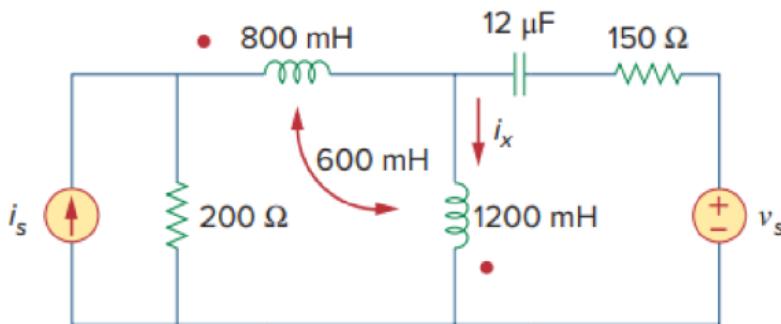


Due Date: 23:59, July 31th, 2025

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  $v_s = 110 \cos(600t + 30^\circ) V$

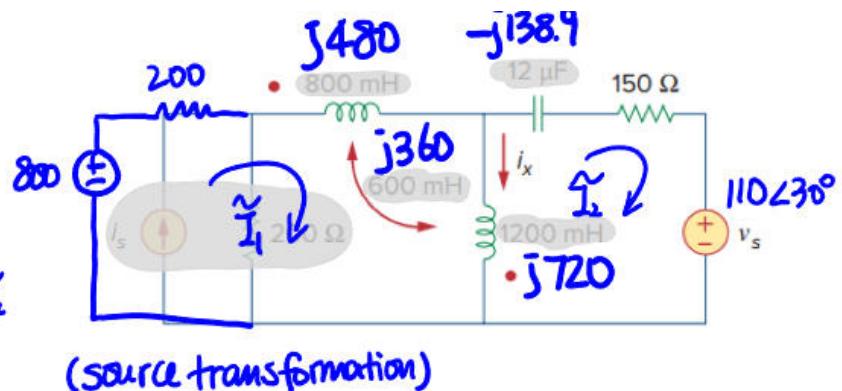


Left mesh

$$\begin{aligned} -800 + (200 + j480) \tilde{I}_4 - j360 (\tilde{I}_1 - \tilde{I}_2) \\ -j360 \tilde{I}_4 + j720 (\tilde{I}_1 - \tilde{I}_2) = 0 \end{aligned}$$

Right mesh

$$\begin{aligned} j360 \tilde{I}_4 + j720 (\tilde{I}_2 - \tilde{I}_1) - j138.9 \tilde{I}_2 + 150 \tilde{I}_2 \\ + 110 \angle 30^\circ = 0 \end{aligned}$$



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

— Solving equations involving complex numbers can be time consuming.

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

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

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

$$i_x = 1.1 \cos(600t - 66.0^\circ) A \quad \text{— remember to give the time-domain expression}$$

**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  $I_2$ .

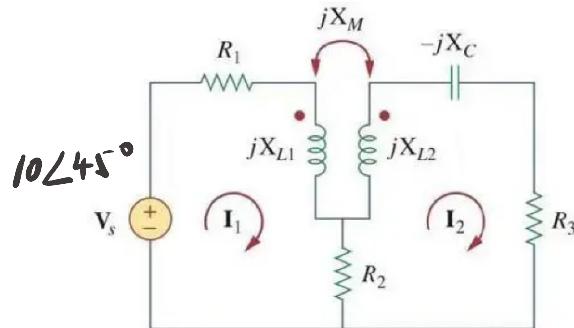


Figure 2: Exercise 7.2

$$\left\{ \begin{array}{l} V_s = (R_1 + jX_{L1} + R_2)I_1 - R_2 I_2 - jX_M I_2 \\ 0 = (jX_{L2} - jX_C + R_3 + R_2)I_2 - R_2 I_1 - jX_M I_1 \end{array} \right.$$

$$\downarrow$$

$$10\angle 45^\circ = (10 + j15)I_1 - (5 + j2)I_2$$

$$0 = (j19.5 + 5)I_2 - (5 + j2)I_1$$

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

$$\left\{ \begin{array}{l} I_1 = 0.569 \angle -14.83^\circ \text{ A} \\ I_2 = 0.125 \angle -45.43^\circ \text{ A} \end{array} \right.$$

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

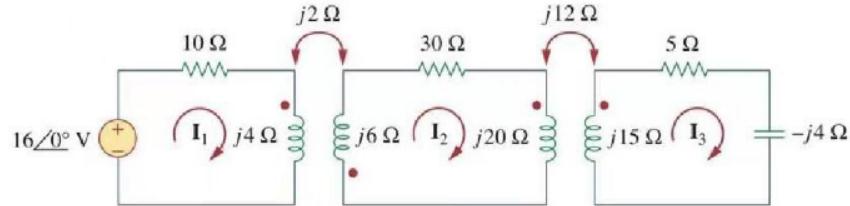


Figure 3: Exercise 7.3

## Mesh Analysis

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

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

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

$$\Rightarrow \begin{cases} I_1 = 1.475 \angle -41.41^\circ \text{ A} \\ I_2 = 77.5 \angle -134.85^\circ \text{ mA} \\ I_3 = 77 \angle -110.41^\circ \text{ mA} \end{cases}$$

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

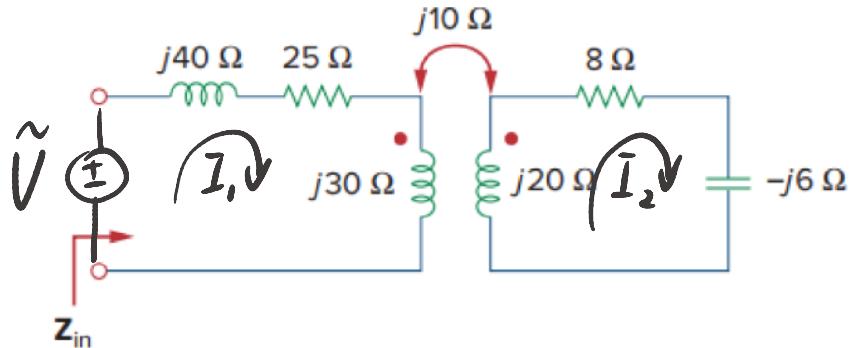


Figure 4: Exercise 7.4

$$\begin{cases} -\tilde{V} + (j70 + 25)I_1 - j10I_2 = 0 \\ -j10I_1 + (j12 + 8)I_2 = 0 \end{cases}$$

$$\Rightarrow \tilde{Z}_{in} = \frac{\tilde{V}}{I_1} = 28.1 + j64.6 \Omega = 70.5 \angle 66.5^\circ$$

**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  $10 + j40\Omega$ .

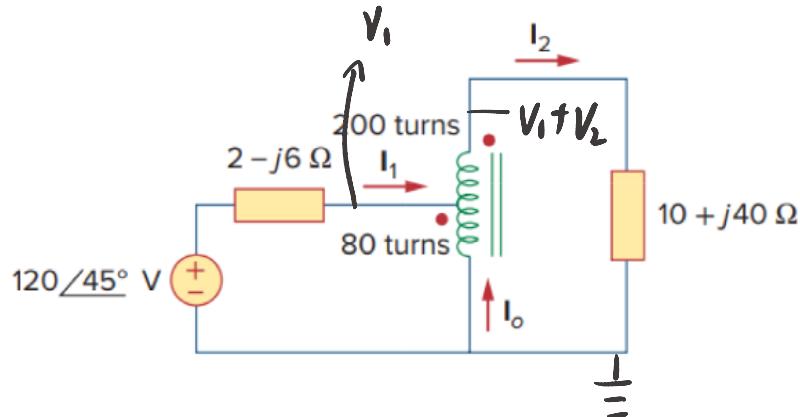


Figure 5: Exercise 7.5

**KCL:**

$$I_2 = I_1 + I_0$$

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

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

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

$$\Rightarrow I_0 = 21.8 \angle -90.8^\circ \text{ A} \quad I_1 = 30.6 \angle 89.2^\circ \text{ A} \quad \Rightarrow P = |I_2|^2 R = 756.9 \text{ W}$$

$$I_2 = 8.7 \angle 89.2^\circ \text{ A}$$