10.1 Impedence Transformation I

Given the Following Transmission Line:

$$Z_{1} = \frac{Z_{0}}{2} \mid Z_{2} = \frac{Z_{0}}{3}$$

$$\longrightarrow y$$

Compute \$,(0) & Z,(-2/4) by hand and using smith Chart

10.1.1 Hand Calculation

Impedence Continuity states:

$$Z_{1}(0) = Z_{2}(0)$$

where Spatially dependence says:

$$Z_n(y) = Z_n\left(\frac{1+\widetilde{g}(y)}{1-\widetilde{g}_n(y)}\right)$$

$$Z_{1}\left(\frac{1+\widetilde{g}_{1}(o)}{1-\widetilde{g}_{1}(o)}\right)=Z_{2}\left(\frac{1+\widetilde{g}_{2}(o)}{1-\widetilde{g}_{2}(o)}\right)$$

Since \mathbb{Z}_2 impedence line goes to infinity, then no reflected wave is produced thus $\widetilde{\mathcal{P}}_2(y) = 0$ for all y

$$\frac{1+\tilde{\mathfrak{H}}(0)}{1-\mathfrak{H}(0)} = \frac{Z_2}{Z_1} \qquad * Z_1 = \frac{Z_2}{2}, Z_2 = \frac{Z_2}{3}$$

$$\frac{1+\tilde{\mathfrak{H}}}{1-\tilde{\mathfrak{H}}} = \frac{2}{3} \qquad * \tilde{\mathfrak{H}}(y) = \tilde{\mathfrak{H}}e^{2j\beta y} \rightarrow \tilde{\mathfrak{H}}(0) = \tilde{\mathfrak{H}} \quad \text{(some complex const)}$$

$$Z_1(-\lambda_{14}) = Z_1\left(\frac{1/\sqrt{s}}{1/\sqrt{s}}\right)$$

 $= Z_1\left(\frac{g^3}{5}, \frac{g}{4}\right)$
 $= Z_1(-\lambda_{14}) = (3/2)Z_1$

10.1.2 Smith Chart

1. Computing normalized impedance and associated normalized resistance r & x:

$$Z_{1}(o) = Z_{2}(o)$$

$$Z_{1}\left(\frac{1+\widetilde{S}_{1}(o)}{1-\widetilde{S}_{1}(o)}\right) = Z_{2}\left(\frac{1+\widetilde{S}_{2}(o)}{1-\widetilde{S}_{2}(o)}\right) \quad *\widetilde{S}_{2}(y) = 0$$

$$\left(\frac{1+\widetilde{S}_{1}(o)}{1-\widetilde{S}_{1}(o)}\right) = \frac{Z_{2}}{Z_{1}}$$

$$\therefore \ \widehat{C}_{1}(o) = \left(\frac{Z_{2}/Z_{1}-1}{Z_{2}Z_{2}+1}\right)$$

Normalized impedance is found as:

$$\frac{\mathbb{Z}_2}{\mathbb{Z}_1} = \frac{2}{3} = \Gamma + i\chi$$

2. from smith Chart:

3. Where:

$$\widetilde{\mathfrak{J}}_{i}(-\frac{\lambda_{i}}{\lambda_{i}}) = \widetilde{\mathfrak{J}}_{i}(0) e^{j2\beta_{i}(-\Delta_{i})} = \widetilde{\mathfrak{J}}_{i}(0) \cancel{\cancel{4}} 2\beta_{i}(-\Delta_{i}) \qquad \cancel{\cancel{4}} \not = -2\beta_{i}\Delta_{i} = -\pi$$

= 1/5 from Smith Chart using CW rotation of -11 from \$.(0)

4. from the smith Chart this yields:

5. Z, can be determined at y=- A, as:

$$Z_{1}(-\Delta_{1}) = Z_{1}\left(\frac{1+\widetilde{y_{1}}(-\Delta_{1})}{1-\widetilde{y_{1}}(-\Delta_{1})}\right) *\widetilde{y_{1}}(-\Delta_{1}) = 1$$

$$= Z_{1}\left(\frac{1+\frac{1}{2}}{1-\frac{1}{2}}\right)$$

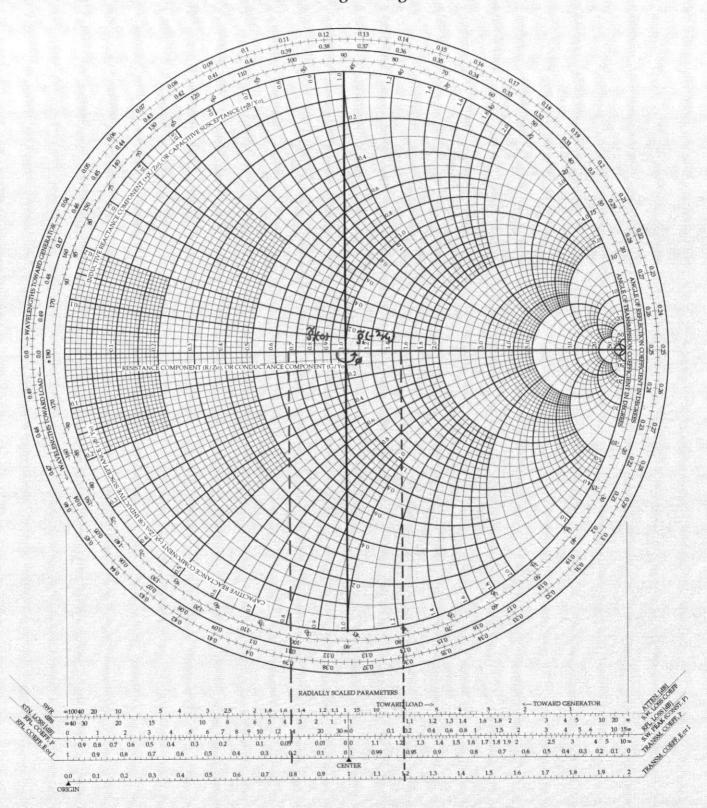
$$= Z_{1}\left(\frac{1+\frac{1}{2}}{1-\frac{1}{2}}\right)$$

$$= Z_{1}\left(-\Delta_{1}\right) = \frac{3}{2}Z_{1} \qquad \text{write in terms of } Z_{0}! \text{ (which is given.)}$$

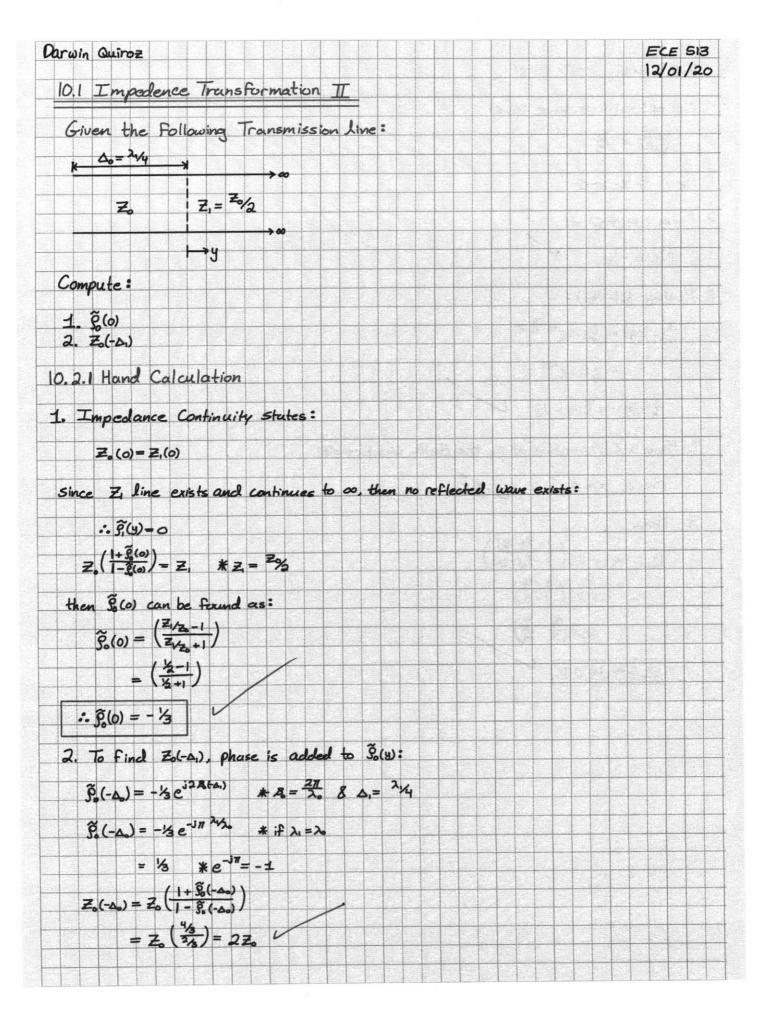
$$Z_1(-\Delta_1) = \frac{3}{2} Z_1$$

The Complete Smith Chart

Black Magic Design



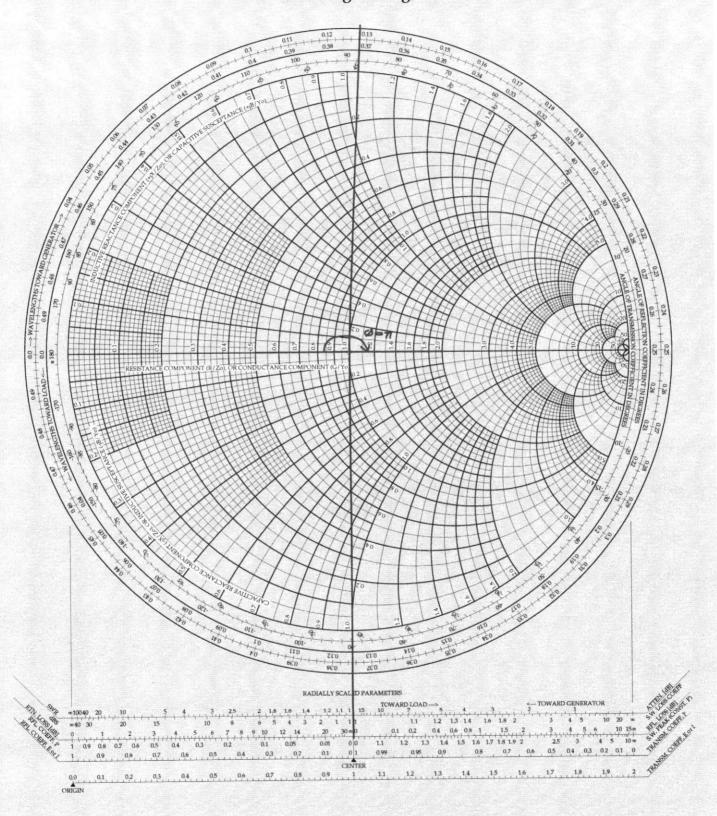
\$2



1. Normalised Impedance Says: $\frac{2(\omega)}{2(\omega)} = \frac{1}{2}$ then $f = \frac{1}{2}$, $x = 0$ 2. From Smith Chart $\frac{2}{3}(\omega) = -\frac{1}{3}$ 3. Finding $3(-\frac{1}{2})$; $\frac{2}{3}(-\frac{1}{2}) = -\frac{1}{3}(\omega) = -\frac{1}{3}(\omega)$ $= \frac{1}{3}(\omega) = -\frac{1}{3}(\omega) = \frac{1}{3}(\omega)$ $= \frac{1}{3}(\omega) = -\frac{1}{3}(\omega) = \frac{1}{3}(\omega)$ 4. From a CW rotation of π , the Smith Chart reads: $f = \frac{1}{3}(\omega)$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3}))$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3}))$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$ $= \frac{1}{3}(-\frac{1}{3}(-\frac{1}{3})$	10	2.2 Using Smith Chart
Then $\Gamma = \frac{1}{2}$. $X = 0$ Then $Smith$ Chart $ \widehat{\xi}(o) = -\frac{1}{2} $ 3. Finding $S_{i}(-\frac{1}{2}N_{i})$: $ \widehat{S}_{i}(-\frac{1}{2}N_{i}) = \widehat{S}_{i}(o)e^{-\frac{1}{2}\frac{N}{4}} $ $ = \widehat{S}_{i}(o)e^{-\frac{1}{2}N_{i}} $ $ \widehat{\xi}(-\frac{1}{2}N_{i}) = -\widehat{S}_{i}(o)e^{-\frac{1}{2}\frac{N}{4}} $ $ = \widehat{S}_{i}(o)e^{-\frac{1}{2}N_{i}} $ $ \widehat{\xi}(-\frac{1}{2}N_{i}) = -\widehat{S}_{i}(o)e^{-\frac{1}{2}\frac{N}{4}} $ $ \frac{1}{2}(-\frac{1}{2}N_{i}) = \frac{1}{2}(\frac{1}{2}(-\frac{N}{2}N_{i})) $ $ = \frac{1}{2}(\frac{1}{2}N_{i}) $	10	and using unity chair
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3. Finding $S_{\alpha}(-\frac{\lambda_{2}}{\lambda_{1}})$: $\widehat{S}_{\alpha}(-\frac{\lambda_{2}}{\lambda_{1}}) = \widehat{S}_{\alpha}(0)e^{-\frac{\lambda_{1}}{\lambda_{1}}}$ $= \widehat{S}_{\alpha}(0)e^{-\frac{\lambda_{1}}{\lambda_{1}}}$ $\widehat{S}_{\alpha}(-\frac{\lambda_{2}}{\lambda_{1}}) = -\widehat{S}_{\alpha}(0) = \frac{\lambda_{3}}{\lambda_{3}}$ 4. From a CW rotation of π , the Smith Chart reads: $\Gamma = 20, Z = 0$ 5. Then $Z_{\alpha}(-\frac{\lambda_{1}}{\lambda_{2}}) = Z_{\alpha}(\frac{1+\frac{\lambda_{1}}{\lambda_{1}}}{1-\frac{\lambda_{2}}{\lambda_{2}}})$ $= Z_{\alpha}(\frac{1+\frac{\lambda_{1}}{\lambda_{2}}}{1-\frac{\lambda_{2}}{\lambda_{2}}})$ $= Z_{\alpha}(\frac{1+\frac{\lambda_{1}}{\lambda_{2}}}{1-\frac{\lambda_{2}}{\lambda_{2}}})$ $Z_{\alpha}(-\frac{\lambda_{1}}{\lambda_{2}}) = 2Z_{\alpha}$		0(0)4
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$ \begin{array}{l} \widetilde{S}(-\frac{1}{2}) = -\widetilde{S}(0) = \frac{1}{3} \\ 4. \text{ From a CW rotation of } \pi, \text{ the Smith Chart reads:} \\ \Gamma \approx 20, X + 0 \end{array} $ 5. Then $ \begin{array}{l} Z_0(-\frac{1}{2}) = Z_0\left(\frac{1+\frac{1}{3}(-\frac{1}{2})}{1-\frac{1}{3}(-\frac{1}{2})}\right) \\ = Z_0\left(\frac{1+\frac{1}{3}}{3} \cdot \frac{3}{2}\right) \end{array} $ $ \begin{array}{l} Z_0(-\frac{1}{3}) = 2Z_0 \end{array} $ $ \begin{array}{l} \widetilde{Z}_0(-\frac{1}{3}) = 2Z_0 \end{array} $		28, -311
4. From a CW rotation of π , the Smith Chart reads: $\Gamma \approx 20, x = 0$ 5. Then $Z_{0}(-\infty) = Z_{0}\left(\frac{1+\frac{6}{3}(-\frac{5\pi}{3})}{1-\frac{5}{3}(-\frac{5\pi}{3})}\right)$ $= Z_{0}\left(\frac{1+\frac{5}{3}}{1-\frac{5}{3}}\right)$ $= Z_{0}\left(\frac{1+\frac{5}{3}}{3} + \frac{3}{2}\right)$ $Z_{0}(-\infty) = 2Z_{0}$		= 5,(0)e
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5. Then $Z_{o}(-24) = Z_{o}\left(\frac{1+8(-24)}{1-8(-24)}\right)$ $= Z_{o}\left(\frac{1+8}{1-13}\right)$ $= Z_{o}\left(\frac{1}{3}\cdot\frac{3}{3}\right)$ $Z_{o}(-24) = 2Z_{o}$	21	
5. Then $Z_{s}(-24) = Z_{s}\left(\frac{1+\frac{1}{16}(-\frac{1}{16})}{1-\frac{1}{16}(-\frac{1}{16})}\right)$ $= Z_{s}\left(\frac{1+\frac{1}{16}}{1-\frac{1}{16}}\right)$ $= Z_{s}\left(\frac{4}{3} \cdot \frac{3}{2}\right)$ $Z_{s}(-24) = 2Z_{s}$ $Z_{s}(-24) = 2Z_{s}$	٦.	From a CW rotation of T, the Smith Chart reads:
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Z ₀ (+>4)=2Z ₀		3/4 3)
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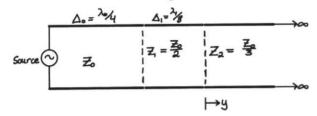
The Complete Smith Chart

Black Magic Design



103 Impadence Transformation III

Given the Following Transmission Line:



10.1.3 Hand Calculation

Impedence Continuity states:

$$Z_{1}(0) = Z_{2}(0)$$

Since Z_2 line continues to ∞ , $\tilde{S}_2(y) = 0$ due to no reflected wave, then: $Z_1\left(\frac{1+\tilde{S}_1(0)}{1-\tilde{S}_1(0)}\right) = Z_2$

then \$, (0) can be found as:

$$\begin{split} \widetilde{S}_{1}^{c}(o) &= \left(\frac{2a_{2}}{2a_{2}} - 1\right) \\ \widetilde{S}_{1}^{c}(o) &= \left(\frac{2a_{2}}{2a_{2}} + 1\right) = -V_{5} \end{split}$$

$$* \sum_{i=1}^{2} = \frac{2a_{2}}{3} \cdot \frac{2}{2a} = \frac{2a_{3}}{3}$$

Then:

$$\widetilde{S}_{1}(-2\%) = \widetilde{S}_{1}(\omega)e^{i2}$$

$$= \widetilde{S}_{1}(\omega)e^{i\frac{\pi}{2}}$$

$$= +: ke$$

From this the impedence Z.(-2/8) can be found:

$$Z_{i}(-\frac{2}{3}) = Z_{i}\left(\frac{1+\widetilde{g}(-\frac{2}{3})}{1-\widetilde{g}(-\frac{2}{3})}\right)$$

$$= Z_1 \left(\frac{1+j\frac{1}{5}}{1-j\frac{1}{5}} \right)$$

Using MatlAB: x

Z₁(-2/6) = Z₁(12/5-1) = Z₁(1e^{-ia1257 π}) = \(\frac{1}{2}\)Z₂(+22.62 * \tan^{-1}(\frac{1}{12})\)≈ 0.1257 π

Why is this (\frac{1}{12})?

Q iven this (\frac{1}{12})?

then from 2nd Boundary at -21/8:

Impedence Continuity

$$Z_{o}\left(\frac{1+S_{o}(-\lambda_{14})}{1-S_{o}(-\lambda_{14})}\right)=Z_{o}e^{-J_{o},1257\pi}+Z_{o}=\frac{Z_{o}}{2}$$

Computing W/ MATLAB

thon:

impedence at source can be found as:

$$Z_{o}(-\Delta, -\Delta_{o}) = Z_{o}\left(\frac{1 + \frac{2}{3}e^{(-\Delta, -\Delta_{o})}}{1 - \frac{2}{3}e^{(-\Delta, -\Delta_{o})}}\right)$$
$$= Z_{o}\left(\frac{1 - 0.388e^{j1.85\pi}}{1 + 0.388e^{j1.8\pi}}\right)$$

Using MathaB:

Calculating using Smith chart

Normalized 1

$$\frac{Z_2}{Z_1} = \frac{1/3}{1/2} = \frac{1/3}{1/2} \Rightarrow r = \frac{1/3}{1/2}, x = 0$$

Using Smith Chart:

Then the reflection is found as:

then \$, (-24) = 15j * CW rotation of 90° due to -2/8 position

From this impedence of Z, courbe found at - 28

$$Z_{1}(-\frac{2}{3}) = Z_{1}\left(\frac{1+\widehat{\mathfrak{J}}_{1}(-\frac{2}{3})}{1-\widehat{\mathfrak{J}}_{1}(-\frac{2}{3})}\right)$$

$$\frac{Z_{i}(-^{2}\%)}{Z_{i}} = \left(\frac{1+^{1}\%j}{j-^{1}\%j}\right) = 0.9231 + 0.3846j$$

$$Z_{1}(-\frac{\lambda_{1/2}}{2}) = Z_{1}(0.4615 + 0.1923i)$$

so at -2/8

r= 0.4615 , x=-0.1923i

then So can be found as:

then moving to Source:

then finally to at source can be found as:

$$Z_{o}(-\lambda y_{8}-\lambda y_{4})=\frac{\left(1+(3875-0.1875j)}{1-(0.3875-0.1875j)}\right)$$

≈ 2.186 x -24.72°

The Complete Smith Chart

Black Magic Design

