(c)

$$Z_s = Z_0 \left[\frac{\cosh \gamma l + \left(\frac{Z_0}{Z_R}\right) \sinh \gamma l}{\left(\frac{Z_0}{Z_R}\right) + \sinh \gamma l} \right]$$

$Z_R = \infty$

$$Z_{op} = Z_0 \left[\frac{\cosh \gamma l}{\sinh \gamma l} \right]$$

$$\boxed{Z_{op} = Z_0 \coth \gamma l}$$

$$Z_0 = \sqrt{Z_{sc} Z_{oc}}$$

$$= \sqrt{Z_0 \tanh \gamma l \; Z_0 \coth h \gamma l}$$

$$\boxed{Z_0 = \sqrt{Z_{sc} Z_{oc}}}$$

$$Z_0 = Z_0$$

$$Z_{sc} = Z_0 \tanh \gamma l$$

$$Z_{oc} = Z_0 \coth \gamma l$$

$$\boxed{\gamma l = \tanh^{-1} \sqrt{\frac{Z_{sc}}{Z_{oc}}}}$$

$$\frac{Z_{sc}}{Z_0} = \tanh \gamma l$$

$$Z_0 = \frac{Z_{oc}}{\coth h \gamma l}$$

$$Z_{oc} = Z_0 \coth h$$

$$\frac{Z_{sc}}{Z_{oc}} = \tanh^2 h \gamma l$$

$$\tanh h \gamma l = \sqrt{\frac{Z_{sc}}{Z_{oc}}}$$

Reflection Coefficient

$$\text{ratio} = \frac{\text{Amp reflected voltage}}{\text{Amp incident wave}}$$

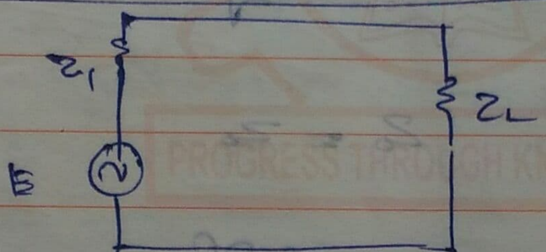
$$\frac{E_R}{E_S} = \frac{2 Z_R}{(Z_R + Z_0)}\left[e^{\gamma s} + \left(\frac{Z_R - Z_0}{Z_R + Z_0}\right)e^{-\gamma l}\right]$$

$$\frac{E_R}{E_S} = (e^{\gamma l})^{-1}$$

$E_R = 0$

$$K = \frac{Z_R - Z_0}{Z_R + Z_0}$$

Reflection factor and Reflection loss



$Z_2 \neq Z_1$

matched — E from source to load — reflected Energy

mismatch — reflected then loss in Energy

Reflection loss.

Matching obtained by ideal transformer (or) phase shifter

$$\frac{V_2}{V_1} = \frac{I_1}{I_2} = \frac{N_2}{N_1} = \frac{1}{a} \qquad \frac{I_1}{I_2} = a$$

$$Z_{in} = a^2 Z_L$$

$$\boxed{Z_{in} = \left(\frac{N_1}{N_2}\right)^2 Z_L}$$

$$a = \sqrt{\frac{Z_{in}}{Z_L}} \qquad \frac{I_1}{I_2} = \frac{1}{\sqrt{\frac{Z_1}{Z_2}}}$$

$$\boxed{\frac{I_1}{I_2} = \sqrt{\frac{Z_2}{Z_1}}}$$

No loss $Z_1 = Z_2$ matched

$$I_1 = \frac{E}{2Z_1}$$

Under matching $I_2' = \sqrt{\frac{Z_1}{Z_2}}\, I_1$

$$I_2' = a\, I_1$$

$$= \frac{E}{2Z_1} \times \sqrt{\frac{Z_1}{Z_2}}$$

$$I_2' = \frac{E}{2\sqrt{Z_1 Z_2}}$$

without matching $I_2 = \frac{E}{Z_1 + Z_2}$

acum current flow

$$\left|\frac{I_2}{I_2'}\right| = \frac{\frac{E}{Z_1+Z_2}}{\frac{E}{2\sqrt{Z_1Z_2}}} = \frac{2\sqrt{Z_1Z_2}}{|Z_1+Z_2|}$$

matching current flow

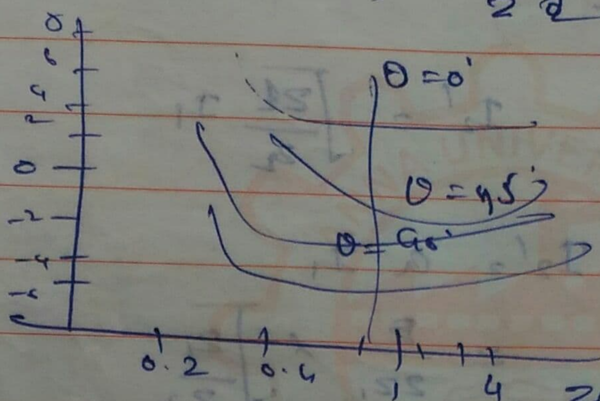
k = reduction factor

Definition

reflection loss / number of nepers (or) dB by which I in load under matched condition exceed the the current actually flowing in load reflection loss = $\ln \left| \dfrac{Z_1+Z_2}{2\sqrt{Z_1 Z_2}} \right|$

$db = 20 \log \left| \dfrac{Z_1+Z_2}{2\sqrt{Z_1 Z_2}} \right|$

Reflection loss (Vs) $\dfrac{Z_1}{Z_2}$



Z_1/Z_2 θ represent angle b/w Z_1 and Z_2

$z^2 = 8-6i$

$(x+iy)^2$

$z^2 = (x+iy)^2 = x^2-y^2+2xy\,i$

$(8-6i) =$

$x^2-y^2 = 8$

$|z|^2 = \sqrt{x^2+y^2}$

$2xy = -6$

$\sqrt{(x+iy)^2}$

$x^2+y^2 = 8$

$|8| = 10$

$|z| = x^2+y^2$

$x^2+y^2 = \sqrt{64+36} = 10$

$(x+iy) = \sqrt{x^2-y^2}$

$x^2+y^2 = 10$

$2x^2 = 36$

$x^2 = 36/2$

$x^2 = 18$

$x^2-y^2 = 8$

$\boxed{x^2+y^2 = 10}$

$\sqrt{x^2-y^2} = 8$

$2x^2 = 18$

$y^2 = 1$

$\boxed{y = \pm 1}$

$\sqrt{x^2+y^2} = 10$

$x^2 = 9$

$\sqrt{8-6i}$

$\boxed{x = \pm 3}$

$\pm(3\pm i)$

$\sqrt{x^2+y^2} = \sqrt{64+36}$

$z = \pm(3$

$= \sqrt{100}$

$+x$	$-y$
$-x$	$+y$

$= 100$ 100

34

$(x+iy) = (-1.147\times10^{-3} + j\,6.625\times10^{-4})$

$x^2 - y^2 = -1.147\times10^{-3} \rightarrow$

$2xy = 6.625\times10^{-4}$

$x^2+y^2 = 1.3245\times10^{-3} \rightarrow$

$2x^2 = 1.775\times10^{-4}$

$x^2 =$

$\boxed{x = 9.42072\times10^{-3}}$ ✓

$y^2 = (1.3245\times10^{-3}) - (8.875\times10^{-5})$

$y^2 = 1.23575\times10^{-3}$

$\boxed{y = 0.0351}$ ✓

$0.0364\ |75$

$(x+iy)^2 = (x^2 - y^2) + 2xy\,i$

$x^2+y^2 =$ Real

$2xy =$ Imag

$x^2+y^2 = \sqrt{x^2+y^2}$

$\underline{\underline{x^2+y^2}}$

$y^2 = (x^2+y^2) - x^2$

$\boxed{y = ?}$

$x^2 - y^2$

x^2+y^2

$2x^2$

$x = ?$

$z = x + iy$

$z^2 = x^2 + y^2$

$x = \pm 3$

$y = \pm 1$

$(3-i)$

$(3+i)$

$x + yi$

$|z|^2 = x^2+y^2$

$10 = x^2+y^2$

$z^2 = 8-6i$ ✓

$= (x^2 - y^2 + 2xyi)$

$x^2 - y^2 = 8$

A generator of 1V 1000 cycle supplies power to 100 mile open wire line terminated in 200Ω resi

the line parameter

$R = 10.4\ \Omega/\text{mile}$ $L = 0.00367\ H/\text{mile}$

$G = 0.8 \times 10^{-6}\ \mho/\text{mile}$ $C = 0.00835\ \mu F/\text{mile}$

Find $Z, Y, Z_0, \gamma, \alpha, \beta, v_p$

$Z = (R + j\omega L) = 10.4 + j(2\pi \times 1000 \times 0.00367)$

$= 10.4 + j\,23.2$

$= 25.2 \angle 66^\circ$

$Y = (G + j\omega C) = (0.8 \times 10^{-6} + j\,2\pi \times 1000 \times 0.00835 \times 10^{-6})$

$= 52.6 \times 10^{-6} \angle 90^\circ$

$$Z_0 = \sqrt{\frac{R + j\omega L}{(G + j\omega C)}}$$

$= 692 \angle -12^\circ$

$\gamma = \sqrt{ZY} = \sqrt{25.2 \angle 66^\circ \times 52.6 \times 10^{-6} \angle 90^\circ}$

$= \sqrt{0.001325 \angle 156^\circ}$

$\gamma = 0.0364 \angle 78^\circ$

$\gamma = \alpha + j\beta$

$\alpha = 0.0364 \cos 78^\circ = 0.00755$ N/mile

$\beta = 0.0364 \sin 78^\circ = 0.00355$ ~~N/m~~ rad/mil

$$v_p = \frac{\omega}{\beta}$$

$$= \frac{2\pi \times 1000}{0.0355}$$

$$\boxed{v_p = 1.77 \times 10^5 \text{ mile/se}}$$

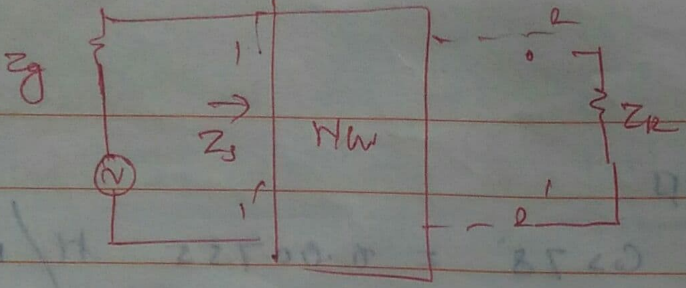
$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{0.0355} = 177 \text{ miles}$$

Insertion losses

filter/mw line b/w gen and load may improve or diminish the match b/w s and load

Impedance match that ↑es ↓es the power ~~match~~ delivered to load resulting (+) or ↓es insertion losses come.

Definition no. of nepers (or) decibel by which current in load is changed by insertion.



Z_s not equal to Z_g then reflection at $1,1'$

line Introduce the attenuation loss.

Impedance not matched at $2,2'$ Reflection losses.

ratio of I actually flowing in load through inserting network to the I flowing in load without inserting n/w.

$$I_s = \frac{I_R(Z_R+Z_0)}{2Z_0}\left(e^{\gamma l} - k e^{-\gamma l}\right) \rightarrow (B)$$

(or) $$I_s = \frac{E}{Z_g+Z_s}$$

I/P Impedance

$$Z_s = Z_0\left(\frac{e^{\gamma l} + k e^{-\gamma l}}{e^{\gamma l} - k e^{-\gamma l}}\right)$$

$$I_s = \frac{E}{Z_g + Z_0\left(\frac{e^{\gamma l} + k e^{-\gamma l}}{e^{\gamma l} - k e^{-\gamma l}}\right)}$$

$$I_s = \frac{E\left(e^{\gamma l} - k e^{-\gamma l}\right)}{Z_g\left(e^{\gamma l} - k e^{-\gamma l}\right) + Z_0\left(e^{\gamma l} + k e^{-\gamma l}\right)}$$

$$=$$

(A) $\Rightarrow$ $$\frac{E\left(e^{\gamma l} - k e^{-\gamma l}\right)}{Z_g\left(e^{\gamma l} - k e^{-\gamma l}\right) + Z_0\left(e^{\gamma l} + k e^{-\gamma l}\right)} =$$

$$= \frac{I_R (Z_R + Z_0)}{2 Z_0} \left(e^{\gamma l} \cancel{- K e^{-\gamma l}}\right)$$

$$I_R = \frac{2 Z_0 E}{(Z_R + Z_0) \left[Z_g \left(e^{\gamma l} - K e^{-\gamma l}\right) + Z_0 \left(e^{\gamma l} + K e^{-\gamma l}\right) \right]}$$

Without Insertion

$$I_R' = \frac{E}{(Z_g + Z_R)}$$

Hence $$\frac{I_R'}{I_R} = \frac{E / (Z_g + Z_R)}{\frac{2 Z_0 \cancel{E}}{(Z_R + Z_0) \left[Z_g \left(e^{\gamma l} - K e^{-\gamma l}\right) + Z_0 \left(e^{\gamma l} + K e^{-\gamma l}\right) \right]}}$$

the I_R eqn

$$I_R = \frac{2 Z_0 E}{(Z_R + Z_0) \left[(Z_g + Z_0) e^{\gamma l} + (Z_0 - Z_g) K e^{-\gamma l} \right]}$$

$$I_R = \frac{2 Z_0 E}{(Z_R + Z_0)(Z_g + Z_0) e^{\gamma l} + (Z_0 - Z_g)(Z_R + Z_0)\left(\frac{Z_R - Z_0}{Z_R + Z_0}\right) e^{-\gamma l}}$$

$$\boxed{I_R = \frac{2 Z_0 E}{(Z_R + Z_0)(Z_g + Z_0) e^{\gamma l} + (Z_0 - Z_g)(Z_L - Z_0) e^{-\gamma l}}}$$

$$\frac{I_R'}{I_R} = \frac{\frac{E}{(Z_g + Z_R)}}{\frac{2 Z_0 E}{(Z_R + Z_0)(Z_g + Z_0) e^{\gamma l} + (Z_0 - Z_g)(Z_R - Z_0) e^{-\gamma l}}}$$

$$= \frac{(Z_R + Z_0)(Z_g + Z_0) e^{\alpha l} e^{j\beta l} + (Z_0 - Z_g)(Z_R - Z_0) e^{-\alpha l} e^{-j\beta l}}{2 Z_0 (Z_g + Z_R)}$$

Lyn

$e^{\alpha l}$ large

$$\frac{I_R'}{I_R} = \frac{(Z_R + Z_0)(Z_g + Z_0) e^{\alpha l} e^{j\beta l}}{2 Z_0 (Z_g + Z_R)}$$

$$\times 2\sqrt{Z_g Z_R}$$

$$= \frac{2\sqrt{Z_g Z_R}\,(Z_R + Z_0)(Z_g + Z_0) e^{\alpha l} e^{j\beta l}}{4\sqrt{Z_g Z_R Z_0^2}\,(Z_g + Z_R)}$$

$$\frac{I_R'}{I_R} = \frac{|Z_g + Z_0|}{2\sqrt{Z_g Z_0}} \cdot \frac{|Z_R + Z_0|}{2\sqrt{Z_R Z_0}} \cdot \frac{2\sqrt{Z_g Z_R}}{|Z_g + Z_R|} e^{\alpha l}$$

Right side represent reflection factors.

$$\frac{2\sqrt{Z_g Z_R}}{|Z_g + Z_R|} = k_s$$

$$\frac{2\sqrt{Z_R Z_0}}{|Z_R + Z_0|} = K_R$$

$$\frac{2\sqrt{Z_g Z_R}}{(Z_g + Z_R)} = K_{SR}$$

$e^{\alpha l}$ loss in line

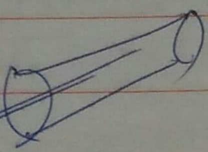
$$\left|\frac{I_R'}{I_R}\right| = \frac{K_{SR}}{K_S \; K_R} e^{\alpha l}$$

$$\text{Insertion } l_n = \ln\left(\frac{1}{K_S}\right) + \ln\left(\frac{1}{K_R}\right) - \ln\left(\frac{1}{K_{SR}}\right) + \alpha l$$

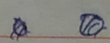
$$\boxed{l_{in\,dB} = 20\left(\log\frac{1}{K_S} + \log\frac{1}{K_R} - \log\frac{1}{K_{SR}} + 0.4343\,\alpha l\right)}$$

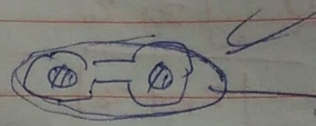
planar trx line

twin line



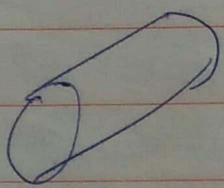
Air twin line

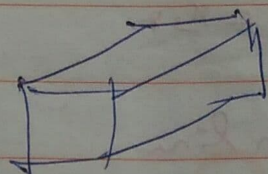




Twinline in Dielectric

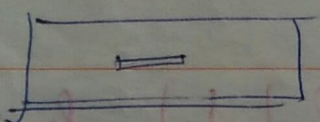
shielded twin line

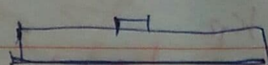




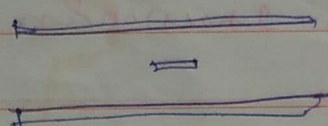
printed structures

μstripline

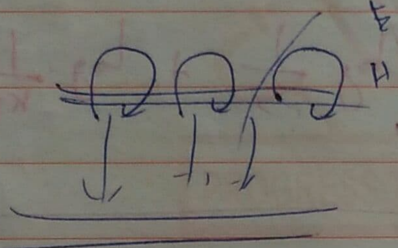


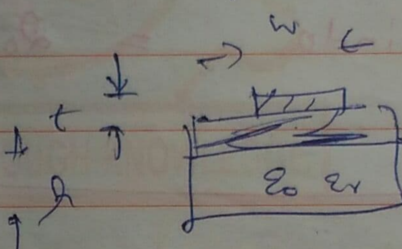


Triplate stripline



Stripline





$$y(x,t) = A\cos\left(2\pi\left(\frac{x}{\lambda} - ft\right)\right)$$

$$= A\cos\left(\frac{2\pi}{\lambda}(x - vt)\right)$$

$$y(x,t) = A\cos(kx - \omega t)$$

$$= A\cos(k(x - vt))$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi f}{v} = \frac{2\pi f}{v} = \frac{\omega}{v}$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi v}{\omega} = \frac{v}{f}$$

h - Dielectric thickness

t - Stripline thickness

w - width of stripline

k = Wave number