ECEn 464 | HW 1

2.1

a. $2\pi f = 3.77\times10^9$, $f = 600\text{MHz}$

b. $v_p = \omega/\beta = 377\times10^9/18.13 = 2\times10^8\ \text{m/s}$

c. $\lambda = v_p/f = 2\pi/\beta = 0.35\ \text{m}$

d. $v_p = 1/\sqrt{\mu\epsilon} = \frac{1}{\sqrt{\epsilon_r}} c_0$, $\epsilon_r = c_0^2/v_p^2 = \left(\frac{3\times10^8}{2\times10^8}\right)^2 = 2.25$

e. $i(z) = 1.8 e^{-j\beta z}\ \text{A}$, $\beta = 18.13\ \text{rad/m}$

f. $v^+(t) = z_0 i^+ = 75 \cdot 1.8 \cos(\omega t - \beta z)\ \text{mV}$

2.11

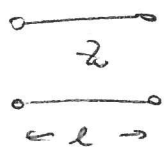
$\ell = 0.0215\ \text{m},\ 0.033\ \text{m}$

4.11

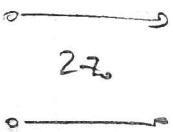
Series: $S_{11} = S_{22} = \dfrac{z}{z+2z_0}$, $S_{12} = S_{21} = \dfrac{2z_0}{z+2z_0}$

Shnt: $S_{11} = S_{22} = \dfrac{-Y}{Y+2Y_0}$, $S_{12} = S_{21} = \dfrac{2Y_0}{Y+2Y_0}$

(4)



$$\bar{\bar{S}} = \begin{bmatrix} 0 & e^{-j\beta\ell} \\ e^{-j\beta\ell} & 0 \end{bmatrix}$$



$$S_{11} = S_{22} = \frac{3}{5 - j4\cot\beta\ell}$$

$$S_{12} = S_{21} = \frac{2(1+S_{11})}{3(e^{j\beta\ell} - \frac{1}{3}e^{-j\beta\ell})}$$

(other forms possible)

4.14

a. No (lossy - $S \neq S^H$)

b. Yes (reciprocal - $S = S^T$)

c. $-20\log_{10}|S_{11}| = 15\ \text{dB}$

d. $IL = -20\log_{10}|S_{12}| = 10.5\ \text{dB}$, $\phi = 45°$

e. $b_1 = [S_{11}\ S_{12}\ S_{13}\ 0]\begin{bmatrix} a_1 \\ 0 \\ -b_3 \\ 0 \end{bmatrix} = S_{11}a_1 - S_{13}b_3 = S_{11}a_1 - S_{13}S_{31}a_1$

$= (S_{11} - S_{13}S_{31})\,a_1$

$= +j0.18$

$= 0.18\angle{+90°}$

$b_3 = S_{31}a_1$