Las Americas Institute of Technology


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**Materia:**

Circuitos Eléctricos II

**Profesor:**

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**Tema del trabajo:**

Ejercicios pautados del cap. 13

## PROBLEMAS

### SECCIÓN 13.2 Teorema de superposición

1. Por medio de superposición, determine la corriente a través de la inductancia $X_L$ en la red de la figura 13.105.

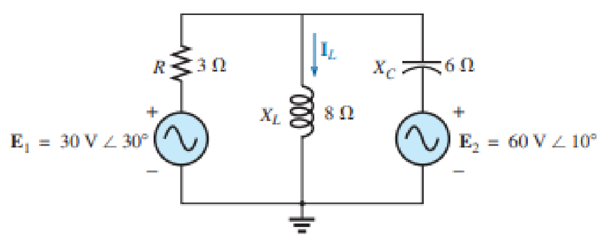
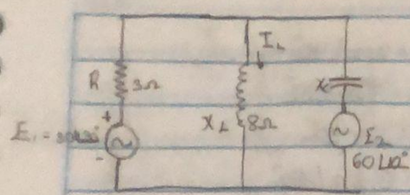



**FIG. 13.105**
*Problema 1.*



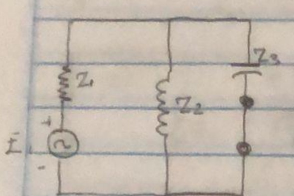

$Z_1 = 3\Omega\angle 0°$

$Z_2 = 8\Omega\angle 90°$

$Z_3 = 6\Omega\angle -90°$

$E_1 = 30V\angle 30°$

$E_2 = 60V\angle 10°$



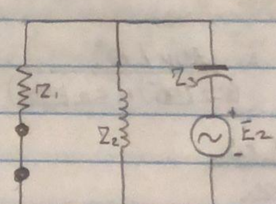

$$Z_a = \frac{Z_2 \cdot Z_3}{Z_2 + Z_3} = \frac{(8\Omega\angle 90)\cdot(6\Omega\angle -90°)}{(8\Omega\angle 90)+(6\Omega\angle -90°)} = 24\Omega\angle -90°$$

$$I = \frac{E_1}{Z_1 + Z_a} = \frac{30V\angle 30°}{(3\Omega\angle 0)+(24\angle -90°)} = \frac{30\angle 30°}{24.19\Omega\angle -82.87} = 1.24\angle 112.88°$$

$$I' = \frac{Z_3 \cdot I}{Z_2 + Z_3} = \frac{(6\Omega\angle -90°)(1.24\angle 112.88)}{(8\Omega\angle 90)+(6\Omega\angle -90)} = \frac{7.44V\angle 22.88°}{2\Omega\angle 90°} = 3.72A\angle -67.13°$$

$$Z_b = \frac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \frac{(3\Omega\angle 0°)(8\Omega\angle 90°)}{(3\Omega\angle 0°)+(8\Omega\angle 90°)} = \frac{24\Omega\angle 90°}{8.54\Omega\angle 69.44°}$$

$$Z_b = 2.81\Omega\angle 20.56°$$




$$I = \frac{E_2}{Z_3 + Z_b} = \frac{60V\angle 10}{(6\Omega\angle -90)+(2.81\Omega\angle 20.56°} = \frac{60V\angle 10°}{5.66\Omega\angle -62.31} = 10.60A\angle 72.31°$$

$$I'' = \frac{Z_1 \cdot I}{Z_1 + Z_2} = \frac{(3\Omega\angle 0°)(10.60A\angle 72.31)}{(3\Omega\angle 0°)+(8\Omega\angle 90°} = \frac{31.8V\angle 72.31}{8.54\Omega\angle 69.44} = 3.72A\angle 2.87$$

$I_{XL} = I' + I''$

$I_{XL} = (3.72A\angle -67.13°) + (3.72A\angle 2.87°)$

$I_{XL} = 6.09A\angle -32.13°$

**2.** Por medio de superposición, determine la corriente a través de la capacitancia $X_C$ en la red de la figura 13.106.

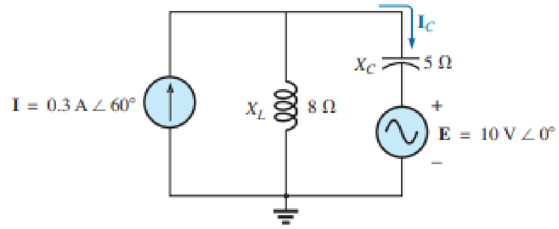
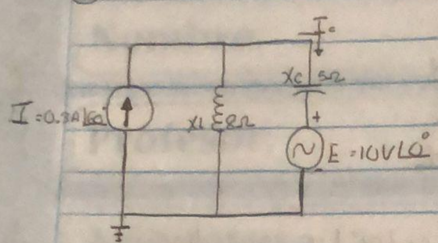



**FIG. 13.106**
*Problema 2.*

(2)




$Z_1 = 8\Omega\angle 90^\circ$

$Z_2 = 5\Omega\angle -90^\circ$

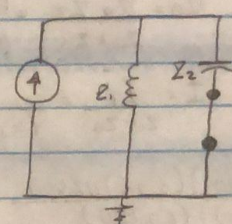
$E = 10V\angle 0^\circ$

$I = 0.3A\angle 60^\circ$

$$I' = \frac{Z_1 \cdot I}{Z_1 + Z_2} = \frac{(8\Omega\angle 90)(0.3A\angle 60^\circ)}{(8\Omega\angle 90^\circ) + (5\Omega\angle -90^\circ)}$$

$$I' = \frac{2.4V\angle 150^\circ}{3\Omega\angle 90^\circ}$$

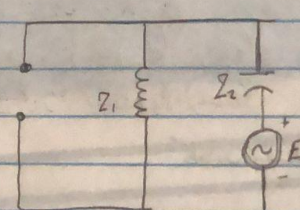
$$I' = 0.8A\angle 60^\circ$$




$$I'' = \frac{E}{Z_1 + Z_2} = \frac{10V\angle 0^\circ}{(8\Omega\angle 90^\circ) + (5\Omega\angle -90^\circ)}$$

$$I'' = \frac{10V\angle 0^\circ}{3\Omega\angle 90^\circ}$$

$$I'' = 3.33A\angle -90^\circ$$




$I_{xc} = I' - I''$

$I_{xc} = (0.8A\angle 60^\circ) - (3.33A\angle -90^\circ)$

$I_{xc} = 4.04A\angle 84.32$

**13.** Determine el circuito equivalente de Thévenin para la parte de la red de la figura 13.117 externa a los elementos entre los puntos *a* y *b*.

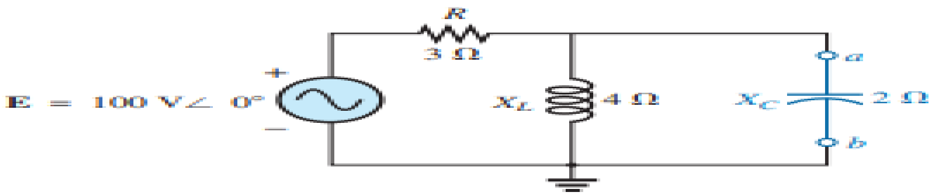
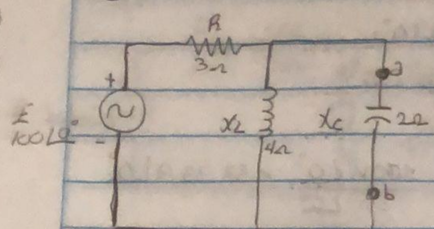



**FIG. 13.117**
*Problemas 13 y 30.*

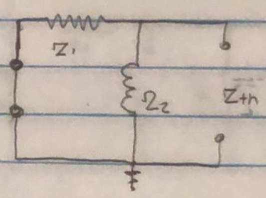
(13)




$Z_1 = 3\Omega\angle 0°$

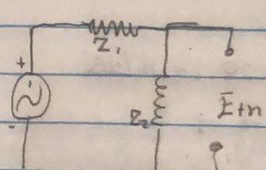
$Z_2 = 4\Omega\angle 90°$

$E = 100V\angle 0°$



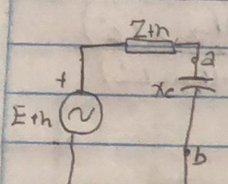

$$Z_{th} = \frac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \frac{(3\Omega\angle 0°)(4\Omega\angle 90°)}{(3\Omega\angle 0°)+(4\Omega\angle 90°)} = \frac{12\Omega\angle 90°}{5\Omega\angle 53.13°}$$

$$Z_{th} = 2.4\Omega\angle 36.87°$$




$$E_{th} = \frac{Z_2 \cdot E}{Z_2 + Z_1} = \frac{(4\Omega\angle 90°)(100V\angle 0°)}{(3\Omega\angle 0°)+(4\Omega\angle 90°)} = \frac{400\angle 90°}{5\Omega\angle 53.13°}$$

$$E_{th} = 80V\angle 36.87°$$



**30. Determine el circuito equivalente de Norton de la red externa para los elementos entre a y b para la red de la figura 13.117.**

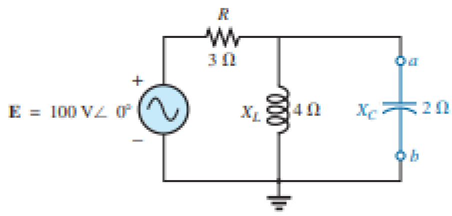
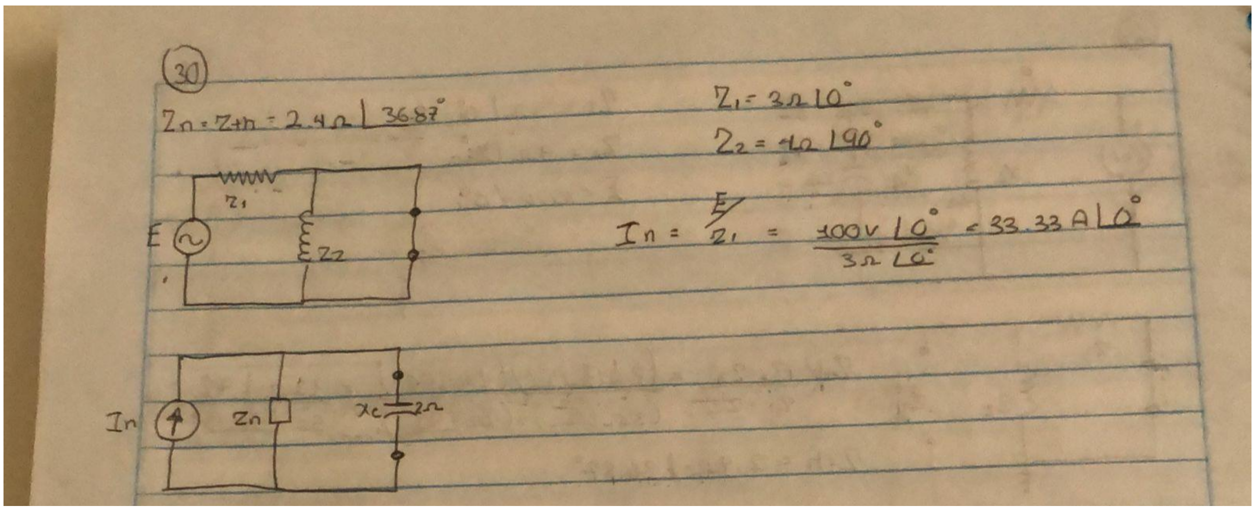



FIG. 13.117
*Problemas 13 y 30.*




**31. Determine el circuito equivalente de Norton de la red externa para los elementos entre a y b para la red de la figura 13.119**.

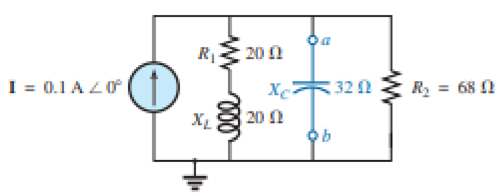
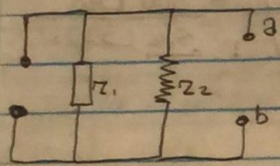



FIG. 13.119
*Problemas 15 y 31.*

31

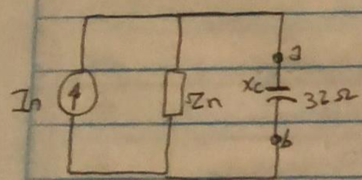



$Z_1 = 20\Omega + j20\Omega \rightarrow 28.28\Omega \angle 45^\circ$

$Z_2 = 68\Omega \angle 0^\circ$

$Z_n = \dfrac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \dfrac{(28.28\angle 45^\circ)(68\Omega \angle 0^\circ)}{(28.28\angle 45^\circ) + (68\Omega \angle 0^\circ)}$

$Z_n = \dfrac{1923.04\Omega}{90.24\Omega \angle 12.50^\circ}$




$Z_n = 21.31\Omega \angle 32.2^\circ$

$I_n = 0.1A \angle 0^\circ$

***33. Determine el circuito equivalente de Norton para la parte de la red de la figura 13.126 externa a los elementos entre los puntos a y b.**

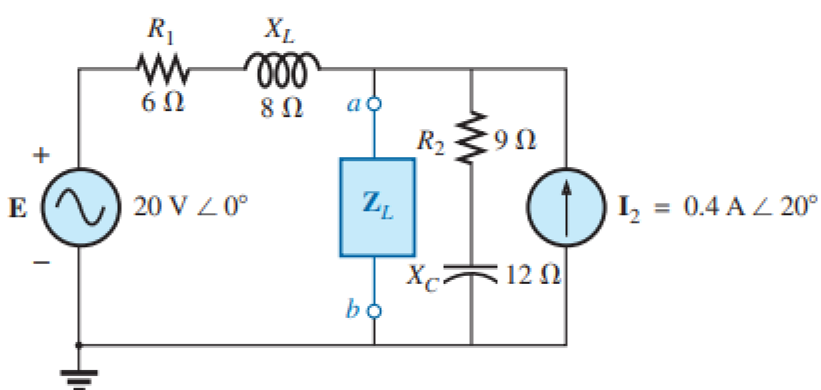
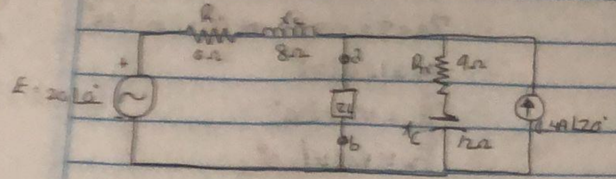



**FIG. 13.126**
*Problema 33.*

53

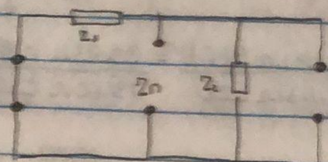



$Z_1 = 6\Omega + j8\Omega \rightarrow 10\Omega\angle 53.13$

$Z_2 = 9\Omega + j12\Omega \rightarrow 15\Omega\angle -53.13^\circ$

$E = 20V\angle 0^\circ$

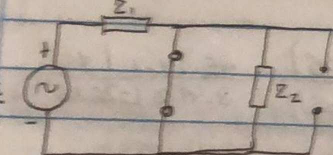
$I = 0.4A\angle 20^\circ$



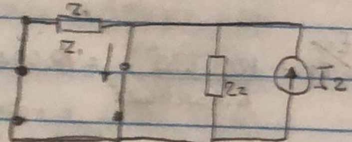

$$Z_n = \frac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \frac{(10\Omega\angle 53.13^\circ)(15\Omega\angle -53.13^\circ)}{(10\Omega\angle 53.13^\circ) + (15\Omega\angle -53.13)}$$

$$Z_n = \frac{150\Omega\angle 0^\circ}{15.52\Omega\angle -14.93}$$

$$Z_n = 9.66\Omega\angle 14.93^\circ$$




$$I' = \frac{E}{Z_1} = \frac{20V\angle 0^\circ}{10\Omega\angle 53.13^\circ} = 2A\angle -53.13^\circ$$

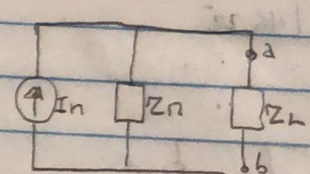


$$I'' = 0.4A\angle 20^\circ$$

$I_n = I' + I''$

$I_n = (2A\angle -53.13^\circ) + (0.4A\angle 20^\circ)$

$I_n = 2.15A\angle -42.88^\circ$



**34. Determine el circuito equivalente de Norton para la parte de la red de la figura 13.127 externa a los elementos entre los puntos a y b.**

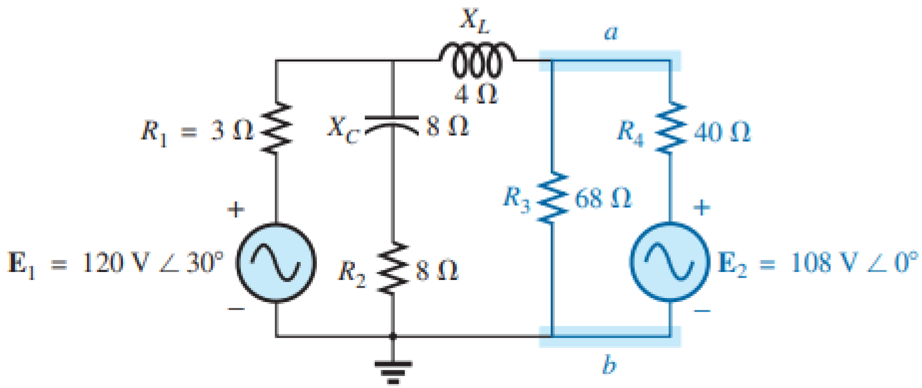
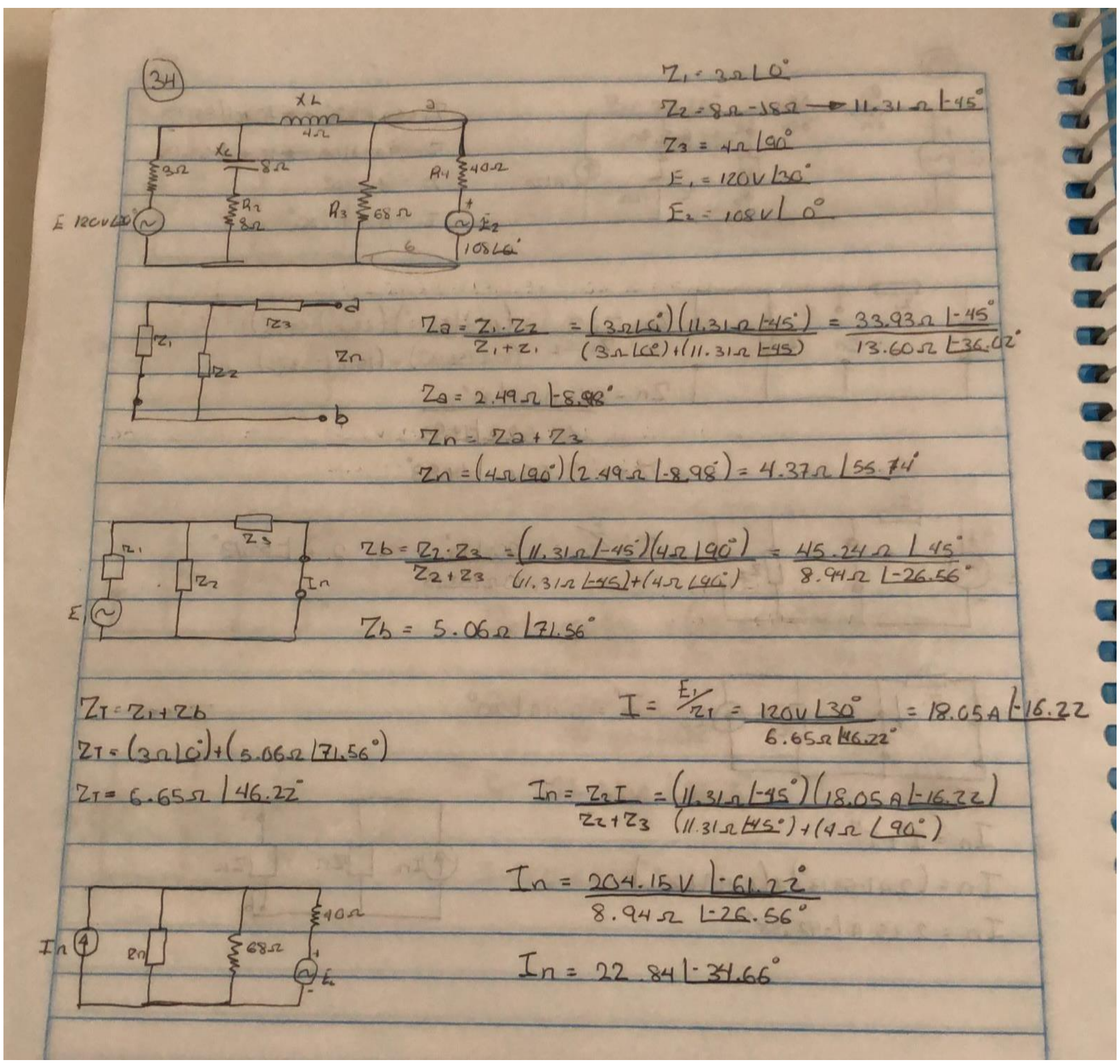



**FIG. 13.127**
*Problema 34.*



(34)

$Z_1 = 3\Omega \angle 0°$

$Z_2 = 8\Omega - j8\Omega \rightarrow 11.31\Omega \angle -45°$

$Z_3 = 4\Omega \angle 90°$

$E_1 = 120V \angle 30°$

$E_2 = 108V \angle 0°$

$Z_a = \frac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \frac{(3\Omega \angle 0°)(11.31\Omega \angle -45°)}{(3\Omega \angle 0°)+(11.31\Omega \angle -45°)} = \frac{33.93\Omega \angle -45°}{13.60\Omega \angle -36.02°}$

$Z_a = 2.49\Omega \angle -8.98°$

$Z_n = Z_a + Z_3$

$Z_n = (4\Omega \angle 90°)(2.49\Omega \angle -8.98°) = 4.37\Omega \angle 55.74°$

$Z_b = \frac{Z_2 \cdot Z_3}{Z_2 + Z_3} = \frac{(11.31\Omega \angle -45°)(4\Omega \angle 90°)}{(11.31\Omega \angle -45°)+(4\Omega \angle 90°)} = \frac{45.24\Omega \angle 45°}{8.94\Omega \angle -26.56°}$

$Z_b = 5.06\Omega \angle 71.56°$

$Z_T = Z_1 + Z_b$

$Z_T = (3\Omega \angle 0°)+(5.06\Omega \angle 71.56°)$

$Z_T = 6.65\Omega \angle 46.22°$

$I = E_1/Z_T = \frac{120V \angle 30°}{6.65\Omega \angle 46.22°} = 18.05A \angle -16.22$

$I_n = \frac{Z_2 I}{Z_2 + Z_3} = \frac{(11.31\Omega \angle -45°)(18.05A \angle -16.22)}{(11.31\Omega \angle 45°)+(4\Omega \angle 90°)}$

$I_n = \frac{204.15V \angle -61.22°}{8.94\Omega \angle -26.56°}$

$I_n = 22.84 \angle -34.66°$

## SECCIÓN 13.5 Teorema de transferencia de potencia máxima

**44.** Determine la impedancia de carga $\mathbf{Z}_L$ para la red de la figura 13.129 para el suministro de potencia máxima a la carga, y determine la potencia máxima suministrada a la carga.

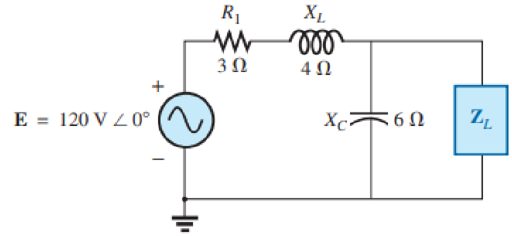
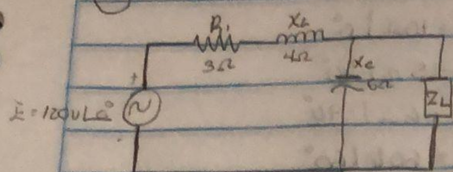



**FIG. 13.129**
*Problema 44.*

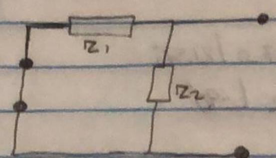
(44)




$Z_1 = 3\Omega + j4\Omega \rightarrow 5\Omega \angle 53.13^\circ$

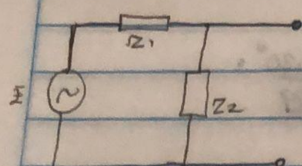
$Z_2 = 6\Omega \angle -90^\circ$

$E = 120V \angle 0^\circ$




$$Z_{th} = \frac{Z_1 \cdot Z_2}{Z_1 + Z_2} = \frac{(5\Omega \angle 53.13^\circ)(6\Omega \angle -90^\circ)}{(5\Omega \angle 53.13^\circ) + (6\Omega \angle -90^\circ)} = \frac{30\Omega \angle -36.87}{3.61\Omega \angle -33.69}$$

$$Z_{th} = 8.31\Omega \angle -3.18$$




$$E_{th} = \frac{(6\Omega \angle -90^\circ)(120V \angle 0^\circ)}{(5\Omega \angle 53.13) + (6\Omega \angle -90^\circ)} = \frac{720V \angle -90^\circ}{3.61\Omega \angle -33.69} = 199.45V \angle -56.31^\circ$$

$$P_{max} = \frac{E_{th}^2}{4 Z_{th}} = \frac{(199.45V)^2}{4(8.31\Omega)}$$

$$P_{max} = \frac{39780.30V}{33.24\Omega}$$

$$P_{max} = 1196.76W$$

***46.** Determine la impedancia de carga $Z_L$ para la red de la figura 13.131 para el suministro de potencia máxima a la carga y determine la potencia máxima suministrada a la carga.

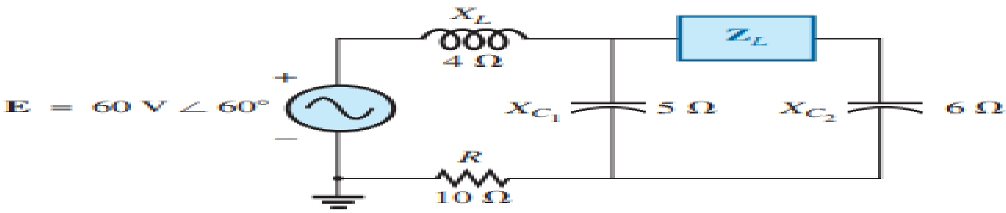
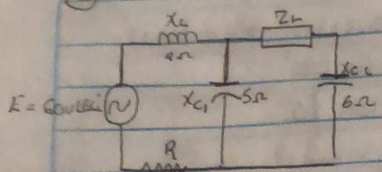



**FIG. 13.131**
*Problema 46.*

(46)



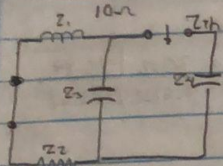

$Z_1 = 4\Omega \angle 90°$

$Z_2 = 10\Omega \angle 0°$

$Z_3 = 5\Omega \angle -90°$

$Z_4 = 6\Omega \angle -90°$

$E = 60V \angle 60°$

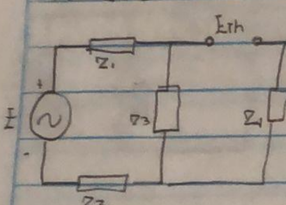



$Z_a = Z_1 + Z_2 = (4\Omega \angle 90°) + (10\Omega \angle 0°) = 10.77\Omega \angle 21.80°$

$Z_b = Z_3 + Z_4 = (5\Omega \angle -90°) + (6\Omega \angle -90°) = 11\Omega \angle -90°$

$$Z_{th} = \frac{Z_a \cdot Z_b}{Z_a + Z_b} = \frac{(10.77 \angle 21.80°)(11\Omega \angle -90°)}{(10.77 \angle 21.80°) + (11\Omega \angle -90°)} = \frac{118.47\Omega \angle -68.20°}{12.21\Omega \angle -34.99} =$$

$Z_{th} = 11.04\Omega \angle -77.03° \rightarrow 2.48\Omega - j14.75\Omega$




$$E_{th} = \frac{Z_3 E}{Z_3 + Z_1 + Z_2} = \frac{(5\Omega \angle -90°)(60V \angle 60°)}{(5\Omega \angle -90°) + (4\Omega \angle 90°) + (10\Omega \angle 0°)}$$

$$E_{th} = \frac{300V \angle -30°}{10.05\Omega \angle -5.71°}$$

$E_{th} = 29.85V \angle -24.29°$

$$P_{max} = \frac{E_{th}^2}{4 Z_{th}} = \frac{(29.85V)^2}{4(2.48\Omega}$$

$$P_{max} = \frac{891.02V}{9.90\Omega}$$

$P_{max} = 90.00W$