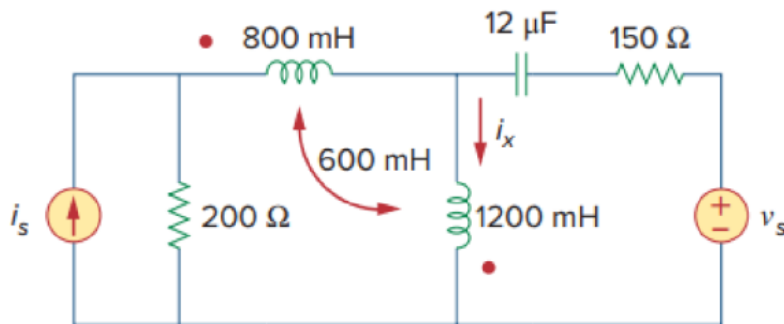


VE215 2025SU Assignment 7

Due Date: 23:59, July.31th, 2025

In order to get full marks, you shall write all the intermediate steps of calculation or proof, unless otherwise indicated. **Please box your answers.**

Exercise 7.1 (20%) Find the unknown current i_x in the circuit below, where $i_s = 4 \cos(600t)A$ and $v_s = 110 \cos(600t + 30^\circ)V$

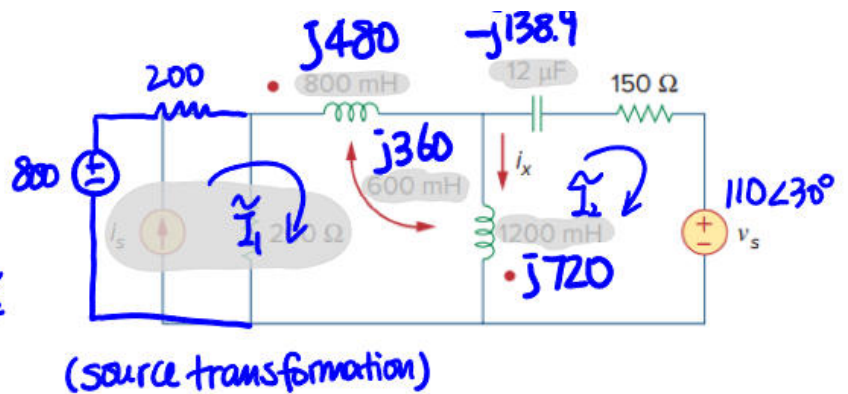


Left mesh

$$\begin{aligned}
 & -800 + (200 + j480) \tilde{I}_1 - j360 (\tilde{I}_1 - \tilde{I}_2) \\
 & -j360 \tilde{I}_1 + j720 (\tilde{I}_1 - \tilde{I}_2) = 0
 \end{aligned}$$

Right mesh

$$\begin{aligned}
 & j360 \tilde{I}_1 + j720 (\tilde{I}_2 - \tilde{I}_1) - j138.9 \tilde{I}_2 + 150 \tilde{I}_2 \\
 & + 110 \angle 30^\circ = 0
 \end{aligned}$$



$$\begin{bmatrix} 200 + j480 & -j360 \\ -j360 & 150 + j581.1 \end{bmatrix} \begin{bmatrix} \tilde{I}_1 \\ \tilde{I}_2 \end{bmatrix} = \begin{bmatrix} 800 \\ -110 \angle 30^\circ \end{bmatrix}$$

$$\tilde{I}_1 = \frac{\begin{vmatrix} 800 & -j360 \\ -110 \angle 30^\circ & 150 + j581.1 \end{vmatrix}}{\begin{vmatrix} 200 + j480 & -j360 \\ -j360 & 150 + j581.1 \end{vmatrix}} \quad \tilde{I}_2 = \frac{\begin{vmatrix} 200 + j480 & 800 \\ -j360 & -110 \angle 30^\circ \end{vmatrix}}{\begin{vmatrix} 200 + j480 & -j360 \\ -j360 & 150 + j581.1 \end{vmatrix}}$$

$$\hat{I}_x = \tilde{I}_1 - \tilde{I}_2 = 1.1 \angle -66.0^\circ$$

$$i_x = 1.1 \cos(600t - 66.0^\circ) A$$

— Solving equations involving complex numbers can be time consuming.

You may as well just list the equations without solving, and go on to other problems if you don't have much time.

— remember to give the time-domain expression

Exercise 7.2 $V_s = 10 \cos(4t + \pi/4)$, $R_1 = R_2 = 5\Omega$, $R_3 = 10\Omega$, $X_{L1} = 15\Omega$, $X_{L2} = 20\Omega$, $X_M = 2\Omega$, $X_C = 0.5\Omega$. Find I_1 and I_2 .

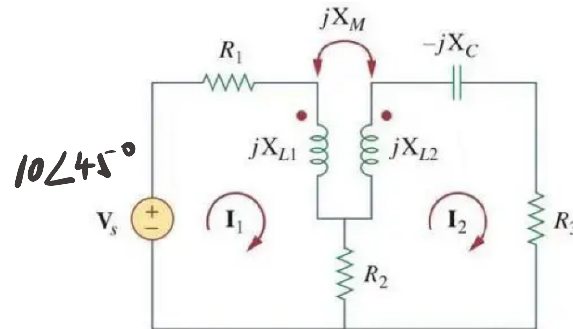


Figure 2: Exercise7.2

$$\begin{cases} V_s = (R_1 + jX_{L1} + R_2)I_1 - R_2 I_2 - jX_M I_2 \\ 0 = (jX_{L2} - jX_C + R_3 + R_2)I_2 - R_2 I_1 - jX_M I_1 \end{cases}$$

$$\Downarrow$$

$$\begin{aligned} 10\angle 45^\circ &= (5 + j15 + 5)I_1 - (5 + j2)I_2 \\ 0 &= (j19.5 + 5)I_2 - (5 + j2)I_1 \end{aligned}$$

$$\Rightarrow I_2 = \frac{5 + j2}{15 + j19.5} I_1$$

$$\begin{cases} I_1 = 0.569\angle -14.83^\circ \text{ A} \\ I_2 = 0.125\angle -45.43^\circ \text{ A} \end{cases}$$

Exercise 7.3 Determine I_1 , I_2 , I_3 in the circuit.

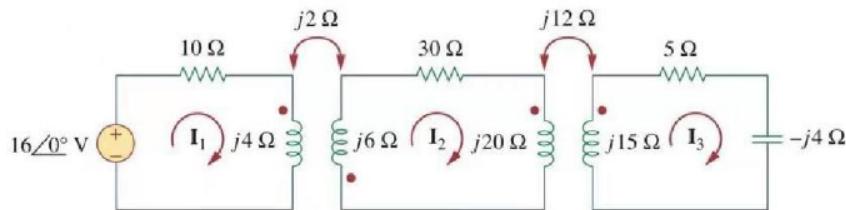


Figure 3: Exercise7.3

Mesh Analysis

$$16 = (10 + j4)I_1 + j2I_2$$

$$0 = j2I_1 + (30 + j26)I_2 - j12I_3$$

$$0 = -j12I_2 + (5 + j11)I_3$$

$$\Rightarrow \begin{cases} I_1 = 1.475 \angle -4.41^\circ \text{ A} \\ I_2 = 77.5 \angle -134.85^\circ \text{ mA} \\ I_3 = 77 \angle -110.41^\circ \text{ mA} \end{cases}$$

Exercise 7.4 Find the input impedance Z_{in} of the circuit below.

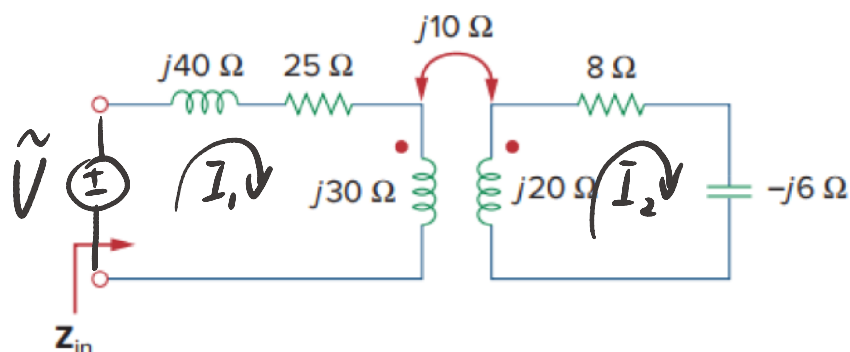


Figure 4: Exercise7.4

$$\begin{cases} -\tilde{V} + (j70 + 25)\tilde{I}_1 - j10\tilde{I}_2 = 0 \\ -j10\tilde{I}_1 + (j12 + 8)\tilde{I}_2 = 0 \end{cases}$$

$$\Rightarrow \tilde{Z}_{in} = \frac{\tilde{V}}{\tilde{I}_1} = 28.1 + j64.6 \, \Omega = 70.5 \angle 66.5^\circ$$

Exercise 7.5 Find the current I_1 , I_2 and I_0 in the circuit below, and the average power delivered to the load $10 + j40\Omega$.

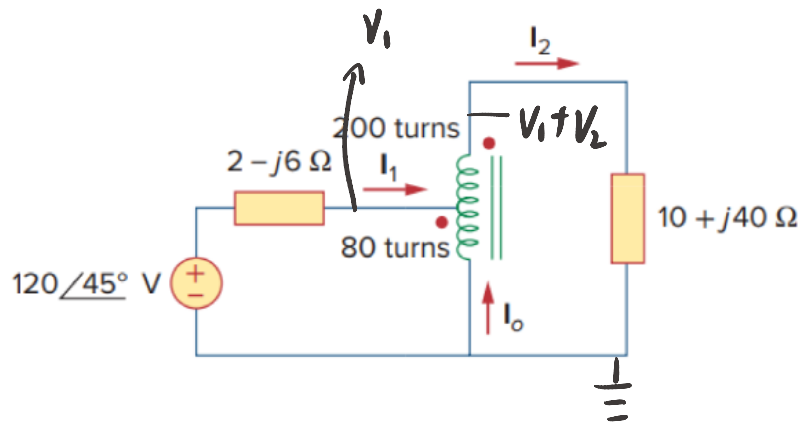


Figure 5: Exercise7.5

KCL:

$$I_2 = I_1 + I_0$$

$$\frac{I_0}{I_2} = -\frac{200}{80} \quad \frac{V_2}{V_1} = \frac{200}{80}$$

KCL:
$$I_1 = \frac{120\angle 45^\circ - V_1}{2 - j6}$$

$$I_2 = \frac{V_1 + V_2}{10 + j40}$$

$$\Rightarrow \begin{aligned} I_0 &= 21.8\angle -90.8^\circ \text{ A} \\ I_1 &= 30.6\angle 89.2^\circ \text{ A} \\ I_2 &= 8.7\angle 89.2^\circ \text{ A} \end{aligned}$$

$$\Rightarrow P = |I_2|^2 R = 756.9 \text{ W}$$