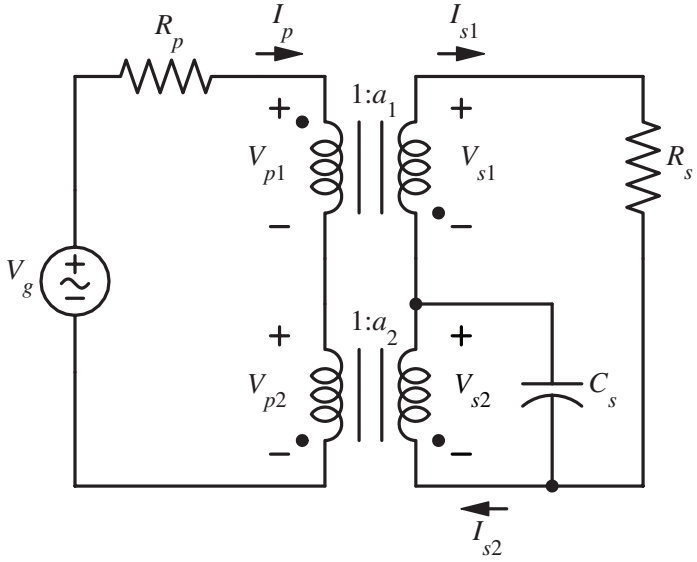
# Solution of ECE 202 Test 7 S13

(14 pts) Using the relations between voltages and currents for ideal transformers, it is possible to write a system of three equations and three unknowns for the circuit below. Fill in the blanks with correct numbers.

$$\begin{bmatrix} \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ \\ \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ & 0 \\ \_\_\_\_\_\angle\_\_\_\_\_^\circ & 0 & \_\_\_\_\_\angle\_\_\_\_\_^\circ \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} 120\angle 0^\circ \\ 0 \\ 0 \end{bmatrix}$$

$V_g = 120\angle 0^\circ$ Vrms, $R_p = 50\Omega$ , $R_s = 240\Omega$

$C_s = 320\mu\text{F}$ , $a_1 = 3$ , $a_2 = 0.75$ , $\omega = 200\,\text{s}^{-1}$




$$-V_g + R_p I_p + V_{p1} + V_{p2} = 0$$

$$-V_{s1} + R_s I_{s1} + \frac{1}{j\omega C_s}\left(I_{s1} - I_{s2}\right) = 0$$

$$-V_{s2} + \frac{1}{j\omega C_s}\left(I_{s2} - I_{s1}\right) = 0$$

$$\begin{bmatrix} R_p & 1 & 1 \\ \dfrac{R_s}{-a_1} + \dfrac{1}{j\omega C_s}\left(\dfrac{1}{-a_1} - \dfrac{1}{a_2}\right) & a_1 & 0 \\ \dfrac{1}{j\omega C_s}\left(\dfrac{1}{a_2} - \dfrac{1}{-a_1}\right) & 0 & -a_2 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 50 & 1 & 1 \\ -\dfrac{240}{3} + \dfrac{1}{j200\times 320\times 10^{-6}}\left(-\dfrac{1}{3} - \dfrac{1}{0.75}\right) & 3 & 0 \\ \dfrac{1}{j200\times 320\times 10^{-6}}\left(\dfrac{1}{0.75} + \dfrac{1}{3}\right) & 0 & -0.75 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 50\angle 0^\circ & 1\angle 0^\circ & 1\angle 0^\circ \\ 84.1319\angle 161.97^\circ & 3\angle 0^\circ & 0 \\ 26.0417\angle -90^\circ & 0 & 0.75\angle 180^\circ \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} 120\angle 0^\circ \\ 0 \\ 0 \end{bmatrix}$$

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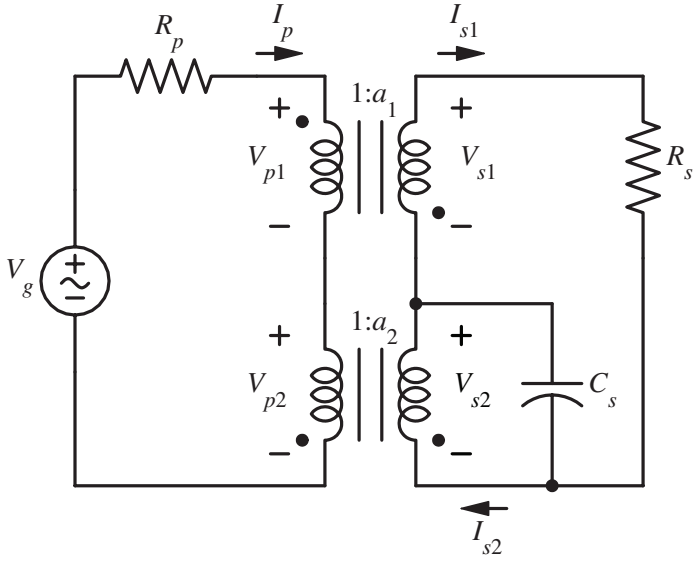
$V_g = 120\angle 0^\circ$ Vrms, $R_p = 75\Omega$ , $R_s = 120\Omega$

$C_s = 240\mu\text{F}$ , $a_1 = 2$ , $a_2 = 0.5$ , $\omega = 100\text{s}^{-1}$




$$-V_g + R_p I_p + V_{p1} + V_{p2} = 0$$

$$-V_{s1} + R_s I_{s1} + \frac{1}{j\omega C_s}\left(I_{s1} - I_{s2}\right) = 0$$

$$-V_{s2} + \frac{1}{j\omega C_s}\left(I_{s2} - I_{s1}\right) = 0$$

$$\begin{bmatrix} R_p & 1 & 1 \\ \dfrac{R_s}{-a_1} + \dfrac{1}{j\omega C_s}\left(\dfrac{1}{-a_1} - \dfrac{1}{a_2}\right) & a_1 & 0 \\ \dfrac{1}{j\omega C_s}\left(\dfrac{1}{a_2} - \dfrac{1}{-a_1}\right) & 0 & -a_2 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 75 & 1 & 1 \\ -\dfrac{120}{2} + \dfrac{1}{j100\times 240\times 10^{-6}}\left(\dfrac{1}{-2} - \dfrac{1}{0.5}\right) & 2 & 0 \\ \dfrac{1}{j100\times 240\times 10^{-6}}\left(\dfrac{1}{0.5} - \dfrac{1}{-2}\right) & 0 & -0.5 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 75\angle 0^\circ & 1\angle 0^\circ & 1\angle 0^\circ \\ 120.211\angle 119.942^\circ & 2\angle 0^\circ & 0 \\ 104.167\angle -90^\circ & 0 & 0.5\angle 180^\circ \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} 120\angle 0^\circ \\ 0 \\ 0 \end{bmatrix}$$

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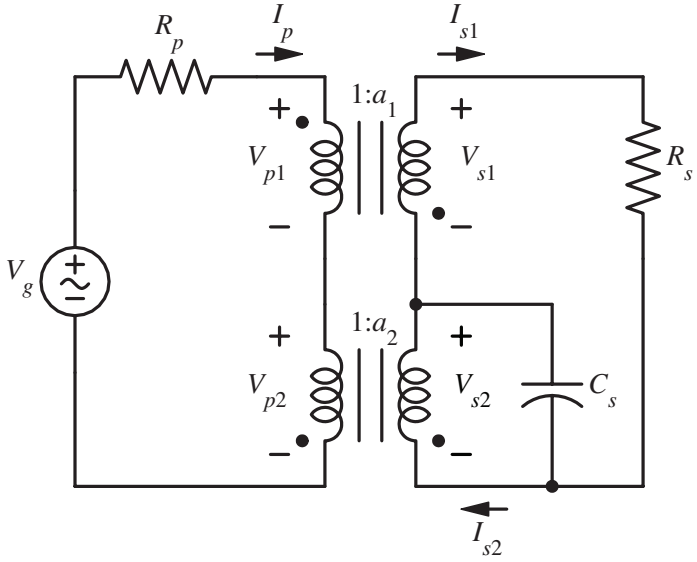
$$\begin{bmatrix} \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ \\ \_\_\_\_\_\angle\_\_\_\_\_^\circ & \_\_\_\_\_\angle\_\_\_\_\_^\circ & 0 \\ \_\_\_\_\_\angle\_\_\_\_\_^\circ & 0 & \_\_\_\_\_\angle\_\_\_\_\_^\circ \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} 120\angle 0^\circ \\ 0 \\ 0 \end{bmatrix}$$

$V_g = 120\angle 0^\circ$ Vrms, $R_p = 100\Omega$ , $R_s = 360\Omega$

$C_s = 400\mu\text{F}$ , $a_1 = 4$ , $a_2 = 0.25$ , $\omega = 300\text{s}^{-1}$




$$-V_g + R_p I_p + V_{p1} + V_{p2} = 0$$

$$-V_{s1} + R_s I_{s1} + \frac{1}{j\omega C_s}\left(I_{s1} - I_{s2}\right) = 0$$

$$-V_{s2} + \frac{1}{j\omega C_s}\left(I_{s2} - I_{s1}\right) = 0$$

$$\begin{bmatrix} R_p & 1 & 1 \\ \dfrac{R_s}{-a_1} + \dfrac{1}{j\omega C_s}\left(\dfrac{1}{-a_1} - \dfrac{1}{a_2}\right) & a_1 & 0 \\ \dfrac{1}{j\omega C_s}\left(\dfrac{1}{a_2} - \dfrac{1}{-a_1}\right) & 0 & -a_2 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 100 & 1 & 1 \\ -\dfrac{360}{4} + \dfrac{1}{j300\times 400\times 10^{-6}}\left(\dfrac{1}{-4} - \dfrac{1}{0.25}\right) & 4 & 0 \\ \dfrac{1}{j300\times 400\times 10^{-6}}\left(\dfrac{1}{0.25} - \dfrac{1}{-4}\right) & 0 & -0.25 \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} V_g \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 100\angle 0^\circ & 1\angle 0^\circ & 1\angle 0^\circ \\ 96.718\angle 158.519^\circ & 4\angle 0^\circ & 0 \\ 35.4167\angle -90^\circ & 0 & 0.25\angle 180^\circ \end{bmatrix} \begin{bmatrix} I_p \\ V_{p1} \\ V_{p2} \end{bmatrix} = \begin{bmatrix} 120\angle 0^\circ \\ 0 \\ 0 \end{bmatrix}$$