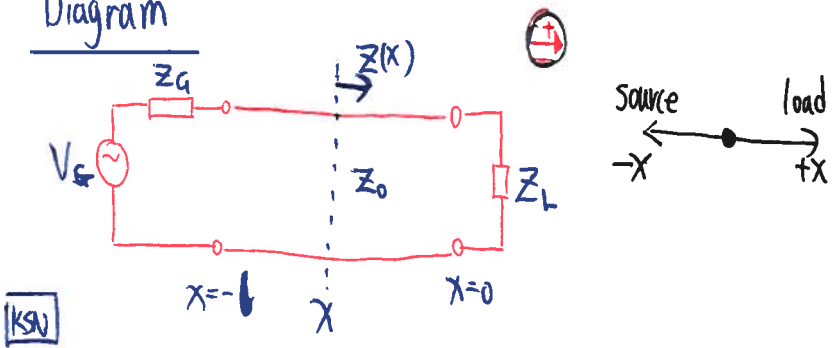
MM12

(1) Transmission line model

Diagram



KSU

Formula (Generalized k and Z):

$$k(x) = \frac{Z(x) - Z_0}{Z(x) + Z_0} [\cdot] \qquad Z(x) = Z_0 \frac{1+k(x)}{1-k(x)} [\Omega]$$

$$k(0) = k_L = \frac{Z_L - Z_0}{Z_L + Z_0} [\cdot] \qquad Z(0) = Z_L = Z_0 \frac{1+k_L}{1-k_L} [\Omega]$$

$$k(x) = k_L \cdot e^{j2\beta x}$$

Smith chart

We see that:

$k(x) \rightleftarrows Z(x)$

$k(x)$ and $Z(x)$ are complex functions.

So we can express the functions as:

$$Z(x) = R(x) + jX(x) \ [\Omega]$$

$$k(x) = U(x) + jV(x) \ [\cdot]$$

Normalize $Z(x)$ with Z_0

$$Z_n = \frac{Z(x)}{Z_0} = r(x) + jx(x) \ [\cdot]$$

For reflection coefficient

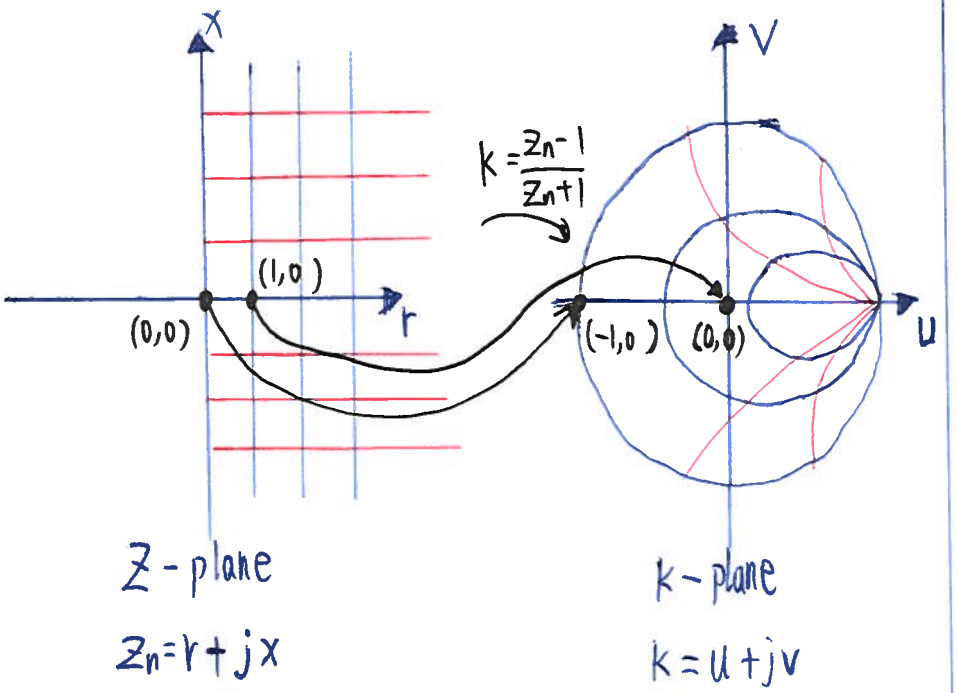
$$k(x) = \frac{Z(x) - Z_0}{Z(x) - Z_0} = \frac{Z(x)/Z_0 - 1}{Z(x)/Z_0 + 1}$$

$$= \frac{Z_n - 1}{Z_n + 1} \ [\cdot]$$

and reversely

$$Z_n = \frac{1+k}{1-k} \ [\cdot]$$

(1) Smith chart's construction



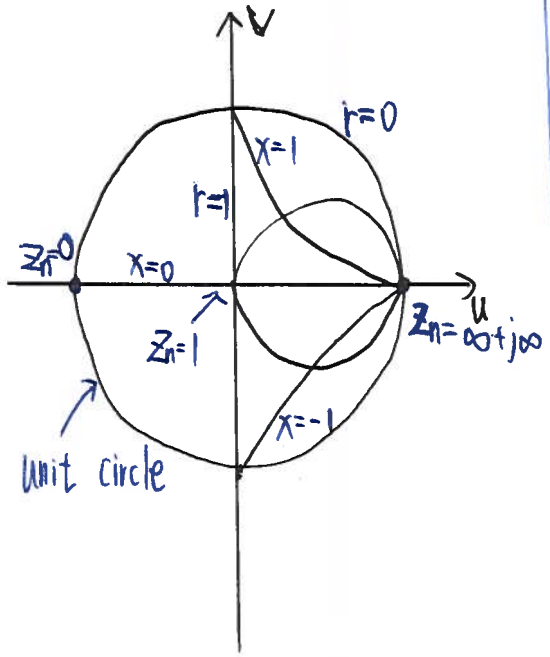
Z-plane

$z_n = r + jx$

k-plane

$k = u + jv$

Significant points and curves



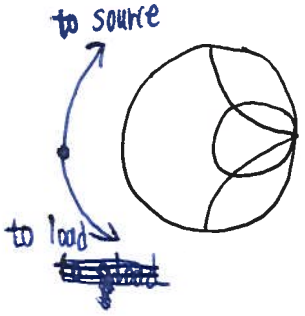
Turn around smith chart

$$k(x) = k_L \cdot (e^{j2\beta x})$$

$$= k_L \cdot (1\angle 2\beta x)$$

$$= k_L \cdot (1\angle 2\pi \frac{x}{\lambda/2}) \quad [\cdot]$$

(where $2\beta x = 2 \cdot \frac{2\pi}{\lambda} x = 2\pi \cdot \frac{x}{\lambda/2}$)



($\frac{\lambda}{2}$ is for the whole circle

(3) Admittance chart

For admittance, we can see

$$Y_n = \frac{1}{Z_n} = \frac{Z_0}{Z(x)} = \frac{Y(x)}{Y_0} = \frac{1-k}{1+k} = \frac{1+(-k)}{1-(-k)}$$

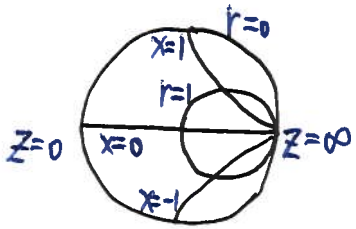
where $Y_0 = \frac{1}{Z_0}$ and $Y(x) = \frac{1}{Z(x)}$

If $k' = -k$,

$$Y_n = \frac{1+k'}{1-k'}$$

Mirror according to (0,0) (center)

Z- and Y- Chart



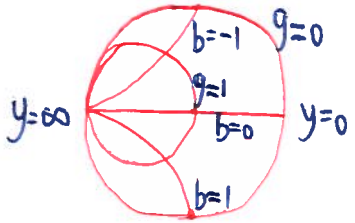
Z- chart

$Z_n = r + jX$

where

r is resistance

x is reactance



Y- chart

$Y_n = g + jb$

g is conductance

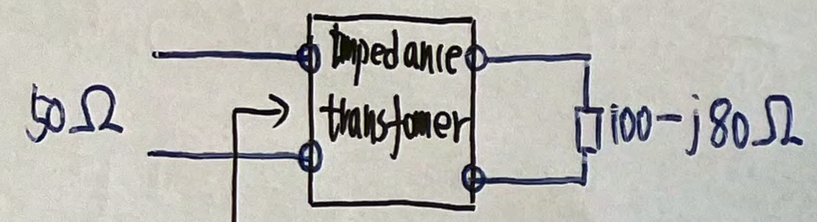
b is susceptance

(4) Single stub impedance transformer

Example:

$Z_0 = 50\ \Omega$

$Z_L = 100 - j80\ \Omega$



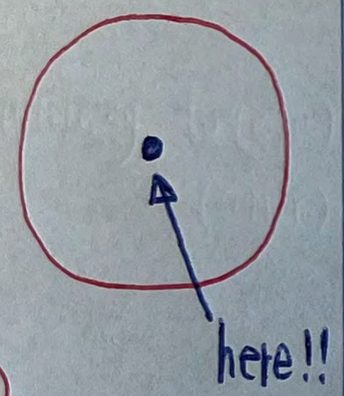
requirement

$Z_{in} = Z_0 = 50\Omega$

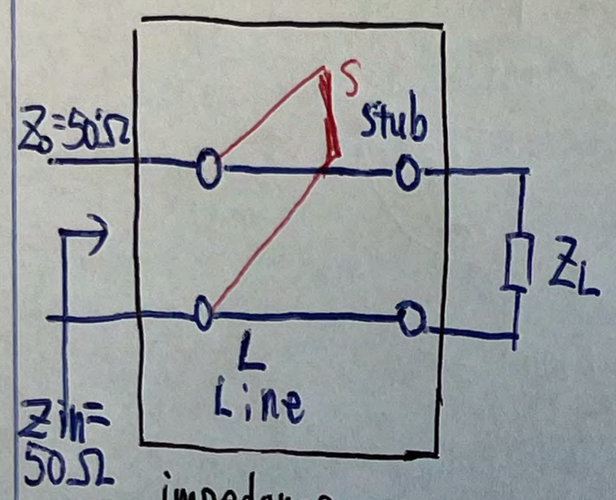
or $k = 0$

or $Z_n = 1 + j0 = 1$

or $Y_n = 1 + j0 = 1$ $(g=1, b=0)$



Solution



impedance transformer

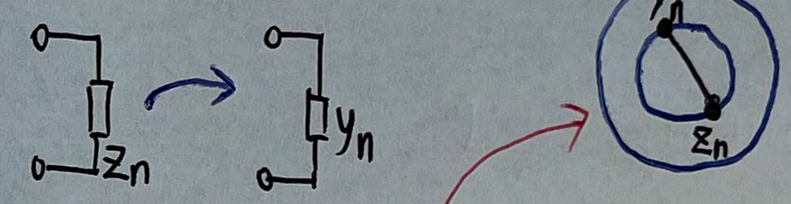
Steps

① Normalize Z_L

$$Z_n = \frac{Z_L}{Z_0} = \frac{100 - j80}{50}$$

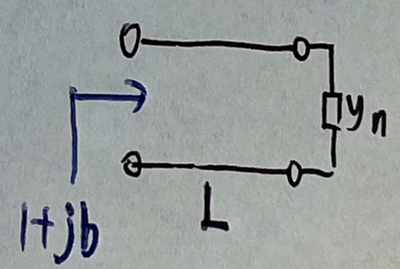
$$= 2 - j1.6$$

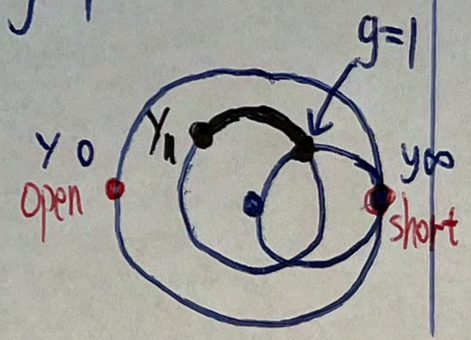
② Find the admittance Y_n of Z_n



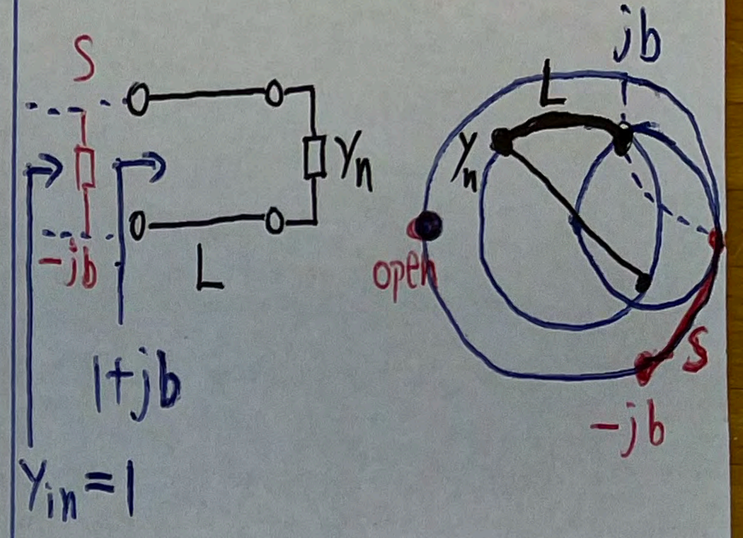
The chart is Y-chart now!!

③ Insert line L until $g=1$

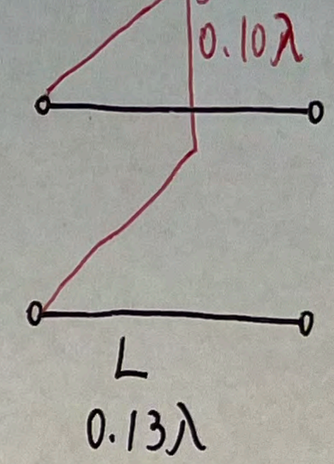




④ ~~[redacted]~~ Mount a stub of $-jb$ in parallel.



Solution



short stub