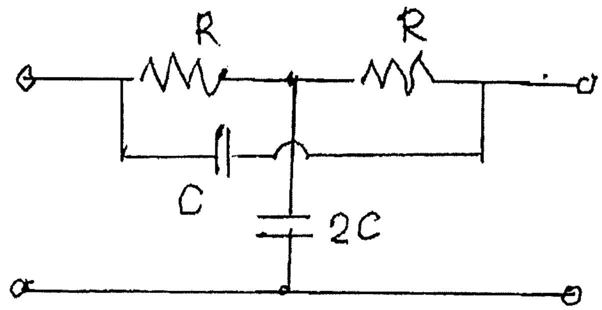
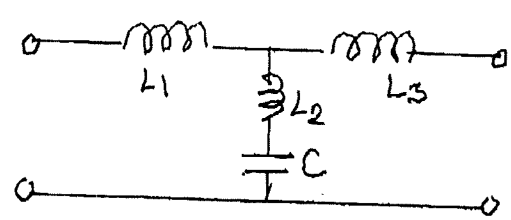
MIDTERM EXAMINATION

October 19,2022 Open Book

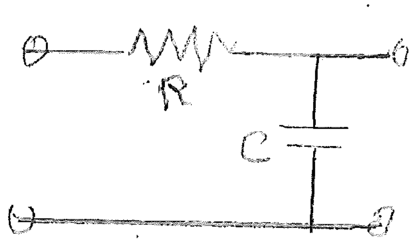
1. Find the short-circuit parameters of the circuit shown below. Assume R = 5 kΩ, C = 10 pF and f = 3 MHz.

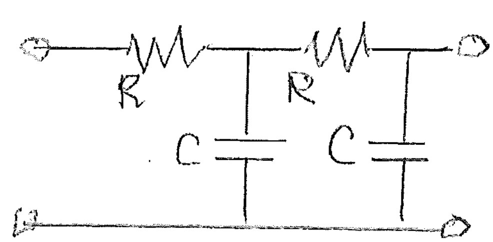


2. Two of the short-circuit admittances of the circuit shown are $y_{11} = y_{22} = (7s^2 + 1)/(16s^3 + 4s)$. Find all element values.



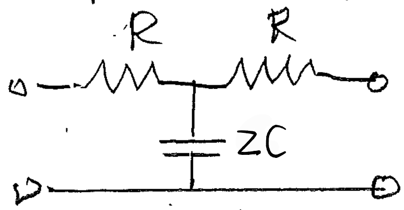
3. **Find the chain matrices of the two-ports shown below.**





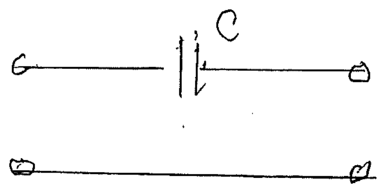
Solutions.

1. Splitting into parallel two-ports.



$$y_{11a} = y_{22a} = \frac{G}{2}\,\frac{2sC + G}{sC + G}$$

$$y_{12a} = y_{21a} = -\frac{G}{2}\,\frac{G}{sC + G}$$



$$y_{11b} = y_{22b} = -y_{12b} = -y_{21b} = j\omega C$$

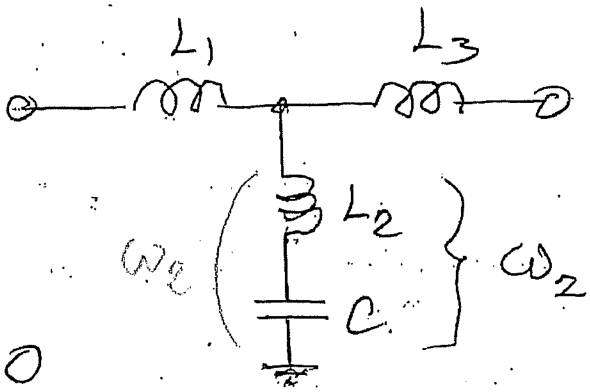
$$\frac{G}{2}$$

$$\underset{\sim}{Y} = \begin{bmatrix} 1.47 + j2.38 & -0.53 - j1.38 \\ & \end{bmatrix} \times 0.1\,\text{mS}$$

2. Next sheet

3. Next sheet

3. Find the element values of the two-port shown from $y_{11} = y_{22} = (7s^2+1)/(16s^3+4s)$.



For $s=0$

$$y_{11}^{-1} = y_{22}^{-1} = s(L_1+L_3) \Rightarrow L_1+L_3 = 4\,H$$

For $s = j\omega_2$

$$y_{11}^{-1} = y_{22}^{-1} = j\omega_2 L_1 + j\omega_2 L_3 \Rightarrow L_1 = L_3 = 2H$$

For $s \to \infty$

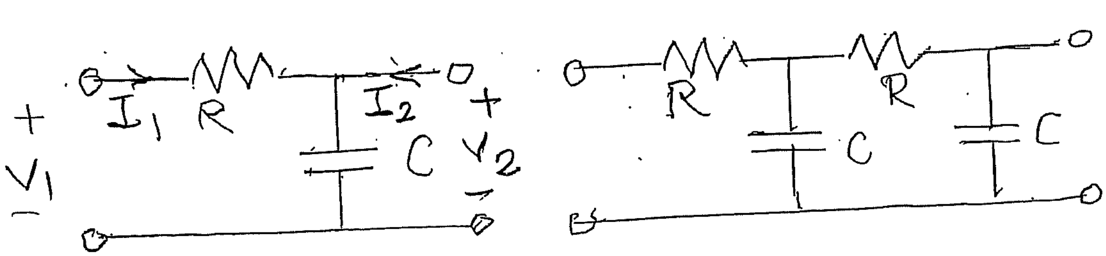
$$y_{11}^{-1} \to sL_1 + s\frac{L_1 L_2}{L_1+L_2} = sL_1\left(1+\frac{L_2}{L_1+L_2}\right) = s\frac{16}{7}$$

$L_1/L_2 = 6$, $L_2 = 1/3\,H$

$$y_{11}^{-1} - sL_1 = \frac{16s^3+4s}{7s^2+1} - s2 = \frac{2s^3+2s}{7s^2+1}$$

Hence, $\omega_2 = \pm 1$, $C_2 = 1/L_2 = 3F$

3



Solutions

1a. $I_1 = sCV_2 - I_2$

$$V_1 = RI_1 + V_2 = R(sCV_2 - I_2) + V_2$$

$$\underset{\sim}{T} = \begin{bmatrix} sRC + 1 & +R \\ sC & +1 \end{bmatrix}$$

b. Find $\underset{\sim}{T}^2 = \begin{bmatrix} (sRC+1)^2 + sRC & R(sRC+1) + R \\ sC(sRC+1) + sC & sRC+1 \end{bmatrix}$