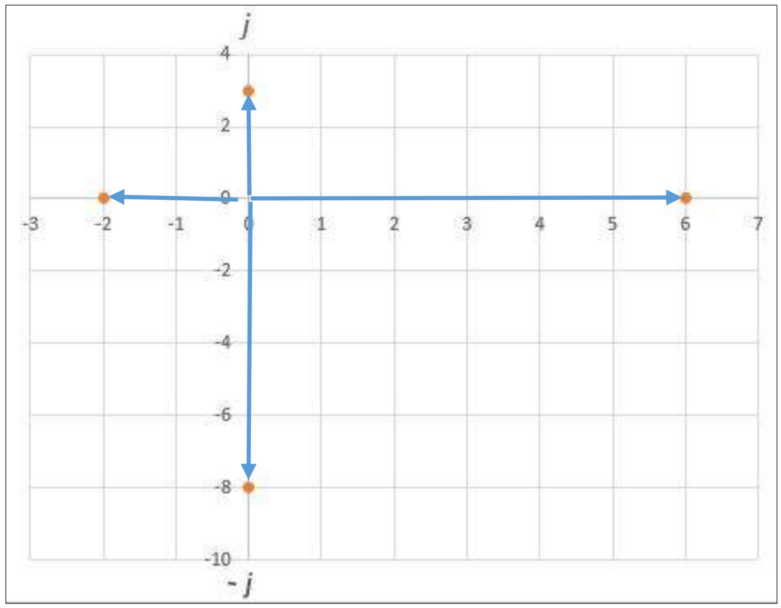
Cálculos del Capítulo N° 15:

Parte 1: CIRCUITOS EN SERIE

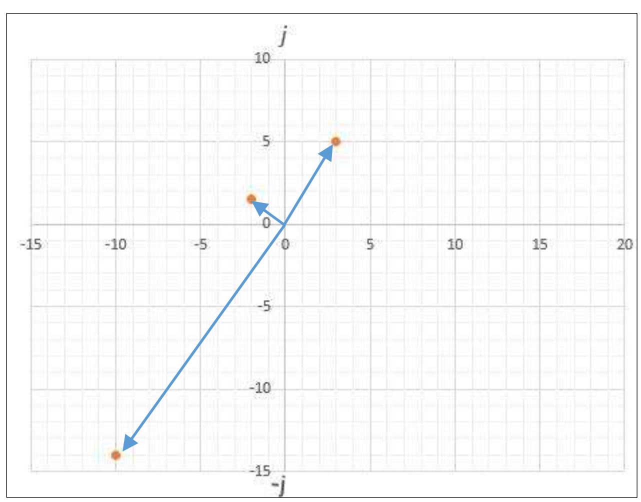
SECCIÓN 15-1 El sistema de los números complejos

2. Localice los siguientes en el plano complejo:
   (a) +6
   (b) -2
   (c) +*j*3
   (d) –*j*8



6. A continuación, se describen puntos localizados en el plano complejo. Exprese cada uno 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.
   (b) 2 unidades a la izquierda del origen sobre el eje real, y 1.5 unidades hacia arriba sobre el eje j.
   (c) 10 unidades a la izquierda del origen sobre el eje real, y 14 unidades hacia abajo sobre el eje –j.

   (a) 3 + *j*5
   (b) -2 +*j*1.5
   (c) -10 - *j*14



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

(a) 40 – *j*40

(b) 50 – *j*200

(c) 35 – *j*20

(d) 98 + *j*45

a. 40 – *j*40

$$c\angle \pm \theta$$
$$c = \sqrt{A^2 + B^2}$$
$$\boldsymbol{A = 40}$$
$$\boldsymbol{B = -40}$$
$$c = \sqrt{(40)^2 + (-40)^2} = 40\sqrt{2} = 56.56$$
$$\theta = \tan^{-1}\left(\frac{\pm B}{A}\right)$$
$$\theta = \tan^{-1}\left(\frac{-40}{40}\right)$$
$$\theta = \tan^{-1}(-1)$$
$$\theta = -45°$$
$$40\sqrt{2}\angle -45°$$

b. 50 – *j*200

$$c\angle \pm \theta$$
$$c = \sqrt{A^2 + B^2}$$
$$\boldsymbol{A = 50}$$
$$\boldsymbol{B = -200}$$
$$c = \sqrt{(50)^2 + (-200)^2} = 50\sqrt{17} = 206.15$$
$$\theta = \tan^{-1}\left(\frac{\pm B}{A}\right)$$
$$\theta = \tan^{-1}\left(\frac{-200}{50}\right)$$
$$\theta = \tan^{-1}(-4)$$
$$\theta = -75.96°$$
$$50\sqrt{17}\angle -75.96°$$

c. 35 – *j*20

$$c\angle \pm \theta$$
$$c = \sqrt{A^2 + B^2}$$
$$\boldsymbol{A = -20}$$
$$\boldsymbol{B = -20}$$
$$c = \sqrt{(35)^2 + (-20)^2} = 5\sqrt{65} = 40.31$$
$$\theta = \tan^{-1}\left(\frac{\pm B}{A}\right)$$
$$\theta = \tan^{-1}\left(\frac{-20}{35}\right)$$

$$\theta = \tan^{-1}\left(\frac{-4}{7}\right)$$
$$\theta = -29.7°$$
$$5\sqrt{65}\angle -29.7°$$

d. 98 + *j*45

$$c\angle \pm \theta$$
$$c = \sqrt{A^2 + B^2}$$
$$\boldsymbol{A = 98}$$
$$\boldsymbol{B = 45}$$
$$c = \sqrt{(98)^2 + (45)^2} = 107.84$$
$$\theta = \tan^{-1}\left(\frac{\pm B}{A}\right)$$
$$\theta = \tan^{-1}\left(\frac{45}{98}\right)$$
$$\theta = 24.7°$$
$$107.84\angle 24.7°$$

10. Exprese cada uno de los siguientes números polares utilizando un ángulo negativo para reemplazar al positivo.
   (a) 10∠ 120°
   (b) 32∠ 85°
   (c) 5∠ 310°

   (a) 10∠ -240
   (b) 32∠ -275°
   (c) 5∠ -50°

12. Identifique el cuadrante en el cual se localiza cada uno de los puntos del problema 10.
   (a) 10∠ 120°
   (b) 32∠ 85°
   (c) 5∠ 310°

   (a) Segundo Cuadrante
   (b) Primer Cuadrante
   (c) Tercer Cuadrante

14. Sume los siguientes conjuntos de números complejos:
   (a) 9 + *j*5 y 5 + *j*8
   (b) 3.5 – *j*4 y 2.2 + *j*6
   (c) -18 + *j*23 y 30 – *j*15
   (d) 12∠45° y 20∠32°
   (e) 38∠75° y 1 + *j*1.8
   (f) 50 – *j*39 y 60∠ -30°

(a) $9 + j5$ y $5 + j8$

$$= (9+5) + j(5+8) = \mathbf{14 + j13}$$

(b) $3.5 - j4$ y $2.2 + j6$

$$= (3.5+2.2) + j(-4+6) = \mathbf{5.7 + j2}$$

(c) $-18 + j23$ y $30 - j15$

$$= (-18+30) + j(23-15) = 22 + j8$$

(d) $12\angle 45°$ y $20\angle 32°$

No se puede sumar números complejos de forma polar, por ende, se transforman de números complejos de forma polar a forma rectangular

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 12\cos 45° = \mathbf{6\sqrt{2}}$$
$$B = 12\,\mathrm{sen}\,45° = \mathbf{6\sqrt{2}}$$
$$A + j\mathrm{B} = \mathbf{6\sqrt{2} + j6\sqrt{2}}$$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 20\cos 32° = \mathbf{17}$$
$$B = 20\,\mathrm{sen}\,32° = \mathbf{10.6}$$
$$A + j\mathrm{B} = \mathbf{17 + j10.6}$$

- $6\sqrt{2} + j6\sqrt{2}$ y $17 + j10.6$

$$= (6\sqrt{2} + 17) + j(6\sqrt{2} + 10.6) = 25.5 + j19$$

(e) $38\angle 75°$ y $1 + j1.8$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 38\cos 75° = \mathbf{9.83}$$
$$B = 38\,\mathrm{sen}\,75° = \mathbf{36.7}$$
$$A + j\mathrm{B} = \mathbf{9.83 + j36.7}$$

- $9.83 + j36.7$ y $1 + j1.8$

$$= (9.83 + 1) + j(36.7 + 1.8) = 10.83 + j38.5$$

(f) $50 - j39$ y $60\angle -30°$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 60\cos 30° = \mathbf{30\sqrt{3}}$$
$$B = 60\,\mathrm{sen}\,30° = \mathbf{30}$$
$$A + j\mathrm{B} = \mathbf{30\sqrt{3} + j30}$$

- $50 - j39\ \ y\ \ 30\sqrt{3} + j30$

$$= \left(50 + 30\sqrt{3}\right) + j(-39 + 30) = 102 - j9$$

16. Multiplique los siguientes números:
    - **(a)** 4.5∠48° y 3.2∠90°
    - **(b)** 120∠ -220° y 95∠200°
    - **(c)** -3∠150° y 4 – *j*3
    - **(d)** 67 + *j*84 y 102∠40°
    - **(e)** 15 – *j*10 y –25 – *j*30
    - **(f)** 0.8 + *j*0.5 y 1.2 – *j*1.5

(a) 4.5∠48° y 3.2∠90°

$$(4.5) * (3.2)\angle(48° + 90°) = 14.4\angle 138°$$

(b) 120∠ -220° y 95∠200°

$$(120) * (95)\angle(-220° + 200°) = 11400\angle - 20°$$

(c) -3∠150° y 4 – *j*3

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = -3\cos 150° = \mathbf{2.6}$$
$$B = -3\,\mathrm{sen}\,150° = -1.5$$
$$A + j\mathrm{B} = \mathbf{2.6 - j1.5}$$

- $2.6 - j1.5\ y\ \ 4 - \ j3$

$$(2.6 - j1.5) * (\ 4 - \ j3) = 10.4 - j7.8 + 4.5 - j6 = 14.9 - j13.8$$

(d) 67 + *j*84 y 102∠40°

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 102\cos 40° = \mathbf{78.13}$$
$$B = 102\,\mathrm{sen}\,40° = \mathbf{65.56}$$
$$A + j\mathrm{B} = \mathbf{78.13 - j65.56}$$

- $67\ +\ j84\ y\ \ 78.13 - j65.56$

$$(67\ +\ j84) * (\ 78.13 - j65.56)$$
$$= 5234.71 - j4392.52 - 5507.04 + j6562.92$$
$$= -272.33 + j2170.4$$

(e) 15 – *j*10 y –25 – *j*30

$$(15 - \ j10) * (-25 - \ j30) = -375 - j450 + 300 + j300 = -75 - j150$$

(f) 0.8 + *j*0.5 y 1.2 – *j*1.5

$$0.8\ \ (+\ j0.5\ ) * (\ 1.2 - \ j1.5) = 0.96 - j1.2 - 0.75 + j0.6 = 0.21 - j0.6$$

18. Realice las siguientes operaciones:
    - **(a)** $\frac{2.5\angle 65° - 1.8\angle -23°}{1.2\angle 37°}$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$

$$A = 2.5\cos 65° = \mathbf{1.05}$$
$$B = 2.5\,\mathrm{sen}\, 65° = \mathbf{2.26}$$
$$A + j\mathrm{B} = \mathbf{1.05 + \mathit{j}2.26}$$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = -18\cos -23° = \mathbf{-16.57}$$
$$B = -18\,\mathrm{sen} -23° = \mathbf{7.03}$$
$$A + j\mathrm{B} = \mathbf{-16.57 + \mathit{j}7.03}$$

- $1.05 + j2.26\ y\ -16.57 + j7.03$

$$= (1.05 - 16.57) + j(2.26 + 7.03) = -15.52 + j9.29$$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 1.2\cos 37° = \mathbf{0.96}$$
$$B = 1.2\,\mathrm{sen}\, 37° = \mathbf{0.72}$$
$$A + j\mathrm{B} = \mathbf{0.96 + \mathit{j}0.72}$$

$$\frac{-16.57 + j7.03}{0.96 + j0.72} = \frac{(-16.57 + j7.03) * (0.96 - j0.72)}{(0.96 + j0.72) * (0.96 - j0.72)}$$
$$= \frac{-15.9 + j18.68 - 5.06}{0.96 - 0.72} = \frac{-15.96 + j18.68}{0.24}$$
$$= 66.5 + j77.83$$

(b) $\frac{(100\angle 15°)(85 - j150)}{25 + j45}$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 100\cos 15° = \mathbf{96.6}$$
$$B = 100\,\mathrm{sen}\, 15° = \mathbf{25.88}$$
$$A + j\mathrm{B} = \mathbf{96.6 + \mathit{j}25.88}$$

- $96.6 + j25.88\ y\ 85\ -\ j150$

$$= (96.6 + 85) + j(25.88 - 150) = 181.6 - j124.12$$

$$\frac{181.6 - j124.12}{25\ +\ j45} = \frac{(181.6 - j124.12) * (25 -\ j45)}{(25\ +\ j45) * (25 -\ j45)} = \frac{4540 - j10548.6 + 5585.4}{25 - 45}$$
$$= \frac{10125.4 - j10548.6}{-20} = -506.27 + j527.43$$

(c) $\frac{(250\angle 90° + 175\angle 75°)(50 - j100)}{(125 + j90)(35\angle 50°)}$

$$A = C\cos\theta$$
$$B = C\,\mathrm{sen}\,\theta$$
$$A = 250\cos 90° = \mathbf{0}$$
$$B = 250\,\mathrm{sen}\, 90° = \mathbf{250}$$
$$A + j\mathrm{B} = \mathbf{0 + \mathit{j}250}$$

$$A = C\cos\theta$$
$$B = C\,\text{sen}\,\theta$$
$$A = 175\cos 75° = \mathbf{45.3}$$
$$B = 175\,\text{sen}\,75° = \mathbf{169.03}$$
$$A + j\text{B} = \mathbf{45.3 + j169.03}$$

- $0 + j250 + 45.3 + j169.03 = 45.3 + j214.33$
- $(45.3 + j214.33) * (50\ -\ j100) = 23598 + j6186.5$

$$A = C\cos\theta$$
$$B = C\,\text{sen}\,\theta$$
$$A = 35\cos 50° = \mathbf{22.5}$$
$$B = 35\,\text{sen}\,50° = \mathbf{26.8}$$
$$A + j\text{B} = \mathbf{22.5 + j26.8}$$

- $(125\ +\ j90) * (22.5 + j26.8) = 5224.5 + j5375$

$$= \frac{23598 + j6186.5}{5224.5 + j5375} = \frac{(23598 + j6186.5) * (5224.5 - j5375)}{(5224.5 - j5375) * (5224.5 - j5375)}$$
$$= \frac{90035313.5 - j94517880.75}{5224.5 - 5375}$$
$$= \frac{90035313.5 - j94517880.75}{-150.5} = -598241.3 + j628025.8$$

(d) $\frac{(1.5)^2(3.8)}{1.1} + j\left(\frac{8}{4} - j\frac{4}{2}\right)$

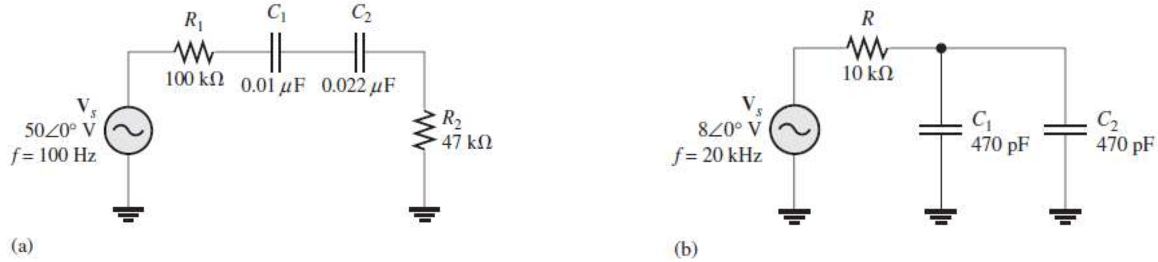
$$7.77 + j2 - 2 = 5.77 + j2$$

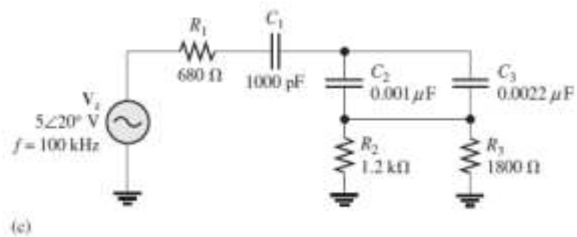
SECCIÓN 15-2 Respuesta sinusoidal de circuitos RC en serie

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

SECCIÓN 15-2 Respuesta sinusoidal de circuitos RC en serie

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





(a) El a

$$x_{C1} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 0.1 * 0.01} = 159.15k\Omega$$
$$x_{C2} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 0.1 * 0.022} = 72.34k\Omega$$
$$Z = R_1 - jx_{C1} - jx_{C2} + R_2$$
$$Z = 100k\Omega - j59.15k\Omega - j72.34k\Omega + 47k\Omega$$
$$Z = \sqrt{R^2 + x^2c} < -\tan\left(\frac{X_c}{R}\right)$$
$$Z = \sqrt{(147)^2 + (231.49)^2} < \tan\left(\frac{231.49}{147}\right)$$
$$Z = 274.22 < -57.58\ k\Omega$$

(b) El b

$$x_{C1} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 20khz * 4.7x10^{-7}\mu F} = 16931.37k\Omega$$
$$x_C = \frac{16931.37}{2} = 8465.68k\Omega$$
$$Z = R_1 - jx_C$$
$$Z = 10k\Omega - j8465.68k\Omega$$
$$Z = \sqrt{R^2 + x^2c} < -\tan\left(\frac{X_c}{R}\right)$$
$$Z = \sqrt{(10)^2 + (8465.68)^2} < \tan\left(\frac{8465.68}{10}\right)$$
$$Z = 8465.68 < -89.93\ k\Omega$$

(c) El c

$$x_{C1} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 100\ kHz * 0.001\mu F} = 1.59k\Omega$$
$$x_{C2} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 100\ kHz * 0.001\mu F} = 1.59k\Omega$$
$$x_{C3} = \frac{1}{2\pi fC} = \frac{1}{2\pi * 100\ kHz * 0.0022\mu F} = 0.72k\Omega$$
$$Z = R_1 - jx_{C1} - j\ x_{C2} \| x_{C2} + R_2 \| R_3$$
$$Z = 0.68k\Omega - j1.59k\Omega - j\frac{(1.59) * (0.72)}{1.59 + 0.72}k\Omega + \frac{(1.2)(1.8)}{1.2 + 1.8}k\Omega = 1.4k\Omega - j2.05k\Omega$$
$$Z = \sqrt{R^2 + x^2c} < -\tan\left(\frac{X_c}{R}\right)$$
$$Z = \sqrt{(1.4)^2 + (2.05)^2} < \tan\left(\frac{2.05}{1.4}\right)$$

$$Z = 2.48 < -55.56\ k\Omega$$

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

$$x_{C1} = \frac{1}{2\pi fC} = Ractancia\ v(k\Omega)$$

a) $\frac{1}{2\pi*100*0.0047} = 338.62k\Omega$

$$z = 56 - j338.62$$

b) $\frac{1}{2\pi*500*0.0047} = 67.72k\Omega$

$$z = 56 - j67.72$$

c) $\frac{1}{2\pi*1000*0.0047} = 33.862k\Omega$

$$z = 56 - j338.6267.72$$

d) $\frac{1}{2\pi*2500*0.0047} = 13.54k\Omega$

$$z = 56 - j67.72$$

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

A)

$$C = \frac{1}{\frac{1}{0.01}+\frac{1}{0.022}} = 0.006875\ uF$$

$$Xc = \frac{1}{2\pi*100Hz*0.006875\text{uF}} = 231.49\text{K}\Omega$$

$$Z = \sqrt{(100K\Omega)^2 + (231{,}49)^2} < -\tan^{-1}\left(\frac{231{,}49\text{K}\Omega}{100\text{K}\Omega}\right)$$

$$Z = 252.17 < -74{,}04\text{K}\Omega$$

$$I = \frac{V}{Z} = \frac{50 < 0°V}{252.17 < -74.04\text{K}\Omega} = 0.20 < 74{,}04mA$$

B)

$$Z = \sqrt{(1K\Omega)^2 + (0.68)^2} < -\tan^{-1}\left(\frac{1\text{K}\Omega}{0.68\text{K}\Omega}\right)$$

$$Z = 1.20 < -61.98\text{K}\Omega$$

$$I = \frac{V}{Z} = \frac{5<0°V}{1.20<-61.98\text{K}\Omega} = 4.17 < 61{,}98mA$$

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

A)

$$C = \frac{1}{\frac{1}{0{,}01} + \frac{1}{0{,}022}} = 0{,}006875\mu f$$

$$R_{fq} = 100\text{K}\Omega + 47\text{K}\Omega = 147\text{K}\Omega$$

$$X_c = \frac{1}{2\pi(100Hz)(0{,}006875\mu f)} = 231{,}49\text{K}\Omega$$

$$Z = \sqrt{(147\text{K}\Omega)^2 + (231{,}49)^2} < -\tan^{-1}\left(\frac{231{,}49\text{K}\Omega}{147\text{K}\Omega}\right)$$

$$Z = 247{,}22 < -63{,}98\text{K}\Omega$$

$$I = \frac{V}{Z} = \frac{50 < 0°V}{274{,}22 < -63{,}98\text{K}\Omega} = 0.188 < 63{,}98mA$$

B)

$$C_{eq} = 0{,}00047\mu f + 0{,}00047\mu f$$

$$C_{eq} = 0{,}00094\mu f$$

$$X_c = \frac{1}{2\pi(20\text{K}Hz)(0{,}00094\mu f)} = 8{,}46\text{K}\Omega$$

$$Z = \sqrt{(10\text{K}\Omega)^2 + (8{,}46\text{K}\Omega)^2} < -\tan^{-1}\left(\frac{8{,}46\text{K}\Omega}{10\text{K}\Omega}\right)$$

$$Z = 13{,}098 < -44{,}70°\text{K}\Omega$$

$$I = \frac{V}{Z} = \frac{8 < 0°V}{13{,}098 < -44{,}70°\text{K}\Omega} = 0{,}61 < 44{,}70°mA$$

c)

$$C_{eq1} = 0{,}001\mu f + 0{,}0022\mu f = 0{,}0032\mu f$$

$$C_{eq2} = \frac{1}{\frac{1}{0{,}0032} + \frac{1}{0{,}001}} = 0{,}000762\mu f$$

$$R_{eq1} = \frac{1}{\frac{1}{1{,}2} + \frac{1}{1{,}6}} = 0{,}72\text{K}\Omega$$

$$R_{eq2} = 0{,}72 + 0{,}66 = 1{,}4\text{K}\Omega$$

$$X_c = \frac{1}{2\pi(100\text{K}Hz)(0{,}000762\mu f)} = 2{,}08\text{K}\Omega$$

$$Z = \sqrt{(1{,}4\text{K}\Omega)^2 + (2{,}08\text{K}\Omega)^2} < -\tan^{-1}\left(\frac{2{,}08\text{K}\Omega}{1{,}4\text{K}\Omega}\right)$$

$$Z = 2{,}50 < -62{,}28°$$
$$I = \frac{V}{Z} = \frac{5 < 20°}{2{,}50 < -62{,}28°} = 2 < 82{,}28° mA$$

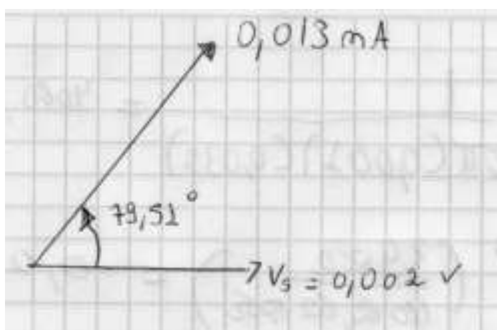
30. Para el circuito de la figura 15-87, trace el diagrama fasorial que muestre todos los voltajes y la corriente total. Indique los ángulos de fase.

$$R_{eq1} = \frac{1}{0.1 + 0.1} = 0{,}05\text{K}\Omega$$

$$X_c = \frac{1}{2\pi(15\text{K}Hz)(0{,}068\mu f)} = 0.15\text{K}\Omega$$

$$Z = \sqrt{(0.05\text{K}\Omega)^2 + (0.15\text{K}\Omega)^2} < -\tan^{-1}\left(\frac{0.15\text{K}\Omega}{0.05\text{K}\Omega}\right)$$

$$Z = 0.15 < -79.51°$$
$$I = \frac{V}{Z} = \frac{0.002 < 20°}{0.15 < -79.51°} = 0.013 < 79{,}51° mA$$



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?

$$\text{Z} = \frac{\text{V}}{\text{I}} = \frac{10}{10} = 1 \qquad X_c = \frac{1}{2\pi(10)(0{,}027)} = 0.58\text{K}\Omega$$

$$Z = \sqrt{(R\text{K}\Omega)^2 + (Xc\text{K}\Omega)^2}$$

$$1 - Xc^2 = R^2$$

$$R^2 = 1 - 0.58^2$$

$$R = 0.81K\Omega$$

$$\theta = -\tan^{-1}\left(\frac{0.58\text{K}\Omega}{0.81K\Omega}\right)$$

Ɵ= -39.56=39.56

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)

$$X_c = \frac{1}{2\pi(0{,}001)(0{,}039)} = 4060{,}62\text{K}\Omega$$
$$\phi = -\tan^{-1}\left(\frac{39\text{K}\Omega}{4060{,}62}\right) = -0{,}06°$$

B)

$$X_c = 40{,}60\text{K}\Omega$$

$$\phi = -6.066°$$

C)

$$X_c = 4{,}08\text{K}\Omega$$

$$\phi = -48{,}56°$$

D)

$$X_c = 0{,}40\text{K}\Omega$$

$$\phi = -93{,}49$$

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

A)

$$X_c = \frac{1}{2\pi(0{,}001)(10)} = 15.91\text{K}\Omega$$
$$\phi = -\tan^{-1}\left(\frac{15.91\text{K}\Omega}{0.01K\Omega}\right) = -99.85°$$

B)

$$X_c = 0.15\text{K}\Omega$$

$$\phi = -95.78°$$

C)

$$X_c = 0.0159\text{K}\Omega$$

$\phi = -64.26°$

D)

$X_c = 0{,}0015\text{K}\Omega$

$\phi = -9.47$

38. Trace el diagrama fasorial de voltaje para el circuito de la figura 15-91 para una frecuencia de 5 kHz con Vs 1 V rms.

F=5KHz

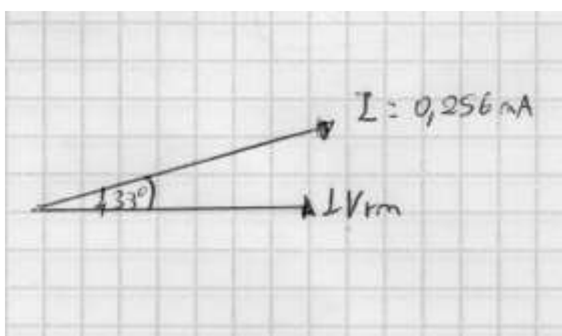
Vs=1Vrms

$$X_c = \frac{1}{2\pi(5KHz)(0{,}39\mu f)} = 0.0816\text{K}\Omega$$

$$Z = \sqrt{(3.9\text{K}\Omega)^2 + (0.0816\text{K}\Omega)^2} < -\tan^{-1}\left(\frac{0.0816\text{K}\Omega}{3.9\text{K}\Omega}\right)$$

$$Z = 3.90 < -1.33°$$

$$I = \frac{V}{Z} = \frac{1 < 0°}{3.9 < -1.33°} = 0.256 < 1{,}33°mA$$



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

$$Z = \frac{(1{,}2 < 0°)(2\text{K}\Omega < 0°)}{\sqrt{(1{,}2)^2 + (2)^2}} < -\tan^{-1}\left(\frac{1{,}2}{2}\right)$$

$$Z = \frac{2{,}4}{2{,}33} < -\tan^{-1}\left(\frac{3}{5}\right)$$

$$Z = 1{,}03 < -34{,}40°$$

42. Repita el problema 41 para las siguientes frecuencias:

$\text{Ceq} = 0.32\ \text{uF}$

$Req = 1.48K\Omega$

A)

$Xc = \frac{1}{2\pi * 1.5 * 0.032\text{uF}} = 0.33\text{K}\Omega$

$Z = \frac{0.488}{1.51} < -\tan^{-1}\left(\frac{1.48\text{K}\Omega}{0.33\text{K}\Omega}\right)$

$Z = 0.323 < -86{,}03\text{K}\Omega$

B)

$Xc = \frac{1}{2\pi * 3 * 0.032\text{uF}} = 0.16\text{K}\Omega$

$Z = \frac{0.236}{1.48} < -\tan^{-1}\left(\frac{1.48\text{K}\Omega}{0.16\text{K}\Omega}\right)$

$Z = 0.16 < -93{,}14\text{K}\Omega$

C)

$Xc = \frac{1}{2\pi * 5 * 0.032\text{uF}} = 0.099\text{K}\Omega$

$Z = \frac{0.146}{1.483} < -\tan^{-1}\left(\frac{1.48\text{K}\Omega}{0.99\text{K}\Omega}\right)$

$Z = 0.098 < -62{,}46\text{K}\Omega$

D)

$Xc = \frac{1}{2\pi * 10 * 0.032\text{uF}} = 0.049\text{K}\Omega$

$Z = \frac{0.072}{1.480} < -\tan^{-1}\left(\frac{1.48\text{K}\Omega}{0.049\text{K}\Omega}\right)$

$Z = 0.048 < -79{,}64\text{K}\Omega$

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?

$IR1 = \frac{Vs}{R1} = \frac{8V}{0.22uF} = 36.36mA$

$IR2 = \frac{Vs}{R2} = \frac{8V}{0.18uF} = 44.44mA$

$Ic1, c2 = I\ tot\ ; Req = 0.4K\Omega\ ; Ceq = 0.00103uf$

$G = \frac{I}{R} = \frac{1}{0.4} = 2.5$

$$Xc = \frac{1}{2\pi * 50 * 0.00103\text{uF}} = 3.09\text{K}\Omega$$

$$Bc = \frac{1}{Xc} = \frac{1}{3.09}$$

$$Y = \sqrt{2.5^2 + \frac{1}{3.09^2}} < \tan^{-1}(\frac{1}{7.72})$$

$$Y = 2.52 < 8.20us$$

$$I = V * Y = (8 < 0)(2.52 < 8.20)$$

$$Itot = 20.16 < 8.20mA$$

46. Repita el problema 45 con R 5.6 kÆ, C1 0.047 mF, C2 0.022 mF, y f 500 Hz.

$$C_{eq} = C1 \parallel C2 = 0{,}069\mu f$$

$$X_c = \frac{1}{2\pi(0{,}5)(0{,}069)} = 4{,}61\text{K}\Omega$$

$$Z = \frac{25{,}81}{7{,}25} = 3{,}55\text{K}\Omega < -\tan^{-1}\left(\frac{5{,}6}{4{,}61}\right)$$

$$I_r = \frac{V_s}{R} = \frac{100}{5{,}6} = 17{,}85mA$$

$$I_c = \frac{V_s}{X_c} = \frac{100}{4{,}61} = 21{,}69mA$$

$$Z = \frac{1}{y} \quad Y = \frac{1}{z} \quad Y = \frac{1}{3{,}55 < -56{,}15°}$$

$$I_{tot} = V_o y = (100 < 0°)\left(\frac{1}{3{,}55 < -56{,}15}\right) = 28{,}16 < 56{,}15°mA$$

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.

Para ángulos

$$I = V * Y$$

$$30 = 0 + \theta y$$

1. $\theta y = 30$

2. $\theta y = Tan^{-1}\frac{Bc}{G}$

$$1\ y\ 2$$

3. $Tan^{-1}\ \frac{Bc}{G} = 30$

$\frac{Bc}{G} = x; \quad Tan^{-1}(x) = 30$

$x = Tan(30) = 0.5$

$$4. \quad G = \frac{1}{Req} = \frac{1}{\frac{1}{R1}+\frac{1}{47}} = \frac{47+R1}{47R1}$$

$$5. \quad X_c = \frac{1}{2\pi(1)(0{,}01)} = 15{,}91\text{K}\Omega; \quad \text{Bc} = \frac{1}{15.91}$$

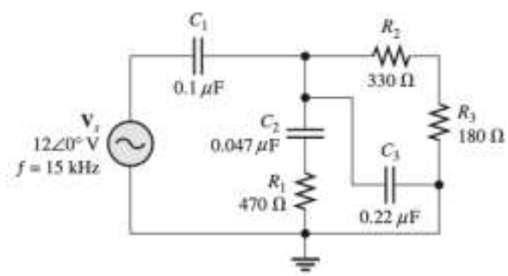
$\frac{Bc}{G} = \frac{47R1}{747.77+15.91R1} = 0.50$

$4700\text{R1} = 37388.5 + 795.5\text{R1}$

$3904.5R1 = 37388.5$

$R1 = 9.57K\Omega$

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



$$R1 = 330\Omega + 180\Omega = 510\Omega$$

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

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

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

$$Z1 = \frac{1}{\frac{1}{510} - \frac{1}{48.228j}} = 4.5202 - j47.80$$

$$Z2 = 470 - j225.751$$

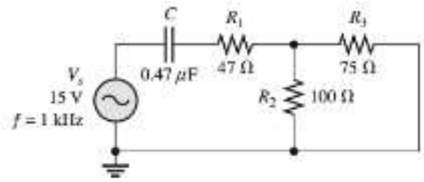
$$Z3 = \frac{1}{\frac{1}{4.5202 - j47.80} + \frac{1}{470 - j225.751}} = 7.7078 - 45.051j$$

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

- Por lo tanto decimos que es un circuito RC

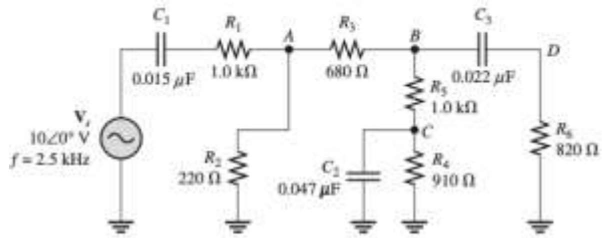
52. Para el circuito de la figura 15-101, determine lo siguiente:

(a) $\mathbf{I}_{tot}$ **(b)** θ **(c)** $\mathbf{V}_{R1}$ **(d)** $\mathbf{V}_{R2}$ **(e)** $\mathbf{V}_{R3}$ **(f)** $\mathbf{V}_{C}$



▲ FIGURA 15–101

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



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

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

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

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

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

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

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

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

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

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

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

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

$$z4 = 1.0 - 4.244j$$

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

$$z1 = 0.82 - 2.893j$$

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

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

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

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

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

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

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

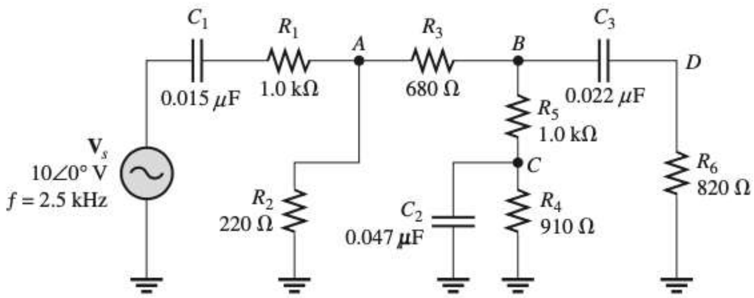
$$Iz6 = \frac{vz7}{z6} = \frac{0.2253 < 73.095}{1.8247 < -22.745} = 0.1234 < 95.8404\ (ma)$$

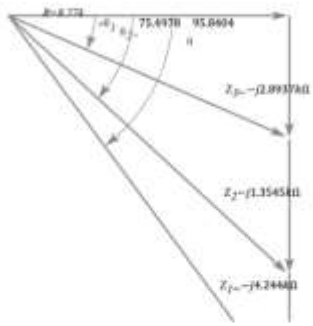
$$Vz5 = vB = VD = Iz6 * Z5 = 0.1234 < 95.8404 * 1.2261 < -35.127 = 0.1513 < 60.71\ (v)$$

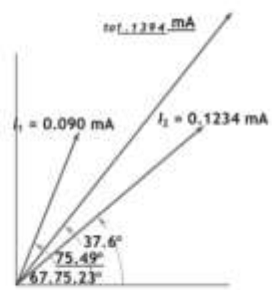
$$Iz3 = \frac{Vz5}{z3} = \frac{0.1513 < 60.71}{1.6796 < -14.522} = 0.090 < 75.2327(ma)$$

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

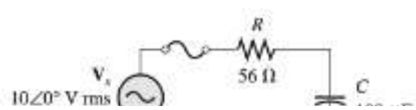
***56.** Trace el diagrama fasorial de voltaje y corriente para la figura 15-103.







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



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

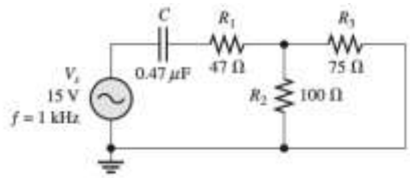
$$z1 = 56 - 79.577j = 137.392 < -35.394$$

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

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

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

60. Determine P_{real}, P_r, P_a, y FP para el circuito de la figura 15-101. Trace el triángulo de potencia.



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

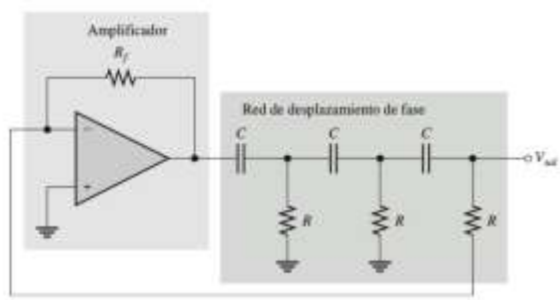
$$Pr = It^2 * R = (0.042815 < 75.1411)^2 * 89.8471 = 0.1647 < 150.28(W)$$

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

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

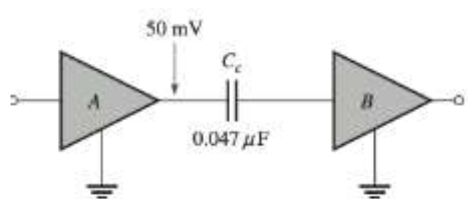
Fp=cos(75.1411)=0.2564

62. Calcule la frecuencia de oscilación para el circuito de la figura 15-62 si todos los capacitores son de 0.0022 μF y todos los resistores de 10 kΩ.



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

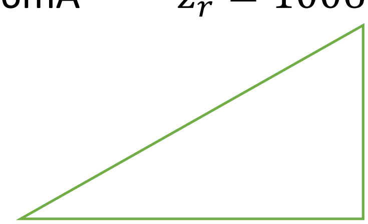
64. El valor rms del voltaje de señal que sale del amplificador *A* en la figura 15-105 es de 50 mV. Si la resistencia de entrada al amplificador *B* es de 10 kΩ, ¿qué tanto de la señal se pierde debido al capacitor de acoplamiento cuando la frecuencia es de 3 kHz?



$$x_c = 1128.75\Omega \qquad z_r = \sqrt{10k^2 + 1128^2}$$

$$I = \frac{v}{z_r} \qquad I = \frac{50mV}{1063\Omega} \qquad I = 4.96\text{mA} \qquad z_r = 10063\Omega$$

$$P = VI \quad P = 0.241\mu w$$



$\Theta = tan^{-1}\left(\frac{1128.75}{10000}\right)$ $\Theta = 6.44^{\circ}$ 0.241μw

$I = \frac{v}{z_T} = 5\mu A$ 6.44° 0.24μw

$P = VI = 2{,}5 * 10^{-8}w$ 0.24μw

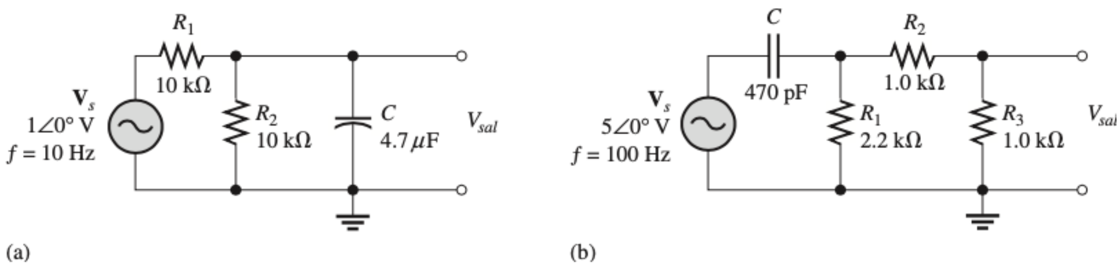
$cos\,\theta = \frac{0{,}24}{P}$

$F_c = \frac{0.24}{0.241}$

=0.99

Se pierde la señal del 0.1%

***66.** Los capacitores de la figura 15-107 han desarrollado un resistencia de fuga de 2 kΩ. Determine los voltajes de salida en esta condición para cada circuito.



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

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

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

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

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

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

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

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

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

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

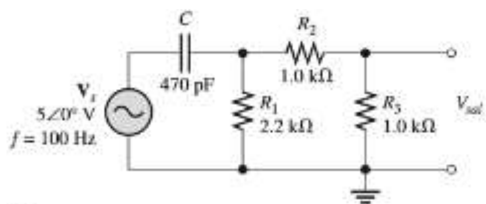
$$Vrb = It * rb = 0.1475 < 87.75(ma) * 1.33k\Omega = 0.1962 < 87.750(v$$

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

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

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)** R_1 abierto **(d)** R_2 abierto **(e)** R_3 abierto



(b)

a) Nos da OV en la salida ya que no se energiza la fase.

b)

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

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

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

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

c)

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

$$Zeq = 2 - 33.8627j$$

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

d)

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

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

e)

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

$$Zeq = 3.2 - 33.8627j$$

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

$$Vsl = 5(v)$$