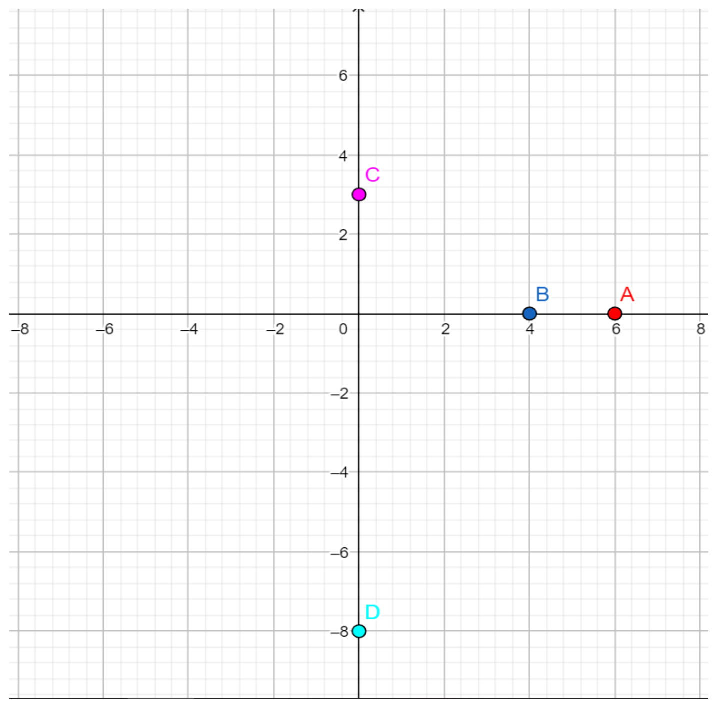
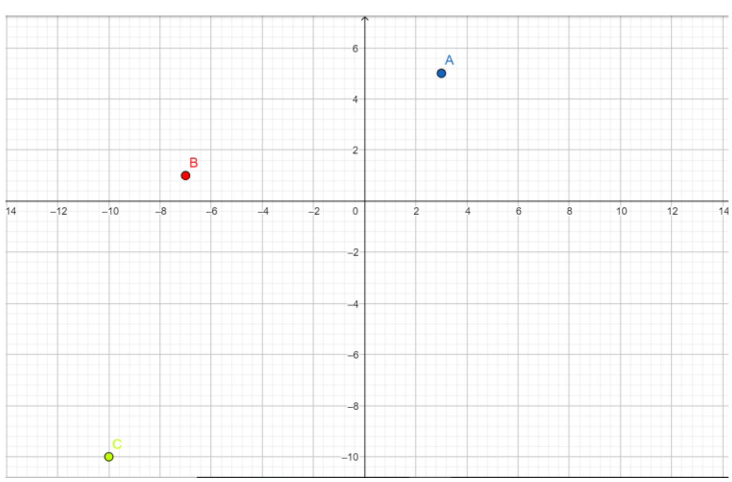
2. Localice los siguientes números complejo en el plano complejo

a. +6   b.   -2   c. +j3   d. - j8



4. Determine las coordenadas de cada punto que tenga igual magnitud, pero esté localizado a 180° de cada uno de los puntos del problema

(a) 3, j5   (b)-7, j1   (c) -10 , -10j



Forma polar

a. 3, j5 = 5,83<59,03°
b. -7 , j1 = 7,07<171,86 °
c. -10 , -10 j =14,14 < -135°

Resolución (Aumentar 180° a los ángulos y luego pasar a forma rectangular)

a. 5,83 < 239.03° = -3 -5j
b. 7,07< 351,86° = 7- 1j
c. 14,14< 45° = 10 + 10 j

6. A continuación se describen puntos localizados en el plano complejo. Exprese cada punto como un número complejo en forma rectangular:

(a) 3 unidades a la derecha del origen sobre el eje real, y 5 unidades hacia arriba sobre el eje j.

- 3 +5j

(b) 2 unidades a la izquierda del origen sobre el eje real, y 1.5 unidades hacia arriba sobre el eje j.

- -2+1,5j

(c) 10 unidades a la izquierda del origen sobre el eje real, y 14 unidades hacia abajo sobre el eje -j.

- -10 -14j

8. Convierta cada uno de los siguientes números rectangulares a forma polar:

a. 40 -40j = 56,56 < -45°

b. 50-200j = 206,15 < - 75,96°

c. 35-j20 = 40,31 < -29,74°

d. 98 + j45 = 107,83 < 24,66 °

10. Exprese cada uno de los siguientes números polares utilizando un ángulo negativo para reemplazar al positivo.

Solución: Restamos el ángulo con 360 °

a. 10 < 120 ° = 10 < -240°

b. 35< 85 ° = 35 < -275 °

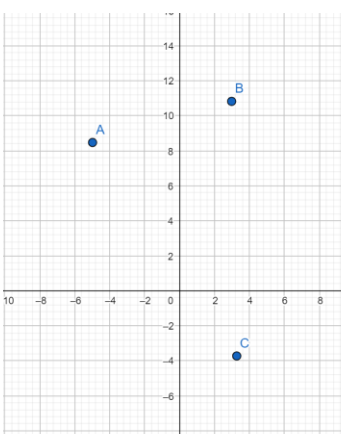
c. 5<310° = 5 < - 50 °

12. Identifique el cuadrante en el cual se localiza cada uno de los puntos del problema 10.

a. 10 < 120 ° = 10 < -240° (2° Cuadrante)

b. 35< 85 ° = 35 < -275 ° (1° Cuadrante)

c. 5<310° = 5 < - 50 ° (4° Cuadrante)



14. Sume los siguientes conjuntos de números complejos:

a. 9 +j3 y 5 j8 = 14 +11 j

b. 3,5 –j4 y 2,2 +j6 = 5,7 + 10j

c. -18 + j23 y 30 –j 15 = 12 + 38 j

d. 12<45° y 20<32° = 25,44 + 19,08 j

e. 15-j10 y -25-j30° = -10-40j

f. 0,8 +j0,5 y 1,2 –j1,5 = 2 – j

16. Multiplique los siguientes números

a. 4,5 < 48° y 3,2 < 90° = 14,4< 138°

b. 120<220| y 95 <200° = 11400 < 60 °

c. -3<150 y 4- j3 = -3<150 y 5<-36,86

d. 67 + j84 y 102∠40° = 8525,08 < 129,65°

e. 15 - j10 y -25 - j30 = 15+ 220 j

f. 0.8 + j0.5 y 1.2 - j1.5 = 0,8 - 0,9 j

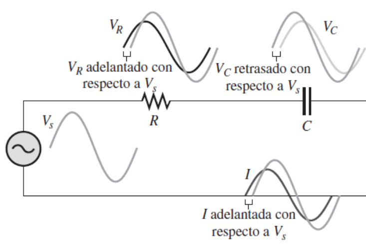
18. Realice las siguientes operaciones:

$$\text{(a)}\ \frac{2.5\angle 65^\circ - 1.8\angle -23^\circ}{1.2\angle 37^\circ} \qquad = \qquad 2{,}524 < 64{,}431\ ^\circ$$

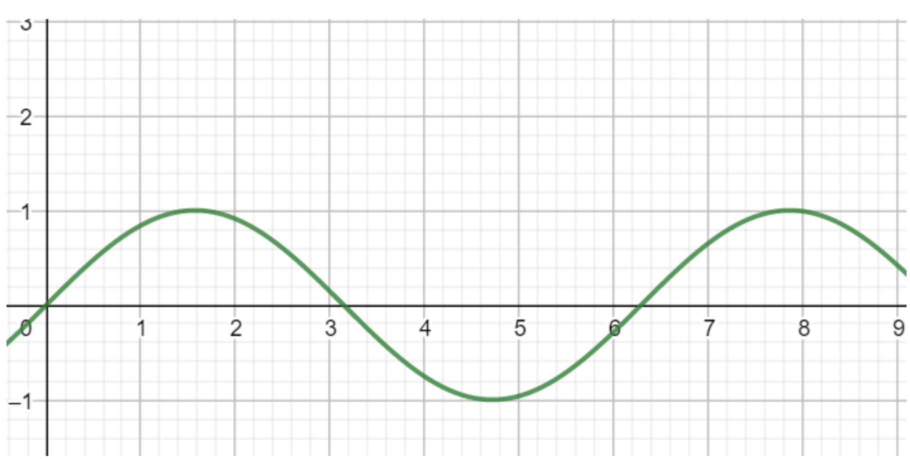
$$\text{(b)}\ \frac{(100\angle 15^\circ)(85 - j150)}{25 + j45} \qquad = \qquad -94{,}598\ -\ 321{,}28\ j$$

$$\text{(c)}\ \frac{(250\angle 90^\circ + 175\angle 75^\circ)(50 - j100)}{(125 + j90)(35\angle 50^\circ)} \qquad = \qquad 3{,}644 - 7{,}944\ j$$

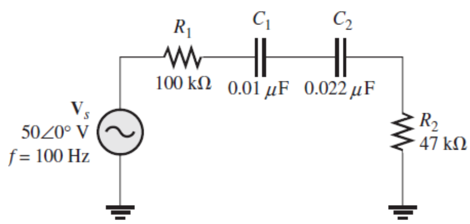
20. ¿Cuál es la forma de onda de la corriente en el circuito del problema 19?



Función seno:



22. Determine la magnitud de la impedancia y el ángulo de fase en cada circuito de la figura 15-85.



(a)

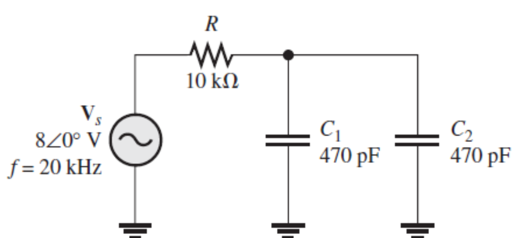
$$C_{eq} = \frac{0{,}01\ \mu * 0{,}022\mu}{0{,}01\mu + 0{,}022\mu} = 6{,}87nF = Xc$$

$$R_{eq} = 100k + 47k = 147\ k\Omega$$

$$Z_{eq} = Req - j\text{Xc}$$

Magnitud : $\sqrt{Req^2 + Xc^2} = \sqrt{147k^2 + 6{,}87n^2} = 147000$

Angulo de fase : $\theta = -\tan\left(\frac{Xc}{Req}\right) = \tan\left(\frac{6{,}87n}{147\ k}\right) = -90°$



(b)

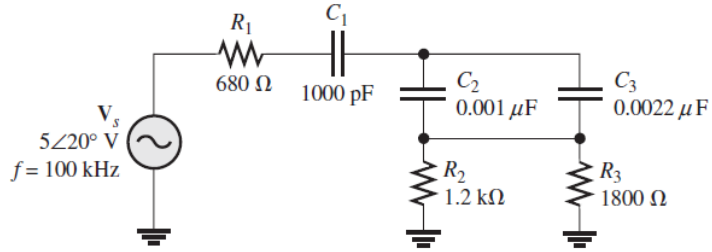
$$C_{eq} = 470\ p + 470\ p = 9{,}4x10^{-10}F$$

$$R_{eq} = \ \ 10k\Omega$$

$$Z_{eq} = Req - j\text{Xc}$$

Magnitud : $\sqrt{Req^2 + Xc^2} = \sqrt{10k^2 + (9{,}4x10^{-10})^2} = 10000$

Angulo de fase : $\theta = -\tan\left(\frac{Xc}{Req}\right) = -\tan\left(\frac{9{,}4x10^{-10}}{10k}\right) = -5{,}385x10^{-12\circ}$



(c)

$$R_{eq1} = R2 \,||R3 = \frac{1{,}2k * 1800}{1{,}2k + 1800} = 720\ \Omega$$

$$C_{eq1} = C2||C3 = 0{,}001\mu + 0{,}0022\mu = 3{,}2\ n\ F$$

$$C_{eq2} = Ceq_1 + C1 = \frac{1000\ p * 3{,}2\ n}{1000\ p + 3{,}2\ n} = 7{,}619x10^{-10}F$$

$$R_{eq2} = R_{eq1} + R1 = 720 + 680 = 1400\ \Omega$$

$$C_{eq2} = Xc$$

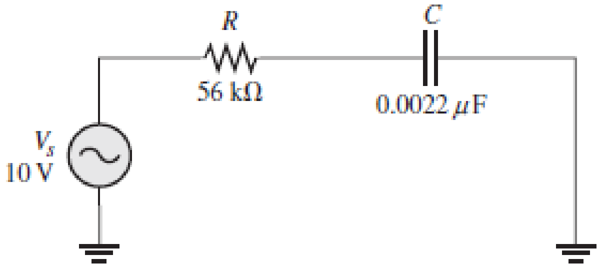
$$R_{eq2} = R_{eq}$$

Magnitud : $\sqrt{Req^2 + Xc^2} = \sqrt{1400^2 + (7{,}619x10^{-10})^2} = 1400$

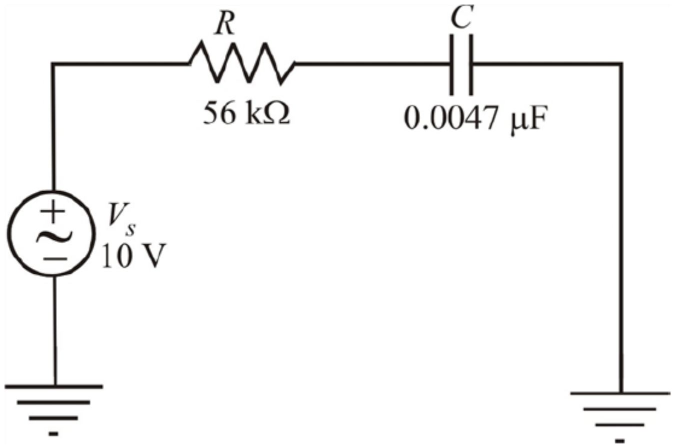
Angulo de fase : $\theta = -\tan\left(\frac{Xc}{Req}\right) = -\tan\left(\frac{7{,}619x10^{-10}}{1400}\right) = -3{,}118x10^{-11\circ}$

24. Repita el problema 23 con *C* = 0.0047 μF.

23 determine la impedancia expresada en forma rectangular para cada una de las siguientes frecuencias:
A) 100 Hz B) 500 Hz C) 1kHz D) 2.5kHz



▲ FIGURA 15–86



A) 100 Hz

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(100)(0.0047x10^{-6})}$$

$$X_c = \frac{1}{2.95\ x10^{-6}}$$

$$X_c = 338.63\ k\Omega$$

$$Z = R - jX_c$$

$$Z = (56 - j338.63)\ k\Omega$$

B) 500 Hz

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(500)(0.0047x10^{-6})}$$

$$X_c = \frac{1}{1.477\ x10^{-5}}$$

$$X_c = 677.26\ k\Omega$$

$$Z = R - jX_c$$

$$Z = (56 - j677.26)\ k\Omega$$

C) 1 kHz

$$X_c = \frac{1}{2\pi fC}$$

$$X_c = \frac{1}{2\pi(1000)(0.0047x10^{-6})}$$

$$X_c = \frac{1}{2.95\ x10^{-5}}$$

$$X_c = 338.62\ k\Omega$$

$$Z = R - jX_c$$

$$Z = (56 - j338.62)\ k\Omega$$

D) 2.5 kHz

$$X_c = \frac{1}{2\pi fC}$$

$$X_c = \frac{1}{2\pi(2500)(0.0047x10^{-6})}$$

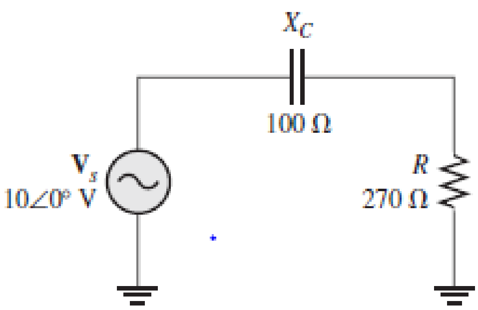
$$X_c = \frac{1}{7.38\ x10^{-5}}$$

$$X_c = 135.45\ k\Omega$$

$$Z = R - jX_c$$

$$Z = (56 - j135.45)\ k\Omega$$

26. Exprese la corriente en forma polar para cada circuito de la figura 15-84.



(a)

$$Z = R - jX_c$$

$$Z = 270 - j100$$

$$Z = \sqrt{R^2 + X_c^2} < -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$Z = \sqrt{270^2 + 100^2} < -tan^{-1}\left(\frac{100}{270}\right)$$

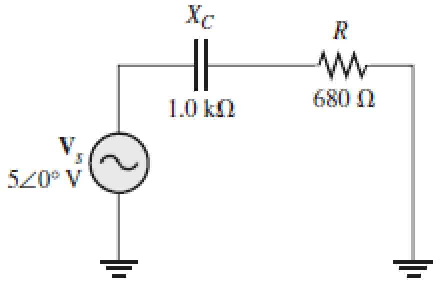
$$Z = \sqrt{82900} < -tan^{-1}(0.37)$$

$$Z = 287.9 < -20.32° \ \Omega$$

$$I = \frac{V_S}{Z}$$

$$I = \frac{10 < 0°}{287.9 < -20.32°}$$

$$I = 0.035 < 20.32° \ A$$



(b)

$$Z = R - jX_c$$

$$Z = 680 - j1000$$

$$Z = \sqrt{R^2 + X_c^2} < -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$Z = \sqrt{680^2 + 1000^2} < -tan^{-1}\left(\frac{1000}{680}\right)$$

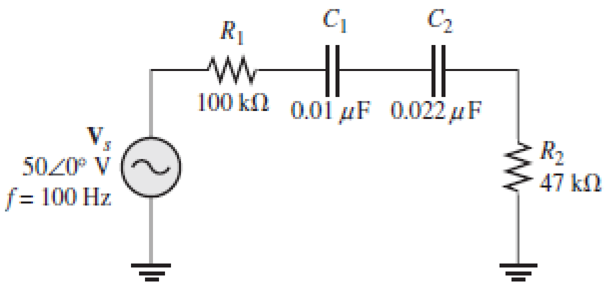
$$Z = 1.21 < -55.78° \ k\Omega$$

$$I = \frac{V_S}{Z}$$

$$I = \frac{5 < 0° \ V}{1.21 < -55.78° \ k\Omega}$$

$$I = 4.13 < 55.78° \ mA$$

28. Determine el ángulo de fase entre el voltaje aplicado y la corriente para cada circuito de la figura 15-85.



(a)

$$X_{c1} = \frac{1}{2\pi f C_1}$$

$$X_{c1} = \frac{1}{2\pi(100)\ 0.01\ x10^{-6}}$$

$$X_{c1} = \frac{1}{6.283\,x10^{-6}}$$

$$X_{c1} = 159.2\ k\Omega$$

$$X_{c2} = \frac{1}{2\pi f C_2}$$

$$X_{c2} = \frac{1}{2\pi(100)\ 0.022\,x10^{-6}}$$

$$X_{c2} = \frac{1}{1.382\,x10^{-5}}$$

$$X_{c2} = 72.34\ k\Omega$$

$$Z = R_1 + R_2 - jX_1 - jX_2$$

$$Z = 100\ k + 47k - j159.2k - j72.34k$$

$$Z = (147 - j231.54)\ k\Omega$$

$$Z = \sqrt{A^2 + B^2} < -tan^{-1}\left(\frac{B}{A}\right)$$

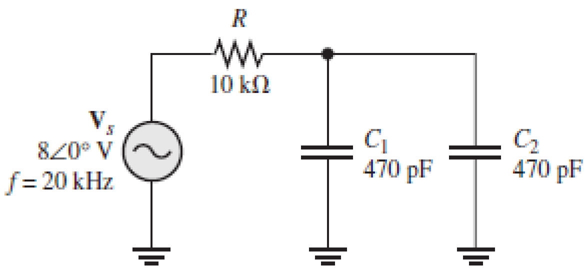
$$Z = \sqrt{(147k)^2 + (-231.54k)^2} < -tan^{-1}\left(\frac{-231.54}{147}\right)$$

$$Z = 274.26 < -57.59°\ k\Omega$$

$$I = \frac{V_S}{Z}$$

$$I = \frac{50 < 0°\ V}{274.26 < -57.59°\ k\Omega}$$

$$I = 182 < 57.59°\ \mu A$$



(b)

$$X_{c1} = \frac{1}{2\pi f C_1}$$

$$X_{c1} = \frac{1}{2\pi(20x10^3)\ 470\,x10^{-12}}$$

$$X_{c1} = 16.93\ k\Omega$$

$$X_{c2} = \frac{1}{2\pi f C_2}$$

$$X_{c2} = \frac{1}{2\pi(20x10^3)\ 470\,x10^{-12}}$$

$$X_{c2} = 16.93\ k\Omega$$

$$Z = R + (-jX_{C1} \,||\, -jX_{C2})$$

$$Z = R + \frac{-jX_{C1}\,(-jX_{C2})}{-jX_{C1}\; - jX_{C2}}$$

$$Z = R + \frac{X_{C1}X_{C2}}{j(X_{C1} + X_{C2})}$$

$$Z = 10\ k - j\frac{16.93\ k(16.93\ k)}{16.93\ k + 16.93\ k}$$

$$Z = (10\ - j8.47)k\Omega$$

$$Z = \sqrt{A^2 + B^2} < -tan^{-1}\left(\frac{B}{A}\right)$$

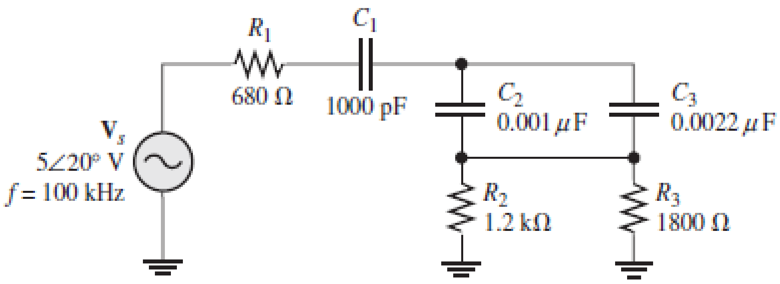
$$Z = \sqrt{(10k)^2 + (-8.47k)^2} < -tan^{-1}\left(\frac{-8.47}{10}\right)$$

$$Z = 13.1 < -40.26°\ k\Omega$$

$$I = \frac{V_S}{Z}$$

$$I = \frac{8 < 0°\ V}{13.1 < -40.26°\ k\Omega}$$

$$I = 610.6 < 40.26°\ \mu A$$



(c)

$$X_{c1} = \frac{1}{2\pi f C_1}$$

$$X_{c1} = \frac{1}{2\pi(100x10^3)\ 1000\ x10^{-12}}$$

$$X_{c1} = 1.59\ k\Omega$$

$$X_{c2} = \frac{1}{2\pi f C_2}$$

$$X_{c2} = \frac{1}{2\pi(100x10^3)\ 0.001\ x10^{-6}}$$

$$X_{c2} = 1.59\ k\Omega$$

$$X_{c3} = \frac{1}{2\pi f C_3}$$

$$X_{c3} = \frac{1}{2\pi(100x10^3)\ 0.0022\ x10^{-6}}$$

$$X_{c3} = 723.4\ \Omega$$

$$Z_1 = (-jX_{C2} \,||\, -jX_{C3})$$

$$Z_1 = \frac{-jX_{C2}\,(-jX_{C3})}{-jX_{C2}\ -jX_{C3}}$$

$$Z_1 = \frac{X_{C2}X_{C3}}{j(X_{C2} + X_{C3})}$$

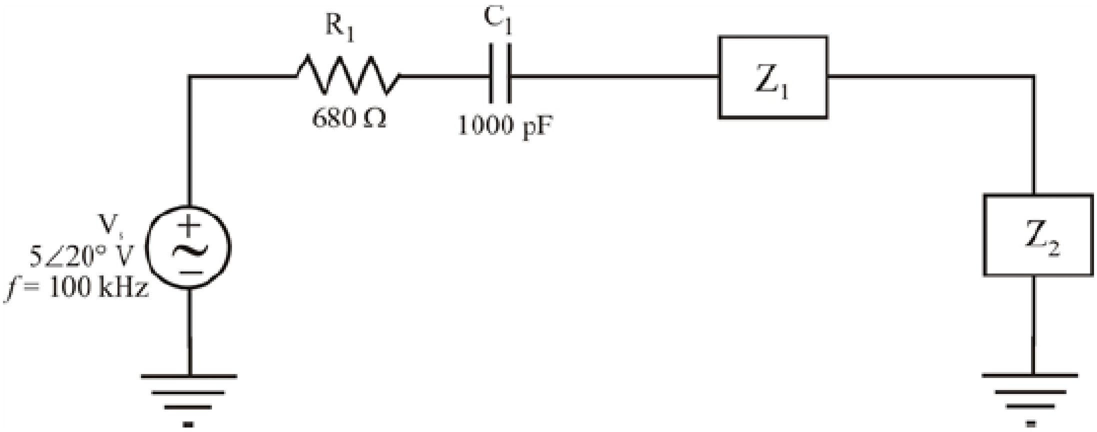
$$Z_1 = \frac{-1150.2k}{-j2313}$$

$$Z_1 = -j497.3\ \Omega$$

$$Z_2 = (R_2\,||R_3)$$

$$Z_2 = \frac{1200(1800)}{1200 + 1800}$$

$$Z_2 = 720\ \Omega$$



$$Z_T = R_1 + (-jX_{C1}) + Z_1 + Z_2$$

$$Z_T = 680 - j1.59k - j497.3 + 720$$

$$Z_T = (1.4 - j2.087)k\Omega$$

$$Z = \sqrt{A^2 + B^2} < -tan^{-1}\left(\frac{B}{A}\right)$$

$$Z = \sqrt{(1.4k)^2 + (-2.087k)^2} < -tan^{-1}\left(\frac{-2.087}{1.4}\right)$$

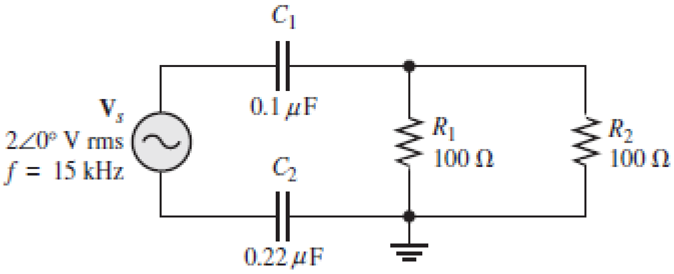
$$Z = 2.51 < -56.15°\ k\Omega$$

$$I = \frac{V_S}{Z}$$

$$I = \frac{5 < 20°\ V}{2.51 < -56.15°\ k\Omega}$$

$$I = 1.99 < 76.15°\ mA$$

30. Para el circuito de la figura 15-87, trace el diagrama fasorial que muestre todos los voltajes y la corriente total. Indique los ángulos de fase.



▲ **FIGURA 15–87**

$$X_{c1} = \frac{1}{2\pi f C_1}$$

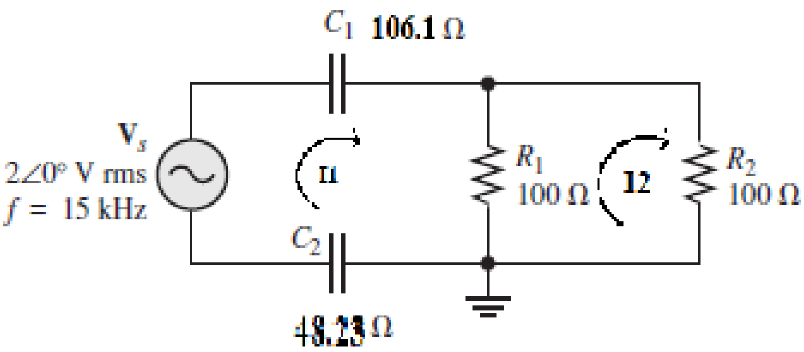
$$X_{c1} = \frac{1}{2\pi(15000)\ 0.1\ x10^{-6}}$$

$$X_{c1} = 106.1\ \Omega$$

$$X_{c2} = \frac{1}{2\pi f C_2}$$

$$X_{c2} = \frac{1}{2\pi(15000)\ 0.22\ x10^{-6}}$$

$$X_{c2} = 48.23\ \Omega$$



LVK:

$$(100 - j154.33)I_1 - 100(I_2) = 2 < 0°$$

$$I_2 = 0.5I_1$$

$$I_1 = \frac{2 < 0°}{50 - j154.33}$$

$$I_1 = 12.33 < 72.05°\ mA$$

$$I_2 = 6.17 < 72.05°\ mA$$

$$V_{C1} = (-jX_{C1})I_1$$

$$V_{C1} = (-j106.1)12.33x10^{-3} < 72.05°$$

$$V_{C1} = 1.308 < -17.95°\ V$$

$$V_{C2} = (-jX_{C2})I_1$$

$$V_{C2} = (-j48.23)12.33x10^{-3} < 72.05°$$

$$V_{C2} = 0.6 < -17.95°\ V$$

$$V_{R1} = R_1(I_1 - I_2)$$

$$V_{R1} = 100(12.33m < 72.05° - 6.17 < 72.05°)$$

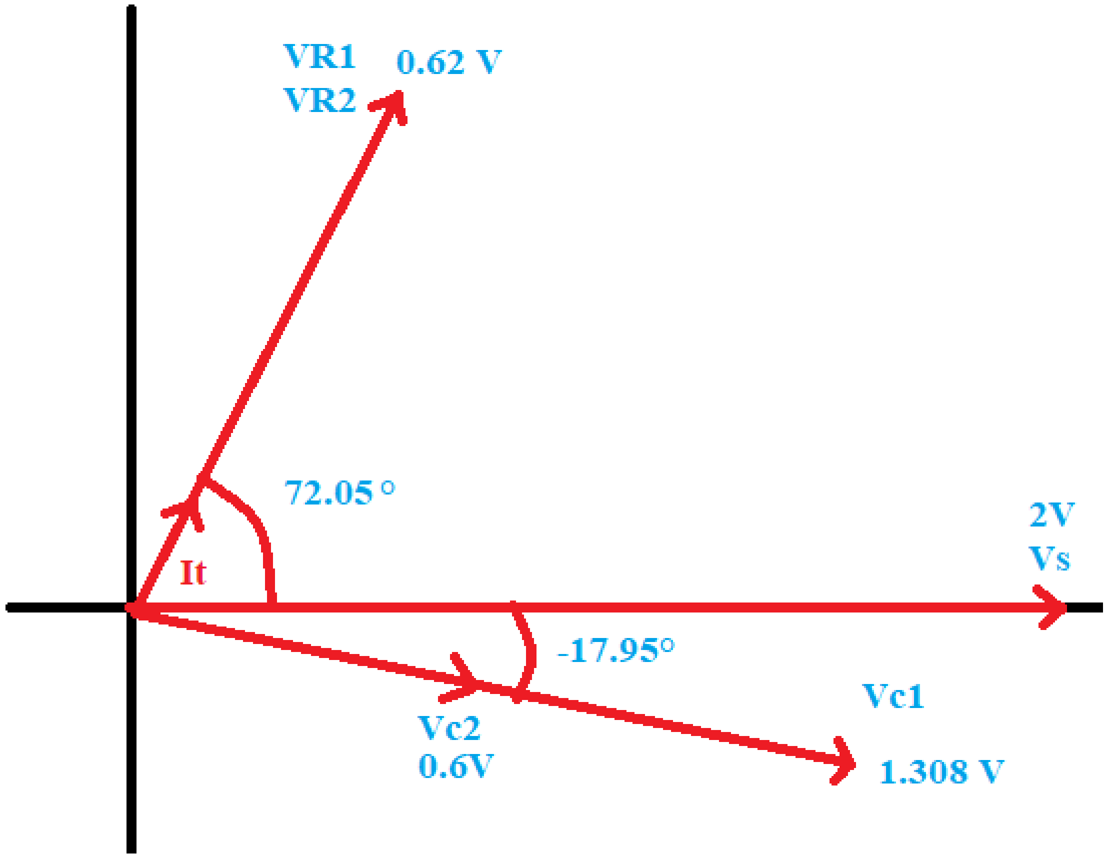
$$V_{R1} = 100(6.16m < 72.05°)$$

$$V_{R1} = 0.62 < 72.05°\ V$$

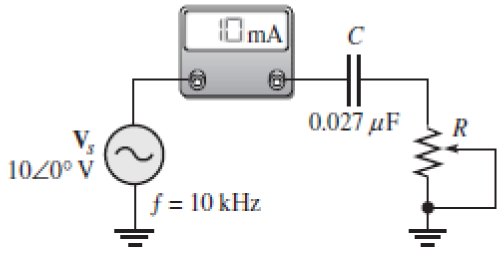
$$V_{R2} = I_2R_2$$

$$V_{R2} = 100((6.16m < 72.05°)$$

$$V_{R2} = 0.62 < 72.05°\ V$$



32. ¿A qué valor se debe ajustar el reóstato de la figura 15-89 para hacer que la corriente total sea de 10 mA? ¿Cuál es el ángulo resultante?



▲ FIGURA 15–89

$$X_c = \frac{1}{2\pi fC}$$

$$X_c = \frac{1}{2\pi(10000)\ 0.0.27\ x10^{-6}}$$

$$X_c = 589.5\ \Omega$$

$$Z = R - jX_c$$

$$Z = R - j589.5$$

$$Z = \sqrt{R^2 + 589.5^2} < tan^{-1}\left(\frac{589.5}{R}\right)$$

$$I = \frac{V}{Z}$$

$$10x10^{-3} = \frac{10}{\sqrt{R^2 + 589.5^2}}$$

$$R^2 + 589.5^2 = 10^6$$

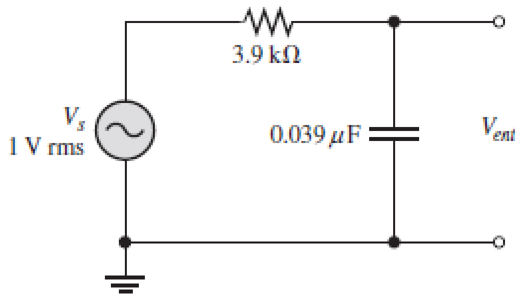
$$R = 807.77\ \Omega$$

$$\Theta = tan^{-1}\left(\frac{589.5}{807.77}\right)$$

$$\Theta = 36.12°$$

34. Para el circuito de retraso de la figura 15-91, determine el desplazamiento de fase entre el voltaje de entrada y el voltaje de salida para cada una de las siguientes frecuencias:

(a) 1 Hz (b) 100 Hz (c) 1 kHz (d) 10 kHz



(a)

$$X_c = \frac{1}{2\pi fC}$$

$$X_c = \frac{1}{2\pi(1)\ 0.039\ x10^{-6}}$$

$$X_c = 4.08\ M\Omega$$

$$V_{out} = \frac{X_c}{\sqrt{(R)^2 + (X_c)^2}} V_S$$

$$V_{out} = \frac{4.08\ M}{\sqrt{(3.9x10^3)^2 + (4.08x10^6)^2}} V_S$$

$$V_{out} = 1Vrms$$

$$\Theta = -tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = -tan^{-1}\left(\frac{3.9k}{4.08M}\right)$$

$$\Theta = -0.055°$$

(b)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(100)\ 0.039\ x10^{-6}}$$

$$X_c = 40.8\ k\Omega$$

$$V_{out} = \frac{X_c}{\sqrt{(R)^2 + (X_c)^2}}\ V_S$$

$$V_{out} = \frac{40.8\ k}{\sqrt{(3.9x10^3)^2 + (40.8x10^3)^2}}\ V_S$$

$$V_{out} = 0.996\ Vrms$$

$$\Theta = -tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = -tan^{-1}\left(\frac{3.9k}{40.8\ k}\right)$$

$$\Theta = -5.46°$$

(c)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(1000)\ 0.039\ x10^{-6}}$$

$$X_c = 4.08\ k\Omega$$

$$V_{out} = \frac{X_c}{\sqrt{(R)^2 + (X_c)^2}}\ V_S$$

$$V_{out} = \frac{4.08\ k}{\sqrt{(3.9x10^3)^2 + (4.08x10^3)^2}}\ V_S$$

$$V_{out} = 0.72\ Vrms$$

$$\Theta = -tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = -tan^{-1}\left(\frac{3.9k}{4.08\ k}\right)$$

$$\Theta = -43.7°$$

(d)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(10000)\ 0.039\ x10^{-6}}$$

$$X_c = 408.2\ \Omega$$

$$V_{out} = \frac{X_c}{\sqrt{(R)^2 + (X_c)^2}}\ V_S$$

$$V_{out} = \frac{408.2}{\sqrt{(3.9x10^3)^2 + (408.2)^2}} V_S$$

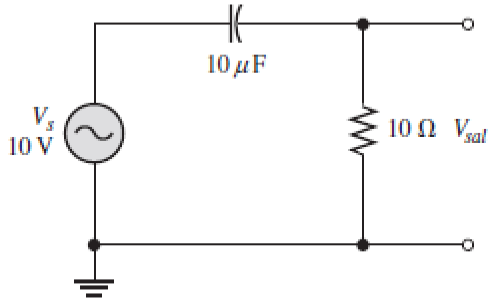
$$V_{out} = 0.12\, Vrms$$

$$\Theta = -tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = -tan^{-1}\left(\frac{3.9k}{408.2\, k}\right)$$

$$\Theta = -84.02°$$

36. Repita el problema 34 para el circuito de adelanto de la figura 15-92.



(a)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(1)\, 10\, x10^{-6}}$$

$$X_c = 15.92\, k\Omega$$

$$V_{out} = \frac{R}{\sqrt{(R)^2 + (X_c)^2}} V_S$$

$$V_{out} = \frac{10}{\sqrt{(10)^2 + (15.92k)^2}}\, 10$$

$$V_{out} = 6.28\, mVrms$$

$$\Theta = -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$\Theta = -tan^{-1}\left(\frac{15.92\, k}{10}\right)$$

$$\Theta = 89.96°$$

(b)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(100)\, 10\, x10^{-6}}$$

$$X_c = 159.2\, \Omega$$

$$V_{out} = \frac{R}{\sqrt{(R)^2 + (X_c)^2}}\, V_S$$

$$V_{out} = \frac{10}{\sqrt{(10)^2 + (159.2)^2}}\, 10$$

$$V_{out} = 0.627\, Vrms$$

$$\Theta = -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$\Theta = -tan^{-1}\left(\frac{159.2}{10}\right)$$

$$\Theta = 86.4°$$

(c)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(1000)\; 10\; x10^{-6}}$$

$$X_c = 15.92\; \Omega$$

$$V_{out} = \frac{R}{\sqrt{(R)^2 + (X_c)^2}}\, V_S$$

$$V_{out} = \frac{10}{\sqrt{(10)^2 + (15.92)^2}}\, V_S$$

$$V_{out} = 5.32\, Vrms$$

$$\Theta = -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$\Theta = -tan^{-1}\left(\frac{15.92}{10}\right)$$

$$\Theta = 57.87°$$

(d)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(10000)\; 10\; x10^{-6}}$$

$$X_c = 1.59\; \Omega$$

$$V_{out} = \frac{R}{\sqrt{(R)^2 + (X_c)^2}}\, V_S$$

$$V_{out} = \frac{10}{\sqrt{(10)^2 + (1.59)^2}}\, V_S$$

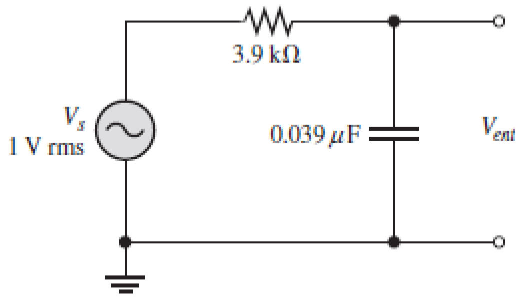
$$V_{out} = 9.87\, Vrms$$

$$\Theta = -tan^{-1}\left(\frac{X_c}{R}\right)$$

$$\Theta = -tan^{-1}\left(\frac{1.59}{10}\right)$$

$$\Theta = 9.034°$$

38. Trace el diagrama fasorial de voltaje para el circuito de la figura 15-91 para una frecuencia de 5 kHz con V_S = V rms.



$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(5000)\ 0.039\ x10^{-6}}$$

$$X_c = 816.17\ \Omega$$

$$V_{out} = \frac{X_c}{\sqrt{(R)^2 + (X_c)^2}}\ V_S$$

$$V_{out} = \frac{816.17}{\sqrt{(3.9x10^3)^2 + (816.17)^2}}$$

$$V_{out} = 0.205\ Vrms$$

$$\Theta = -tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = -tan^{-1}\left(\frac{3.9x10^3}{816.17}\right)$$

$$\Theta = -78.18°$$

$$V_{out} < \Theta = 0.205 < -78.18°\ V$$

$$V_R = \frac{R}{\sqrt{(R)^2 + (X_c)^2}}\ V_S$$

$$V_R = \frac{3.9x10^3}{\sqrt{(3.9x10^3)^2 + (816.17)^2}}$$

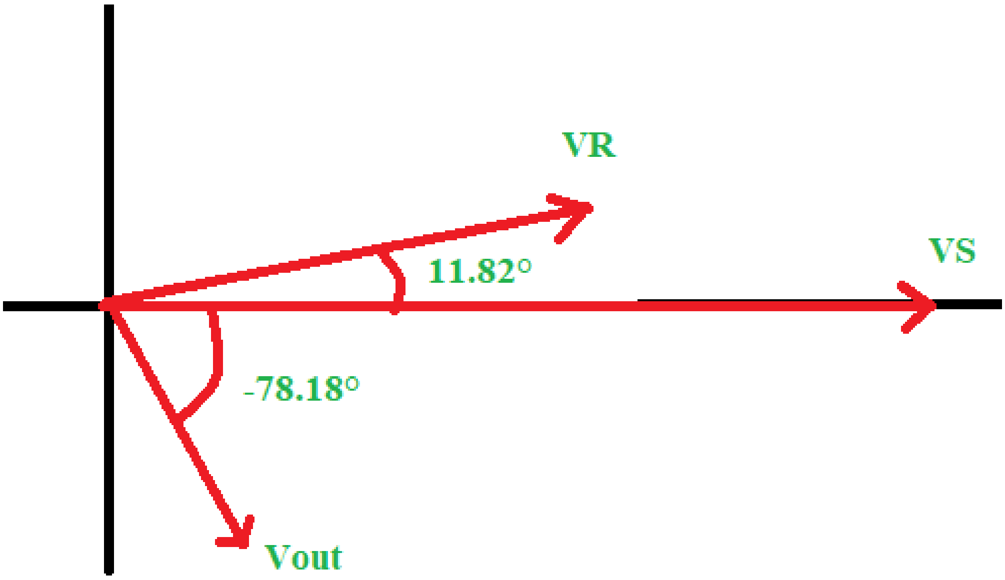
$$V_R = 0.98\ Vrms$$

$$\Theta = tan^{-1}\left(\frac{X_c}{R}\right)$$

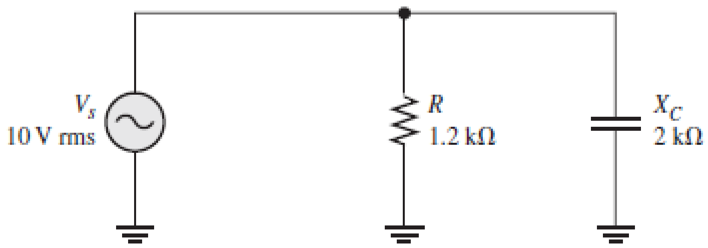
$$\Theta = -tan^{-1}\left(\frac{816.17}{3.9k}\right)$$

$$\Theta = 11.82°$$

$$V_R < \Theta = 0.98 < 11.82°\ V$$



40. Determine la impedancia y exprésela en forma polar para el circuito de la figura 15-93.



▲ FIGURA 15–93

$$Z = \frac{(R < 0°)(X_c < -90°)}{R < 0°) + (X_c < -90°)}$$

$$Z = \frac{(RX_c)(< -90°)}{\sqrt{(R)^2 + (X_c)^2} < -tan^{-1}\left(\frac{X_c}{R}\right)}$$

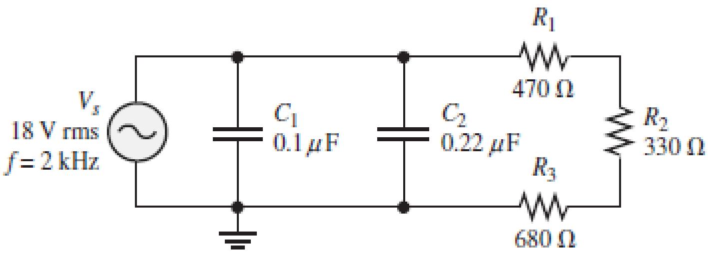
$$Z = \frac{(RX_c)}{\sqrt{(R)^2 + (X_c)^2}} < (-90°+tan^{-1}\left(\frac{X_c}{R}\right)\ )$$

$$Z = \frac{2.4x10^6}{\sqrt{5.44x10^6}} < (-90°+tan^{-1}\left(\frac{2}{1.2}\right)$$

$$Z = 1.03 < -30.96°\ k\Omega$$

42. Repita el problema 41 para las siguientes frecuencias:
(a) 1.5 kHz (b) 3 kHz (c) 5 kHz (d) 10 kHz

41. Determine la magnitud de la impedancia y el ángulo de fase en la figura 15-94.



▲ **FIGURA 15–94**

(a)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = \frac{1}{2\pi(1.5k)\, 0.22\, x10^{-3}}$$

$$X_c = 482.28\ \Omega$$

$$Z = \frac{R\, X_c}{\sqrt{(R)^2 + (X_c)^2}}$$

$$Z = \frac{750\ (482.28)}{\sqrt{(750)^2 + (482.28)^2}}$$

$$Z = 405.64\ \Omega$$

$$\Theta = tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = tan^{-1}\left(\frac{750}{482.28}\right)$$

$$\Theta = 57.25°$$

(b)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = 241.14\ \Omega$$

$$Z = \frac{R\, X_c}{\sqrt{(R)^2 + (X_c)^2}}$$

$$Z = 230\ \Omega$$

$$\Theta = tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = 72.17°$$

(c)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = 144.68\ \Omega$$

$$Z = \frac{R\, X_c}{\sqrt{(R)^2 + (X_c)^2}}$$

$$Z = 142\ \Omega$$

$$\Theta = tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = 79.08°$$

(d)

$$X_c = \frac{1}{2\pi f C}$$

$$X_c = 72.34\ \Omega$$

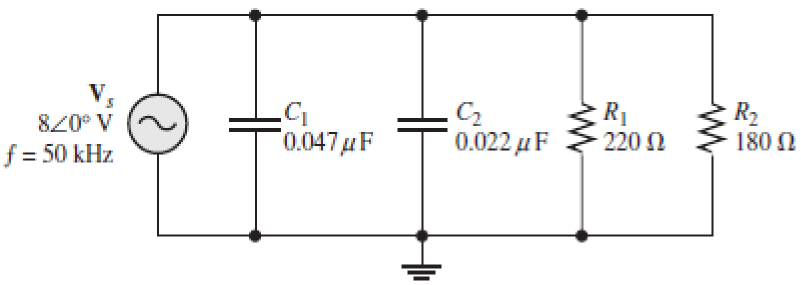
$$Z = \frac{R\ X_c}{\sqrt{(R)^2 + (X_c)^2}}$$

$$Z = 72\ \Omega$$

$$\Theta = tan^{-1}\left(\frac{R}{X_c}\right)$$

$$\Theta = 84.49°$$

44. Para el circuito en paralelo de la figura 15-96, encuentre la magnitud de cada corriente de rama y la corriente total. ¿Cuál es el ángulo de fase entre el voltaje aplicado y la corriente total?



$$X_{c1} = \frac{1}{2\pi f C_1}$$

$$X_c = 67.73\ \Omega$$

$$X_{c2} = \frac{1}{2\pi f C_2}$$

$$X_c = 144.68\ \Omega$$

$$I_{c1} = \frac{V_S}{-jX_{c1}}$$

$$I_{c1} = 118 < 90°\ mA$$

$$I_{c2} = \frac{V_S}{-jX_{c2}}$$

$$I_{c1} = 55 < 90°\ mA$$

$$I_{R1} = \frac{V_S}{R_1}$$

$$I_{R1} = 36.4 < 90°\ mA$$

$$I_{R2} = \frac{V_S}{R_2}$$

$$I_{R1} = 44.4 < 90° \; mA$$

$$I_T = (I_{R1} + I_{R2}) + j(I_{C1} + I_{C2})$$

$$I_T = 190.9 < 64.96° \; mA$$

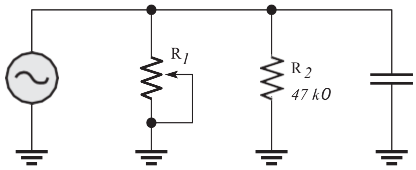
$$\Theta = \Theta_v - \Theta_i$$

$$\Theta = 0° \; - 64.96°$$

$$\Theta = -64.96°$$

***48. Determine el valor al cual R1 debe ser ajustado para obtener un ángulo de fase de 30° entre el voltaje**

de fuente y la corriente total en la figura 15-99.



$$Xc1 = \frac{1}{2\pi(1000\text{Hz})(0.01) * 10 - 6} = -j15.9154k\Omega$$

$$z1 = \frac{1}{\frac{1}{47} - \frac{1}{j15.9154k\Omega}} = 4.83495 - 14.278j$$

$$z2 = \frac{1}{\frac{1}{4.83495 - 14.278j} + \frac{1}{Rl}} =$$

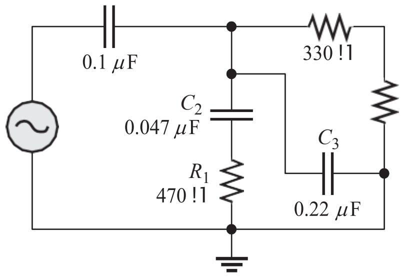
$$\text{IT} = \frac{Vs}{Zeq} = \frac{10 < 0}{\frac{1}{\frac{1}{4.83495 - 14.278j} + \frac{1}{Rl}}} = 0.042815 < 75.1411(A)$$

PARTE 3: CIRCUITOS EN SERIE-PARALELO

SECCIÓN 15–7 Análisis de circuitos RC en serie-paralelo

50. ¿Es el circuito de la figura 15-100 predominantemente resistivo o predominantemente capacitivo?

► FIGURA 15-100



$$\boldsymbol{R1} = \mathbf{330}\Omega + \mathbf{180}\Omega = \mathbf{510}\Omega$$

$$Xc1 = \frac{1}{2\pi(15000\text{Hz})(0.1) * 10 - 6} = -j106.103\Omega$$

$$Xc2 = \frac{1}{2\pi(15000\text{Hz})(0.047) * 10 - 6} = -j225.751\Omega$$

$$Xc3 = \frac{1}{2\pi(15000\text{Hz})(0.22) * 10 - 6} = -j48.228\Omega$$

$$z1 = \frac{1}{\frac{1}{510} - \frac{1}{48.228j}} = 4.5202 - j47.80$$

$$z2 = 470 - j225.751$$

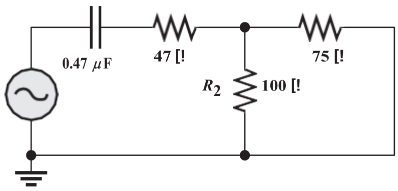
$$z3 = \frac{1}{\frac{1}{4.5202 - j47.80} + \frac{1}{470 - j225.751}} = 7.7078 - 45.051j$$

$$Zeq = 7.7078 - 45.051j - 106.103j = 7.70 - 151.15j$$

Por lo tanto es un circuito RC.

52. Para el circuito de la figura 15-101, determine lo siguiente:

(a) (b) (c) (d) (e) (f)



$$Ra = \frac{1}{\frac{1}{75\Omega} + \frac{1}{100\Omega}} = 42.8471\Omega$$

$$Xc1 = \frac{1}{2\pi(1000\text{Hz})(0.47) * 10 - 6} = -j338.627\Omega$$

$z1 = 47 - j338.627 = 341.8731 < -82.098$

$\text{Zeq} = 42.841\Omega + 47 - j338.627 = 89.8471 - 338.27j = 350.3421 < -75.1411$

$$\text{IT} = \frac{Vs}{Zeq} = \frac{15}{350.3421 < -75.1411} = 0.042815 < 75.1411(A)$$

$Vz1 = \text{I} * \text{Z2} = 0.042815 < 75.1411 * 341.8731 < -82.098 = 14.63 < -6.95(v)$

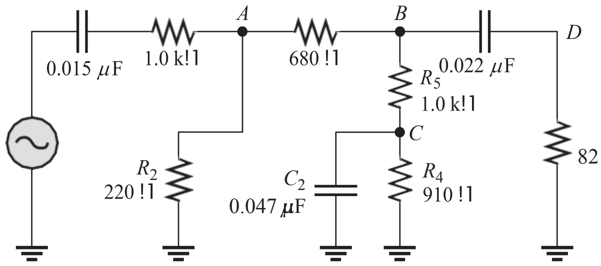
$Vra = \text{I} * \text{Ra} = 0.042815 < 75.1411 * 42.8471\Omega = 1.8344 < 75.1411(v)$

$Vc1 = \text{I} * \text{C1} = 0.042815 < 75.1411 * 338.627 < -90 = 14.498 < -14.85(v)$

$Vr1 = \text{I} * \text{C1} = 0.042815 < 75.1411 * 47 = 2.01 < 75.14$

54. Determine el voltaje y su ángulo de fase en cada punto rotulado en la figura 15-103.

RA 15-103



$$Xc1 = \frac{1}{2\pi(2500\text{Hz})(0.015) * 10 - 6} = -j4244.1318\Omega = -j4.244k\Omega$$

$$Xc2 = \frac{1}{2\pi(2500\text{Hz})(0.047) * 10 - 6} = -j1354.5101\Omega = -j1.3545k\Omega$$

$$Xc3 = \frac{1}{2\pi(2500\text{Hz})(0.022) * 10 - 6} = -j2893.7262\Omega = -j2.8937k\Omega$$

$z4 = 1.0 - 4.244j$

$$z2 = \frac{1}{\frac{1}{0.91} + \frac{1}{-j1.3545}} = 0.626 - 0.4212j$$

$z1 = 0.82 - 2.893j$

$z3 = z2 + 1.0k\Omega = 0.626 - 0.4212j + 1.0 = 1.626 - 0.4212j$

$$z5 = \frac{1}{\frac{1}{1.626 - 0.4212j} + \frac{1}{0.82 - 2.893j}} = 1.0028 - 0.7055j$$

$z6 = z5 + 0.68k\Omega = 1.6828 - 0.7055j$

$$z7 = \frac{1}{\frac{1}{1.6828 - 0.7055j} + \frac{1}{0.22k\Omega}} = 0.1976 - 8.2911j * 10 - 3$$

$zeq = z7 + z4 = 0.1976 - 8.2911j * 10 - 3 + 1.0 - 4.244j = 1.1976 - 4.2522j = 8.775 < -75.497$

$$IT = IA = \frac{10 < 0}{8.775 < -75.497} = 1.1394 < 75.4978\ (ma)$$

$Vz7 = VA = IA * Z7 = 1.1394 < 75.4978 * 0.1977 < -2.4026 = 0.2253 < 73.095\ (v)$

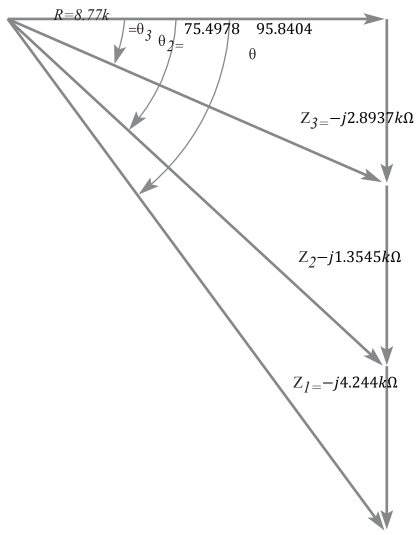
$$Iz6 = \frac{vz7}{z6} = \frac{0.2253 < 73.095}{1.8247 < -22.745} = 0.1234 < 95.8404\ (ma)$$

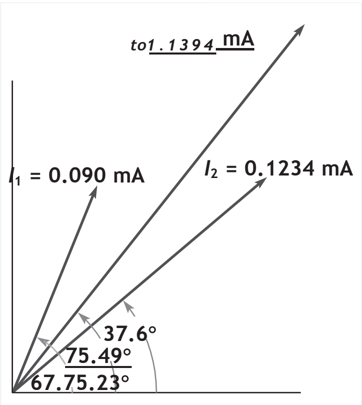
$Vz5 = vB = VD = Iz6 * Z5 = 0.1234 < 95.8404 * 1.2261 < -35.127 = 0.1513 < 60.71\ (v)$

$$Iz3 = \frac{Vz5}{z3} = \frac{0.1513 < 60.71}{1.6796 < -14.522} = 0.090 < 75.2327(ma)$$

$$Vz2 = Vc = Iz3 * Z2 = 0.090 < 75.2327 * 0.7545 < -33.934 = 0.0679 < 41.2983\ (v)$$

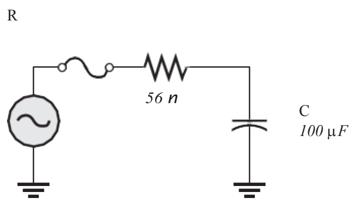
56. Trace el diagrama fasorial de voltaje y corriente para la figura 15-103.





SECCIÓN 15–8 Potencia en circuitos RC

58. En la figura 15-88, ¿cuáles son la potencia real y la potencia reactiva?



$$xc1 = \frac{-j}{\mathbf{2\pi(20Hz)(100) * 10 - 6}} = -j79.577\Omega$$

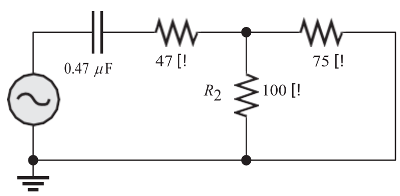
$$z1 = 56 - 79.577j = 137.392 < -35.394$$

$$IT = \frac{V}{Z1} = \frac{10 < 0}{137.392 < -35.394} = 0.0727 < 35.394$$

$Preal = It^2 * R =$(0.0727 < 35.394)^2 $* 56 = 0.2959 < 70.788\ W$

$$Qc = It^2 * xc = (0.0727 < 35.394)^2 * 79.577 < -90 = 0.4205 < -19.212w$$

60. Determine Preal, Pr, Pa, y FP para el circuito de la figura 15-101. Trace el triángulo de potencia.



$$\text{IT} = \frac{Vs}{Zeq} = \frac{15}{350.3421 < -75.1411} = 0.042815 < 75.1411(A)$$

$$Pr = It^2 * R = (0.042815 < 75.1411)^2 * 89.8471 = 0.1647 < 150.28(\ W)$$

$$Qc = It^2 * xc = (0.042815 < 75.1411)^2 * (-338.27) = 0.620 < -29.7178(W)$$

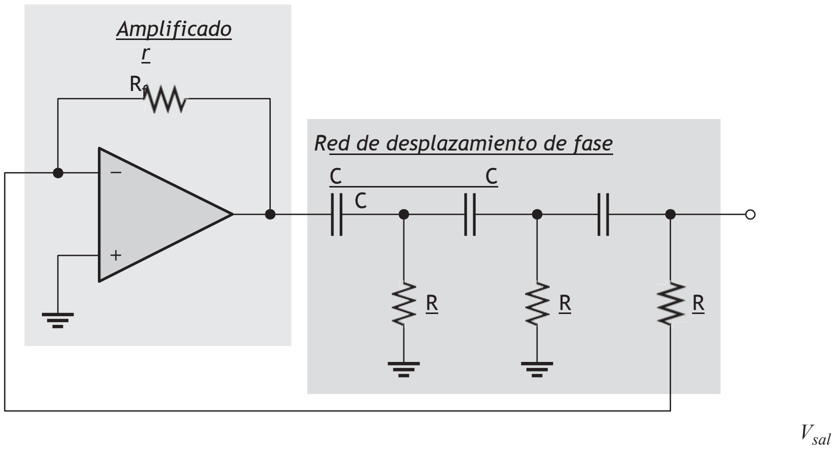
$$Qc = IT * Vt = (0.042815 < 75.1411) * 15v = 0.6422 < 75.1411$$

Fp=cos(75.1411)=0.2564

SECCIÓN 15–9 Aplicaciones básicas

62. Calcule la frecuencia de oscilación para el circuito de la figura 15-62 si todos los capacitores son de

0.0022 mF y todos los resistores de 10 kÆ.

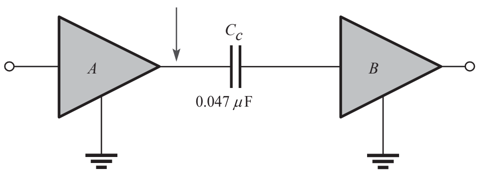


$$fr = \frac{1}{2\pi\sqrt{16} * RC} = \frac{1}{2\pi\sqrt{16} * 10k\Omega * 0.0022uf} = 1.80khz$$

64. El valor rms del voltaje de señal que sale del amplificador A en la figura 15-105 es de 50 mV. Si la resistencia

de entrada al amplificador B es de 10 kÆ, ¿qué tanto de la señal se pierde debido al capacitor

de acoplamiento cuando la frecuencia es de 3 kHz?

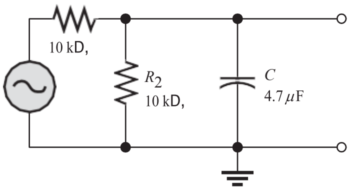


$$fr = \frac{1}{2\pi\sqrt{16} * RC} = \frac{x}{2\pi\sqrt{16} * 10k\Omega * 0.0022uf} = 3khz$$

SECCIÓN 15–10 Localización de fallas

*66. Los capacitores de la figura 15-107 han desarrollado un resistencia de fuga de 2 kÆ. Determine los voltajes

de salida en esta condición para cada circuito.



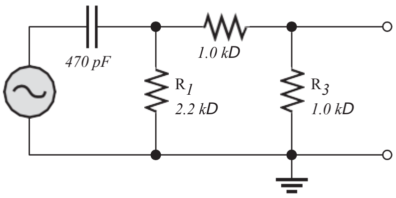
$$xc1 = \frac{-j}{\mathbf{2\pi(10Hz)(4.7) * 10 - 6}} = -j3.38627k\Omega$$

$$z1 = \frac{1}{\frac{1}{-j3.38627k\Omega} + \frac{1}{10k\Omega}} = 1.0287 - 3.0379j = 3.20736 < -71.2925$$

$$Zeq = z1 + 10k = 3.20736 < -71.2925 + 10 = 11.4394 < -15.400$$

$$IT = \frac{V}{Z} = \frac{1 < 0}{11.4394 < -15.400} = 0.08741 < 15.400\ (ma)$$

$$Vsl = I * Z1 = 0.08741 < 15.400\ (ma) * 3.20736 < -71.2925 = 0.2803 < -55.8925(v)$$



$$xc1 = \frac{-j}{\mathbf{2\pi(100Hz)(470) * 10 - 10}} = -j33.8627k\Omega$$

$$Ra = 2.0k\Omega + 2.0k\Omega = 4.0k\Omega$$

$$Rb = \frac{1}{\frac{1}{4.0k\Omega} + \frac{1}{2k\Omega}} = 1.33k\Omega$$

$$z1 = 1.33k\Omega - j33.8627 = 33.88 < -87.750$$

$$IT = \frac{V}{Z1} = \frac{5 < 0}{33.88 < -87.750} = 0.1475 < 87.75(ma)$$

$$Vrb = It * rb = 0.1475 < 87.75(ma) * 1.33k\Omega = 0.1962 < 87.750(v$$

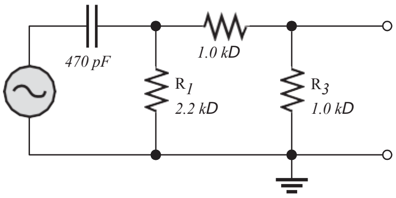
$Ira = \frac{Vrb}{ra} = \frac{0.1962 < 87.750}{4} = 0.0490 < 87.750(ma)$

$Vr1 = Vsl = Ira * r1 = 0.0490 < 87.750 * 2.0k\Omega = 0.098114 < 87.750(v)$

68. Determine el voltaje de salida para el circuito de la figura 15-107(b) para cada uno de los siguientes

modos de falla, y compárelo con la salida correcta:

(a) C abierto (b) C en cortocircuito (c) abierto (d) abierto (e) abierto



A) Nos da ov en la salida ya que no se energiza la fase.

B)

$Ra = 1 + 1 = 2\text{k}\Omega$

$Rb = Req = \frac{1}{\frac{1}{2}+\frac{1}{2.2}} = 1.0476\text{k}\Omega$

$It = \frac{Vt}{Rt} = \frac{5}{1.0476} = 4.7728(ma)$

$I = \frac{V}{R} = \frac{5}{2} = 2.5(ma)$

$$Vsalida = I * 1 = 2.5(v)$$

C)

$xc1 = \frac{-j}{\mathbf{2\pi(100Hz)(470) * 10 - 10}} = -j33.8627k\Omega$

$Zeq = 2 - 33.8627j$

$It = \frac{Vt}{Rt} = \frac{5 < 0}{33.9217 < -86.6199} = 0.1473 < 86.61(ma)$

$Vsalida = I * 1 = 0.1473 < 86.61 * 1 = 0.1473(v)$

D)

Nos da ov en la salida ya que no se energiza la fase.

E)

$$xc1 = \frac{-j}{2\boldsymbol{\pi}(\mathbf{100Hz})(\mathbf{470}) * \mathbf{10-10}} = -j33.8627k\Omega$$

$$Zeq = 3.2 - 33.8627j$$

$$It = \frac{Vt}{zt} = \frac{5 < 0}{3.2 - 33.8627j} = 0.1470 < 84.601(ma)$$

$$Vsl = 5(v)$$