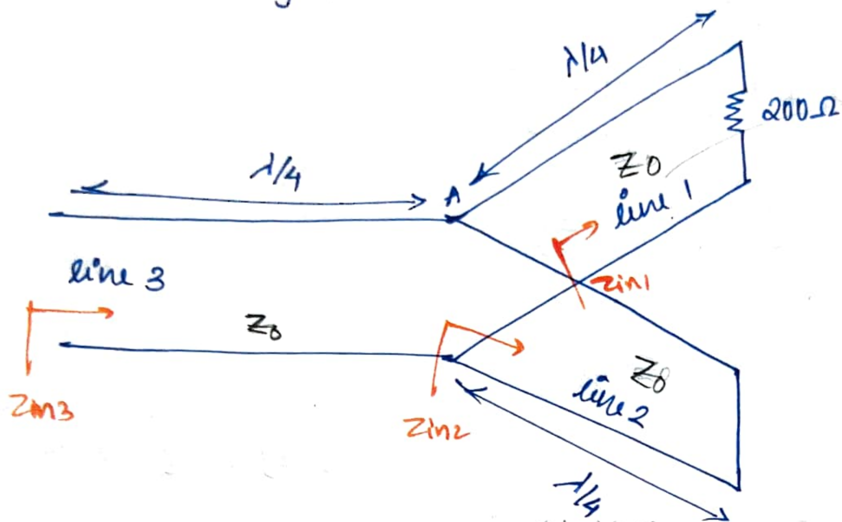
Q) Consider 3 lossless lines as shown in the figure. If $Z_0 = 50\Omega$, Calculate i) Z_{in} looking into line 1

ii) Z_{in} looking into line 2

iii) Z_{in} looking into line 3.



Sol. i) $Z_{in1} = \frac{50^2}{200} = 12.5\,\Omega$

ii) $Z_{in2} = \frac{50^2}{0} = \infty$

iii) $Z_{in3} = \frac{Z_0^2}{Z_L}$;

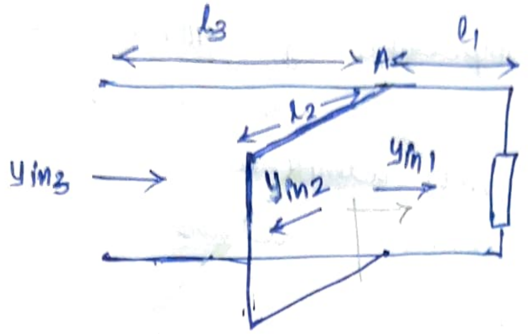
~~At A,~~

$\cancel{y = \frac{200}{(50)^2} + 0}$

$Z_{in1} \parallel Z_{in2} = \frac{12.5\infty}{12.5+\infty} = \frac{\cancel{\infty}(12.5)}{\cancel{\infty}\left(\frac{12.5}{\infty}+1\right)} = 12.5$

$Z_{in3} = \frac{(Z_0)^2}{12.5} = 200\,\Omega.$

2) A section of lossless transmission line is shunted across main line as shown in the figure. If $l_1 = \frac{\lambda}{4}$, $l_2 = \frac{\lambda}{8}$, $l_3 = \frac{7\lambda}{8}$. Find y_{in1}, y_{in2} and y_{in3} (admittances) if $Z_0 = 100\Omega$ and $Z_L = 200 + J150\ \Omega$



Sol.

$l_1 = \lambda/4$

$$Z_{in_1} = \frac{100^2}{250\angle 36.86} = 40\angle -36.86$$

$$y_{in_1} = \frac{250\angle 36.86}{100^2} \neq \frac{200 + J150}{100^2}$$

Refer Quarter wave Transformer,

$$= (20 + J15)\ mS$$

$l_2 = \frac{\lambda}{8}$

for l_2, short ckt, $Z_L = 0$

$$Z_{in2} = Z_0 \left(\frac{\cancel{Z_L} + JZ_0}{Z_0 + J\cancel{Z_L}} \right)$$

$Z_{in2} = JZ_0$

$$= \cancel{Z_0 \left(\frac{200 + J150 + J100}{100 + 200J - 150} \right)}$$

$\therefore\ y_{in2} = \frac{1}{JZ_0}$

$$= \cancel{100 \left(\frac{200 + J250}{200J} \right)}$$

$l_3 = \frac{7\lambda}{8}$

$y\ 806.\ \beta l = \frac{7\pi}{4}$

$\tan \beta l = -1$

Check formula behind!

$$Z_{in3} = Z_0 \left(\frac{Z_L - JZ_0}{Z_0 - JZ_L} \right)$$

$y_3 = 6.4 + J52\ mS$

$$= Z_0 \left(\frac{\frac{1}{y_1 + y_2} - JZ_0}{Z_0 - J\frac{1}{y_1 + y_2}} \right)$$

(or) $z = Z_{in_1} \| Z_{in_2}$

3) An antenna with an impedance of $40 + j30\,\Omega$ is to be matched to a $100\,\Omega$ lossless line with shorted stub.

Determine
i) Required stub admittance
ii) Distance between stub and antenna
iii) Stub length
iv) SWR on each segment.

SMITH CHART.

Sol. Calculate normalised load impedance, plot it on Smith chart.

$$z_L = \frac{Z_L}{Z_0} = \frac{40 + j30}{100} = 0.4 + j0.3$$

→ Diagonal opp. to z_L on S_circle, gives y_L in chart.

$$y_L = 1.6 - j1.2$$

→ Where S-circle intersects $r = 1$ circle (at 2 points) A & B
What are values:

At A: $1 + j1.05 \rightarrow y_1$

B: $1 - j1.05 \rightarrow y_2$

i) Stub admittance required,

$y_s = \pm j1.05$ normalised but.

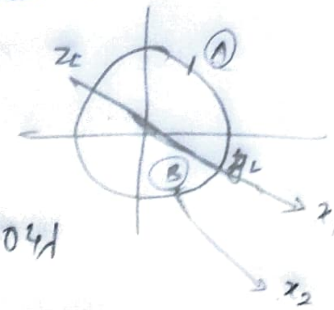
for y_1: $-j1.05$
y_2: $+j1.05$

So $Y_s = y_s \times Y_0 / \dfrac{y_s}{Z_0}$

ii) From y_L, dist. from y_L to stub at A & B

say 2 distances.

y_L to B : $\underbrace{0.03\lambda}_{(x_2 - x_1)}$



$\downarrow$

$0.337\lambda - 0.304\lambda$

y_L to A : @A: $0.5 + 0.164 = 0.664$

$0.664\lambda - 0.304\lambda$ (2)