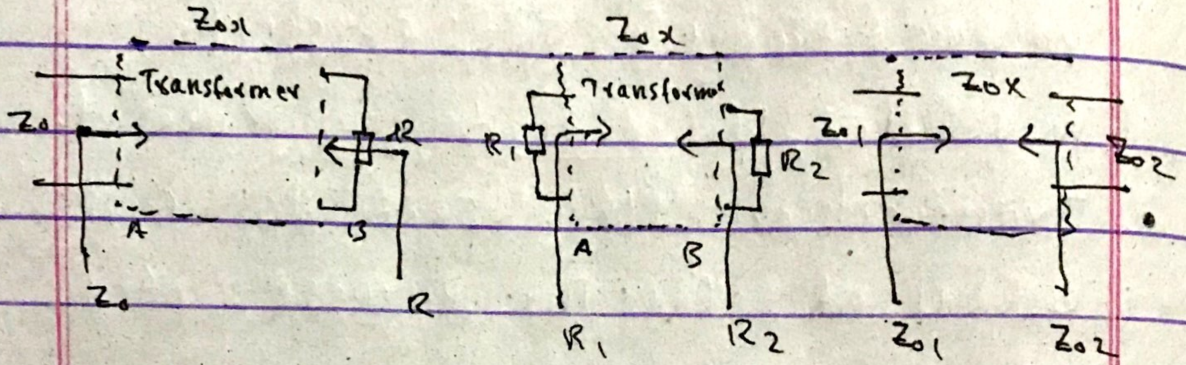
is one of the important aspects of high frequency circuit Analysis. To avoid reflection and for maximum power transfer the circuits have to be impedance matched.

- Transmission line sections can be used for the purpose of impedance matching.
- There are various impedance matching techniques which are discussed in the following:

Quarter wavelength Transformer:

This techniques is generally used for matching a resistive load to a transmission line (a) for matching two resistive load. (b) for matching two transmission lines with unequal characterstic impedance.

See figure All casses are identical in principle as all require matching between to purely resistive impedance.



Principle:.

•) introduction a section of transmission line (called transformer) between two resistance to be matched, Such That The transformed impedance perfectly match.

•) For The transformer we have two parameter to control, Characteristic impedance of The transformer Section and length of The transformer Section.

let us assume that the characteristic impedance of the transformer section Z_{ox} for $\lambda/4$ length. The transformer inverts the normalized impedance.

$$Z_A = \frac{1}{(R/Z_{ox})} \cdot Z_{ox} = \frac{Z_{ox}^2}{R}$$

•) For matching at A. Z_A should be equal to Z_0 i.e

$$\frac{Z_{ox}^2}{R} = Z_0$$

$$\Rightarrow Z_{ox} = \sqrt{R Z_0}$$

Conclusion:

•) Two resistive impedance can be matched by a section of a transmission line which quarter-wavelength long and has characteristic impedance equal to the geometric mean of the

•) The Quarter wavelength transfer is commonly used at the Junction of two transmission line of unequal characterestic impedances.