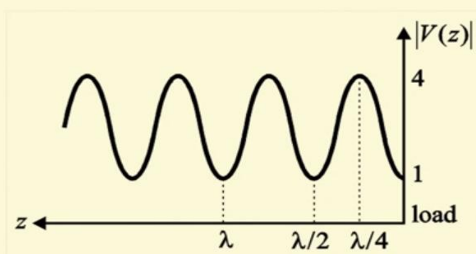
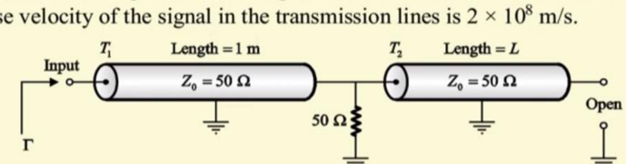
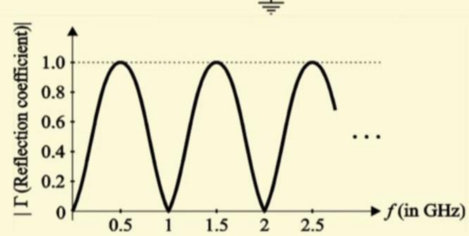
Department of Electrical Engineering
Assignment
Date: 17/04/2020

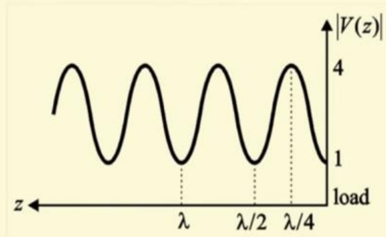
Course Details

Course Title: Antennas & Wave Propagation **Module:** ______
Instructor: ______ **Total Marks:** 30

Student Details

Name: ______ **Student ID:** ______

<table>
<tr><td>Q1.</td><td>(a)</td><td>Voltage standing wave pattern in a lossless transmission line with character
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</td><td>Marks 6
CLO 2</td></tr>
<tr><td></td><td>(b)</td><td>Draw & Explain Equivalent circuit model of a Transmission line</td><td>Marks 4
CLO 1</td></tr>
<tr><td>Q2.</td><td>(a)</td><td>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. The phase velocity of the signal in the transmission lines is 2×10^8 m/s.


The length L (in meters) of T_2 is ________. [Set - 02]</td><td>Marks 6
CLO 2</td></tr>
</table>

	(b)	Derive transmission line equation and describe what it says	Marks 4 CLO 1
Q3.	(a)	Voltage standing wave pattern in a lossless transmission line with characteristic impedance 50 Ω and resistive load is shown in the figure.  **Qu.** The reflection coefficient is given by (A) – 0.6 (B) – 1 (C) 0.6 (D) 0.2	Marks 4 CLO 2
	(b)	Explain two Impedance Matching techniques in detail?	Marks 6 CLO 2

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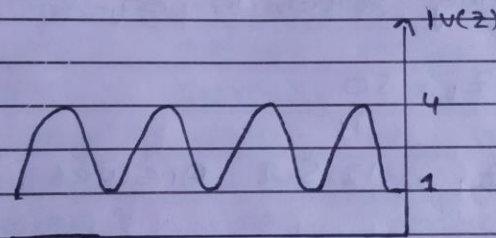
Date :- 17-4-2020

Course title:- Antenna & wave propogation

(a) Q1 Voltage standing wave pattern in a lossless transmission line with characteristic impedance 50Ω & resistive load as shown in 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

$$S.\ wave\ ratio = \frac{V_{max}}{V_{min}} \quad -(1)$$

Putting values in eq.(1)

$= \frac{4}{1}$

S. wave ratio = 4

Now find Z_1

$$S.\ wave\ ratio = \frac{Z_0}{Z_1}$$

$$Z_1 = \frac{Z_0}{S.\ wave\ ratio} \quad -(2)$$

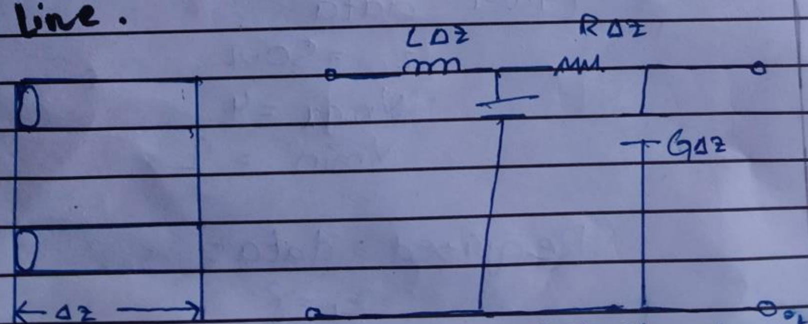
Putting values in eq.-(2)

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

$Z_L = 12.5\Omega$ Answer.

Q1 (b) Draw & explain equivalent circuit **model of transmission line.**

Ans:-



line section equivalent circuit

Explanation:

R, L, G, C are primary line constant

Since the voltage & current of a transmission line vary with position z (and time t) we have no characterized it by a distributed circuit model. Consider an infinitermal line of length Δz, the current set up magnatic field between the conductors (by amphere's law) causing magnetic flux, when current are time varying. So the magnetic flux & a voltage variation alongs the conductor emf is included in an attempt to derive the current oppositely.

$$\boxed{V = L\frac{di}{dt}}$$

$Q_2^{(a)}$

Solution:-

As we know that

$$\Gamma = \frac{Z_1 - Z_0}{Z_1 + Z_0}, \quad f = 1GHz$$

In this case $\Gamma = 0$

$Z_a = 50$

$Z_b = jz_0 \cot \beta L$

$$Z_{eqL} = Z_a \parallel Z_b = 50$$

$Z_b = \alpha$

Now

$$Z_b = -jz_0 \cot \frac{2\pi}{\lambda} . L$$

$$Z_b \; -j50 \cot \frac{2\pi}{\lambda} . L$$

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

if $L = \lambda/2$

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

Now

$l = \lambda/2$

$v_p = 2 \times 10^8$

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

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

At $f = 1 GHz$

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

$\lambda = 0.2 m$

Now

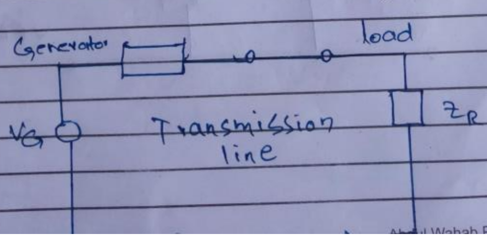
$L = \lambda/2$

$= 0.2/2$

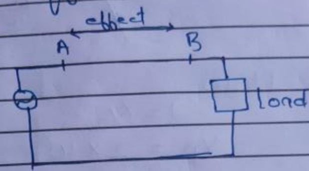
$L = 0.1 m \rightarrow$ Ans

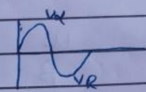
(b) Define transmission line equation & describe what it says.

Ans:-



Transmit time effect





$t_x = \frac{l}{v}$

$T >> t_v$

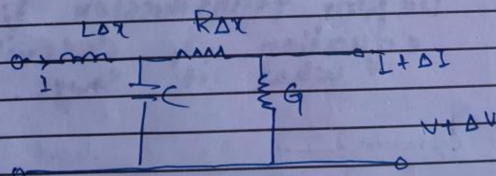
$T >> \frac{l}{v}$

$1/f >> l/v$

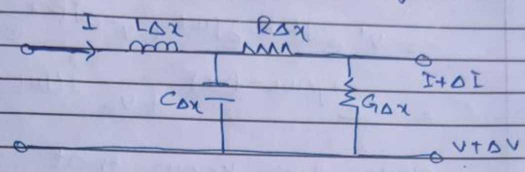
$\frac{v}{f} >> l$

$\lambda >> l$

Primary constant of transmission line



Transmission line equation



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

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

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

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

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

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

After diff

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

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

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

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

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

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

Now we know that

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

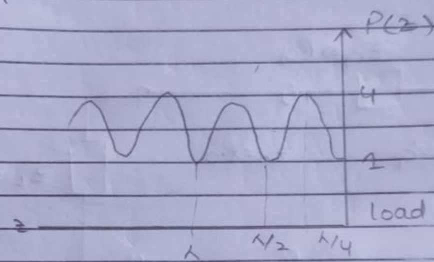
Final equation

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

Transmission of a signal from a generator to a load. A transmission line is a part of the circuit that provides the direct link b/w generator & load. Transmission line can be realized in a number of ways.

Common examples are parallel wire line & the coaxial cables.

Q3 (M) Voltage standing wave pattern in a lossless transmission line with characteristic impedance 50Ω & resistive load



Q4 The reflection coffinelent
(a) −0.6 (b) −1 (c) 0.6 (d) 0.2

Solution

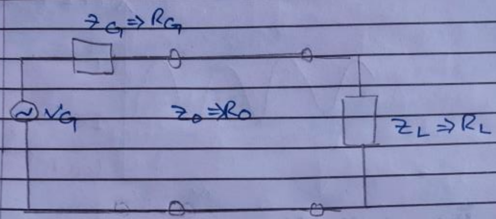
$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

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

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

$\Gamma = 0.6$ Ans

3b Explain two impedance matching technique.



$$Z_L = Z_G$$
$$Z_G \neq R_G$$
$$l = \lambda/4$$
$$Z_{in} = \frac{Z_0^2}{Z_L}$$
$$R_{in} = \frac{R_0^2}{R_L} = R_G$$
$$\left(\frac{R_G}{R_0}\right) = \left(\frac{1}{\frac{R_L}{R_0}}\right)$$
$$R_0 = (R_L R_G)$$

⇒ The operation of an antenna systems over a frequency range is not completely depend upon the frequency response of the antenna element itself but rather on the frequency characteristic

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of the transmission line antenna element combination.

→ In the practice the characteristic impedance of the transmission line is usually real whereas that of the antenna element is complex. Also the variation of each as function of frequency is not the same.