

Sol 1: (a) $Z_{11} = \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right)$

$$Z_{12} = \frac{1}{2} \left(\frac{s^2 LC - 1}{sC} \right)$$

$$Z_{21} = Z_{12}$$

$$Z_{22} = Z_{11}$$

(b) $V/E = \frac{-R Z_{21}}{Z_{12} Z_{21} - Z_{11} Z_{22} - Z_{11} R}$

$$= -R \left(\frac{\frac{1}{2} \frac{s^2 LC - 1}{sC}}{\frac{1}{2} \left(\frac{s^2 LC - 1}{sC} \right) \cdot \frac{1}{2} \left(\frac{s^2 LC - 1}{sC} \right) - \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) \cdot \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) - \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) \cdot R}$$

$$\frac{1}{2} \left(\frac{s^2 LC - 1}{sC} \right) \cdot \frac{1}{2} \left(\frac{s^2 LC - 1}{sC} \right) - \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) \cdot \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) - \frac{1}{2} \left(\frac{s^2 LC + 1}{sC} \right) \cdot R$$

$$\frac{V}{E} = \frac{R \left[\frac{sL}{2} - \frac{1}{2sC} \right]}{\frac{L}{C} + \frac{R}{2sC} + \frac{sLR}{2}} = \frac{s^2 LC - 1}{s^2 LC + 2\frac{sL}{R} + 1}$$

Sol 2:

Zeros:

$$\omega = \pm j \sqrt{\frac{1}{LC}}$$