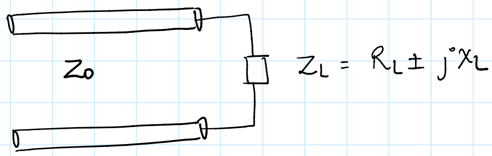
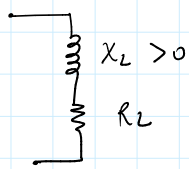
Lec-19

Wednesday, May 13, 2020 8:28 AM

Voltage and Current Standing Wave Pattern on a Complex Load



Case 1: Inductive Load –



$$\Gamma_L = \frac{R_L + jX_L - Z_0}{R_L + jX_L + Z_0}$$

Magnitude and phase of Γ_L

a) $R_L = 0 \quad X_L = Z_0 \quad \longrightarrow$ Purely Inductive Load

$\rightarrow |\Gamma_L| = 1$

$\phi_L = \angle \Gamma_L =$

$X_L = Z_0$

$$\Gamma_L = \frac{jX_L - Z_0}{jX_L + Z_0} \rightarrow \frac{j-1}{j+1} = \frac{\angle(j-1) = 135^\circ}{\angle(j+1) = 45^\circ}$$

$\angle \Gamma_L = 90^\circ$

$$\frac{a-jb}{a+jb} = \frac{re^{j\theta_1}}{ze^{j\theta_2}} = \frac{r}{z} e^{j(\theta_1 - \theta_2)}$$

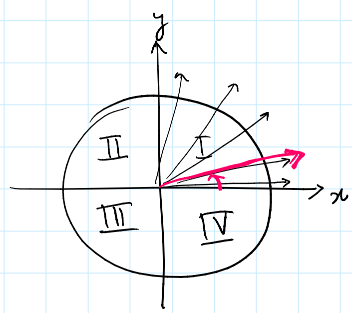
$z = r$

$1\, e^{j(\theta_1 - \theta_2)}$

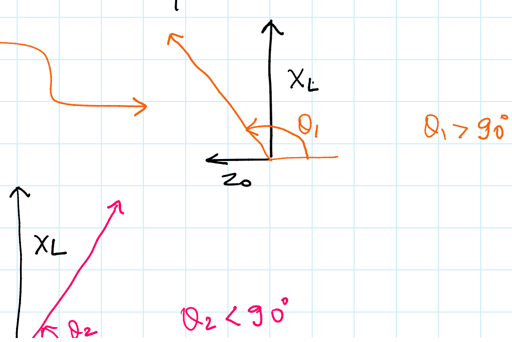
b) $R_L = 0 \qquad X_L \gg Z_0$

$|\Gamma_L| = 1$

$\phi_L = \angle \Gamma_L = \sim 0$ close to 0



$$\frac{jX_L - Z_0}{jX_L + Z_0} =$$



$\theta_z < 90^\circ$

c) $R_L = 0 \quad X_L \ll Z_0$

$|\Gamma_L| = 1$

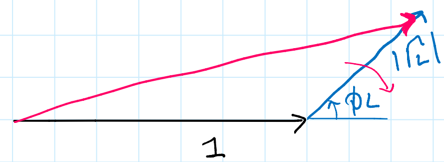
$\phi_L = \angle\Gamma_L = \pi$ (close to 180°).

For inductive + resistive load $\quad \pi < \overset{\phi_L}{\angle\Gamma_L} < 0$

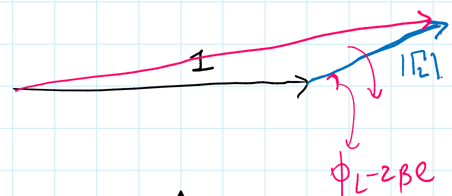
$$V(l) = V^+ e^{j\beta l}\left(1 + |\Gamma_L| e^{j(\phi_L - 2\beta l)}\right)$$

- $|\Gamma_L| < 1$ for $R_L > 0$

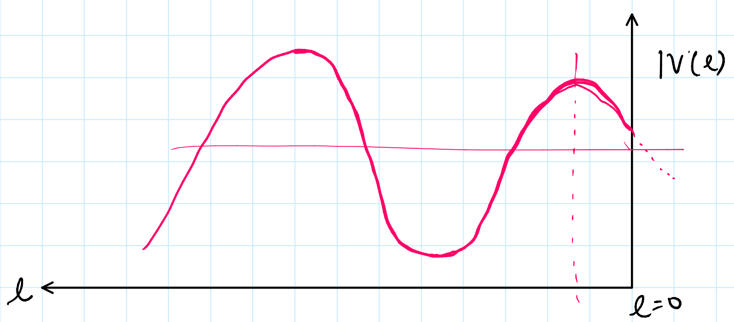
Voltage Phasor $\quad l = 0$

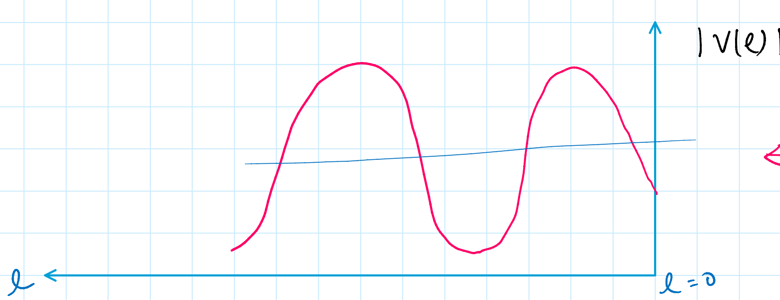


$l > 0$



as $l \uparrow$

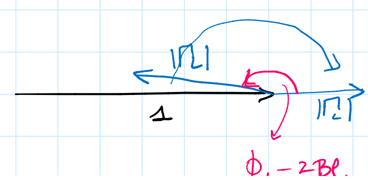




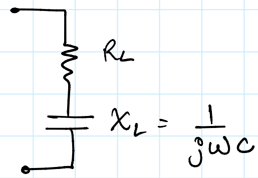
a) $X_L = Z_0$

b) $X_L > Z_0$

c) $X_L < Z_0$



Case 2 : Capacitive Load.



$$\Gamma_L = \frac{R_L - jX_L - Z_0}{R_L - jX_L + Z_0}$$

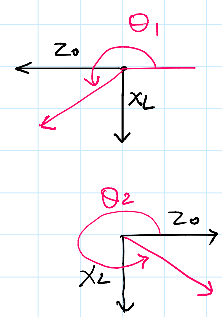
a) $R_L = 0$ → Pure capacitance.

$|X_L| = Z_0$

$|\Gamma_L| = 1$

$\angle \Gamma_L = ?$ -90°

$$\frac{-jX_L - Z_0}{-jX_L + Z_0}$$

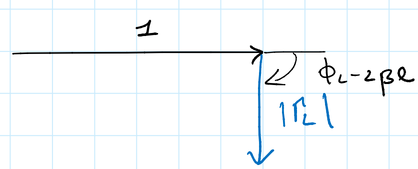


$\boxed{-\pi < \angle\Gamma_L < 0}$ Capacitive load.

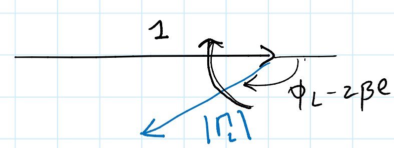
- Figure out $\angle \Gamma_L$ (b) $|X_L| > Z_0$
  (c) $|X_L| < Z_0$

Voltage Phasor

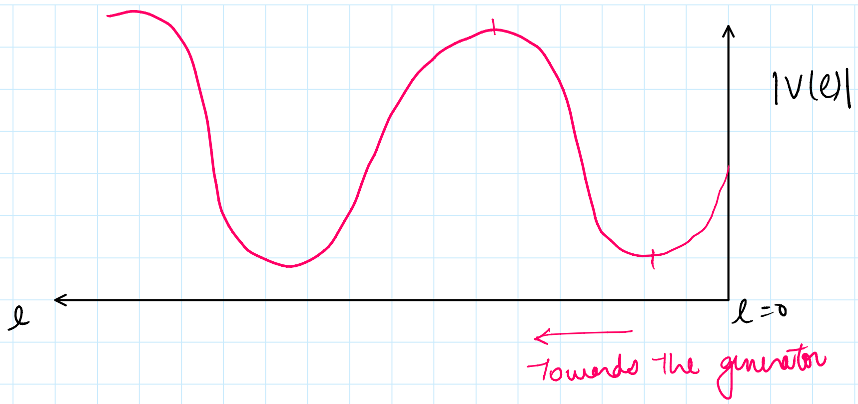
$l = 0$



$l > 0$

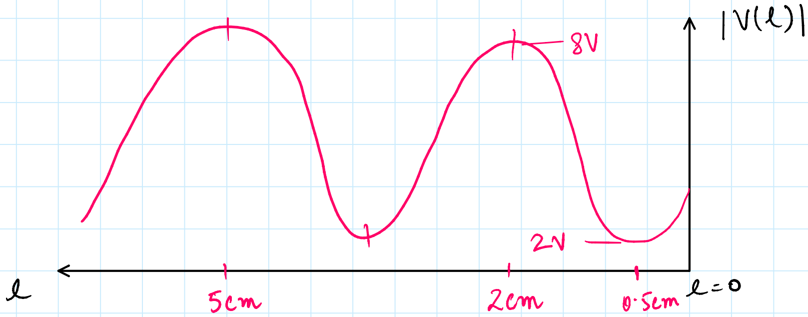


Observation : Magnitude of voltage will be minima first then it will be maxima as we go from load towards the generator.



Example: $Z_0 = 50\Omega$

Z_L = Unknown.



Q1: What is the VSWR ?

$$\rho = VSWR = \frac{|V|_{max}}{|V|_{min}} = \frac{8V}{2V} = 4$$

Q2: Wavelength on this transmission line

Distance between two voltage maximas or two voltage minima $= \frac{\lambda}{2}$

$$\frac{\lambda}{2} = 3cm$$

$$\lambda = 6cm.$$

Q3: Calculate V^+