18) Perform the following operations

a) $\frac{2.5\angle 65^\circ - 1.8\angle -23^\circ}{1.2\angle 37^\circ} = 2.524\angle 69.43$

b) $\frac{(100\angle 15^\circ)(85 - j150)}{25 + j75} = 338.917\angle -106.406^\circ$

c) $\frac{(250\angle 90^\circ + 175\angle 15^\circ)(50 - 100j)}{(125 + 90j)(35\angle 50^\circ)}$

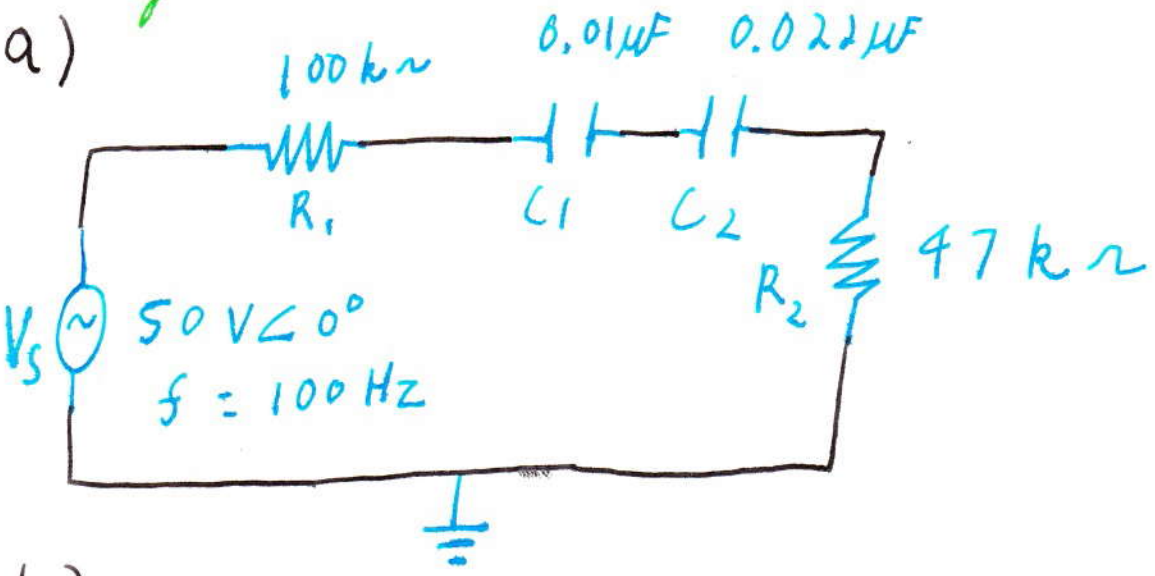
d) $\frac{(1.5)^2(3.8)}{1.1} + j\left(\frac{6}{4}\right)\frac{t}{2}$

c) $8.740\angle -65.357^\circ$

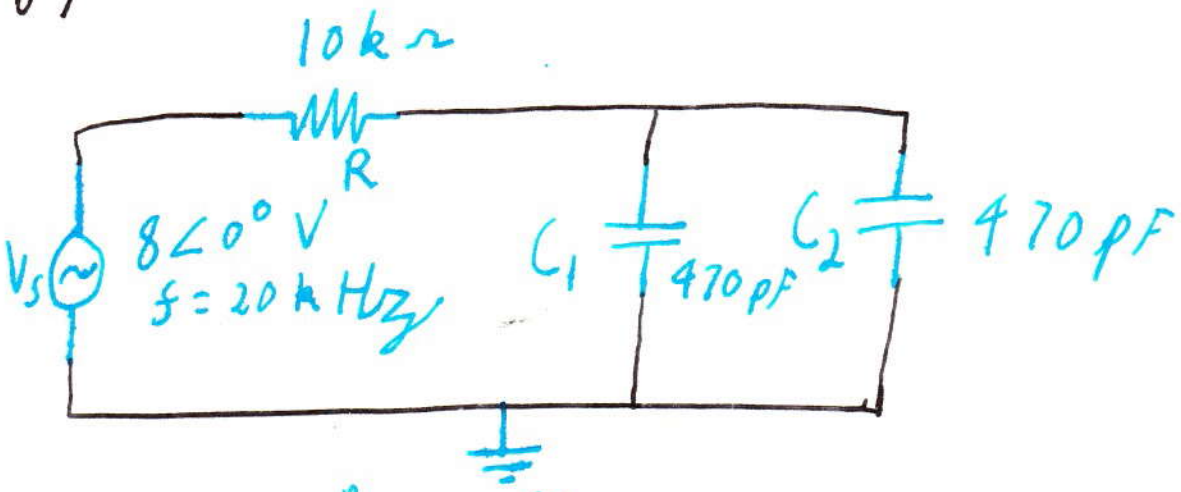
d) $9.975\angle 11.565^\circ$

22) Determine the impedance magnitude and phase angle in each circuit in Figure 15-86.

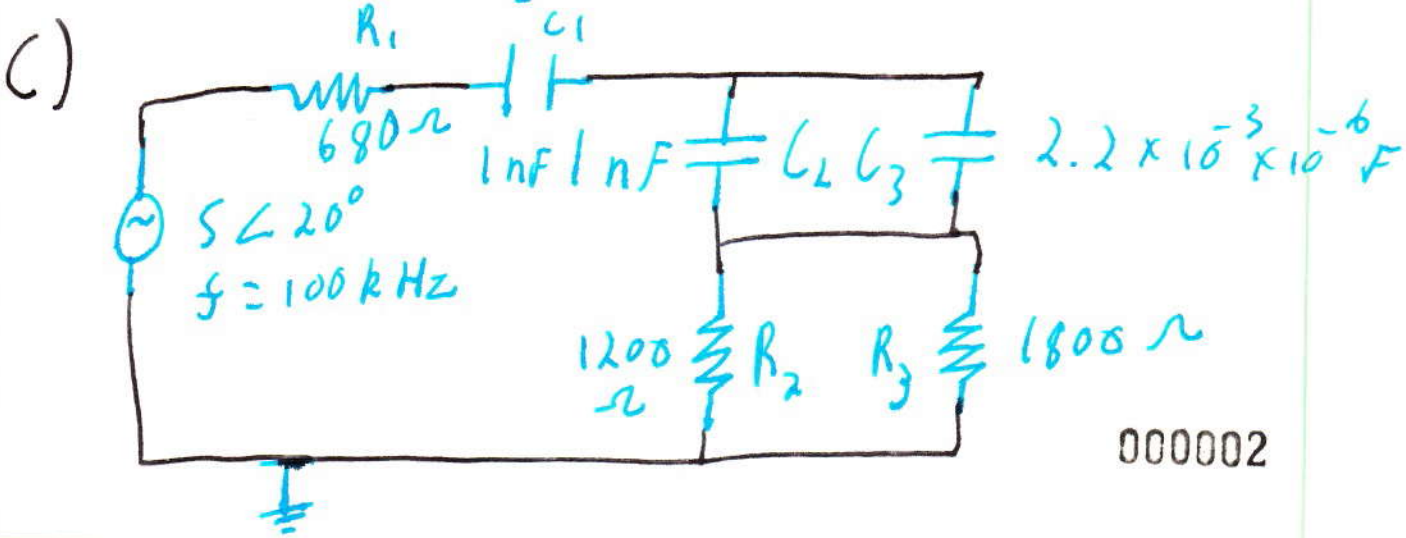
a)



b)



c)



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a)

$$C_{total} = \frac{(10^{-8})(2.2\times10^{-8})}{(10^{-8})+(2.2\times10^{-8})}$$

$$C_{total} = \frac{2.2\times10^{-16}}{3.2\times10^{-8}} = 6.875\times10^{-9}F$$

$$R_{total} = 100\times10^{3} + 47\times10^{3}$$

$$R_{total} = 147\times10^{3}\ \Omega$$

$$X_C = \frac{1}{2\pi fC} \qquad X_C = \frac{1}{2\pi(100)(6.875\times10^{-9})}$$

$$X_C = 2.314981\times10^{5}$$

$$Z_T = 147\times10^{3}\ \Omega - 2.31498\times10^{5}\ j$$

$$Z_T = 274.144\ k\Omega \angle -57.584$$

b)

$$(470 + 470)\,pF = C_T$$

$$C_T = 940\,pF$$

$$\frac{-1j}{2\pi f C_T} = X_C = \frac{-j}{2\pi(20\times10^3)(940\times10^{-12})}$$

$$X_C = -8.4656\times10^3 j$$

$$Z_T = 10\times10^3 - 8.4656\times10^3 j$$

$$\boxed{Z_T = 13.102\times10^3\,\Omega\angle -40.249^\circ}$$

$$\text{ó} \quad \boxed{Z_T = 13.102\,k\Omega\angle -40.249^\circ}$$

000004

C)

$C_{2113} = 10^{-9} + 2.2 \times 10^{9}$

$C_{2113} = 10^{-9} \times 3.2$

$R_{2113} = \frac{1200 \times 1800}{1200 + 1800}$

$R_{2113} = 7.2 \times 10^{2}$

$R_T = 720 + 680 = 1.4\ k\Omega$

$C_T = C_{1+2113} = \frac{10^{9} \times 3.2 \times 10^{-9}}{4.2 \times 10^{-9}}$

$C_T = 7.619 \times 10^{-10}$

$X_C = \frac{-j}{2\pi(100 \times 10^{3})(7.619 \times 10^{-10})}$

$X_C = -2.0889j \times 10^{3}\ \Omega$

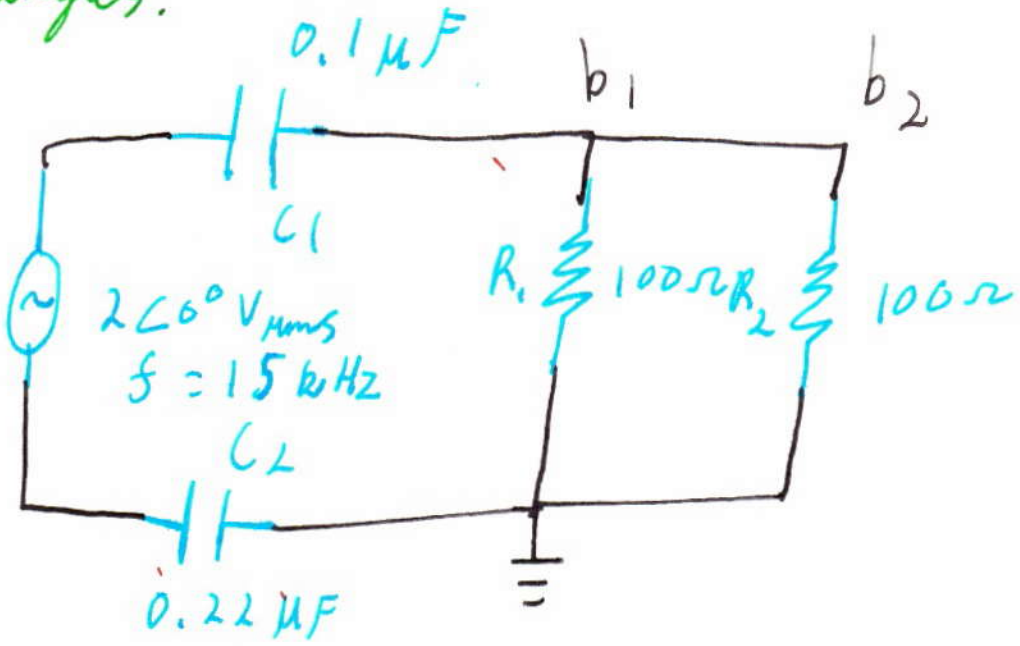
$Z_T = 1.4 \times 10^{3} - 2.0889j \times 10^{3}$

$$Z_T = \sqrt{(1.4 \times 10^3)^2 + (2.0889 \times 10^3)^2}$$

$$\tan^{-1}\left(\frac{-(2.0889 \times 10^3)}{(1.4 \times 10^3)}\right)$$

$$\boxed{Z_T = 2.514 \times 10^3 \angle -56.169^\circ}$$

32) For the circuit in Figure 15-88, draw the phasor diagram showing all voltages and the total current. Indicate phase angles.



$$R_{1||2} = \frac{100 \times 100}{200}$$

$$R_{1||2} = \frac{10^4}{200}$$

$$R_{1||2} = \frac{1}{2} \times 10^2$$

$$R_{1||2} = 50\,\Omega$$

$$C_{1+2} = \frac{10^{-7} \times 2.2 \times 10^{-7}}{10^{-7} + 2.2 \times 10^{-7}}$$

$$C_{1+2} = \frac{2.2 \times 10^{-14}}{3.2 \times 10^{-7}}$$

$$C_{1+2} = 6.875 \times 10^{-8}\,F$$

$$X_C = \frac{-j}{2\pi f C}$$

$$X_C = \frac{-j}{2\pi (15 \times 10^3)(6.875 \times 10^{-8})}$$

$$X_C = -1.5433 \times 10^2 j$$

$$Z_T = 50 - 1.5433 \times 10^2 j$$

$$Z_T = 1.6223 \times 10^2 \angle -72.049^\circ$$

$$Z_T = 162.23 \angle -72.049^\circ$$

$$V = IZ$$

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

$$I_T = \frac{2\angle 0^\circ}{162.23\angle -72.049}$$

$$\boxed{I_T = 12.328 \times 10^{-3} \angle 72.049\ A}$$

$$X_{C_1} = \frac{-j}{2\pi f C} = \frac{-j}{2\pi (15\times 10^3)(10^{-7})}$$

$$X_{C_2} = \frac{-j}{2\pi f C} = \frac{-j}{2\pi (2.2\times 10^{-7})(15\times 10^3)}$$

$$X_{C_1} = -106.10j$$

$$X_{C_2} = -48.229j$$

$V = IZ$

$V_{C_1} = (12.328 \times 10^{-3} \angle 72.049^\circ) \times (-106.10j)$

$\boxed{V_{C_1} = 1.308 \angle -17.951^\circ}$

$V_{C_2} = (12.328 \times 10^{-3} \angle 72.049^\circ) \times (-48.229j)$

$\boxed{V_{C_2} = \cancel{5.945} \quad 0.59456 \angle -17.951^\circ}$

Current divider $= \dot{i}_s \frac{R_{other}}{\Sigma R}$

$\dot{i}_{b_1} = \dot{i}_{b_2}$ $1.2328 \times 10^{-2} \angle 72.049° A$

because equal impedance $\frac{100}{200}$

$\dot{i}_{b_1} = \dot{i}_{b_2} = \frac{1}{2} 1.2328 \times 10^{-2} \angle 72.049° A$

$\dot{i}_{b_1} = \dot{i}_{b_2} = 6.164 \times 10^{-3} \angle 72.049°$

$V = iZ$

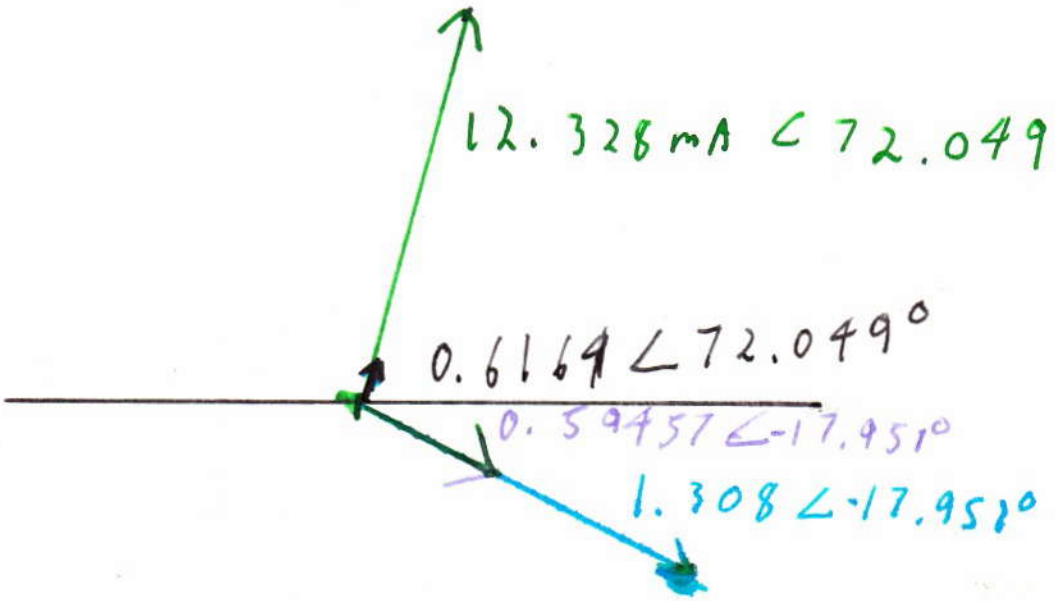
$6.164 \times 10^{-3} \angle 72.049°$

$\times 100$

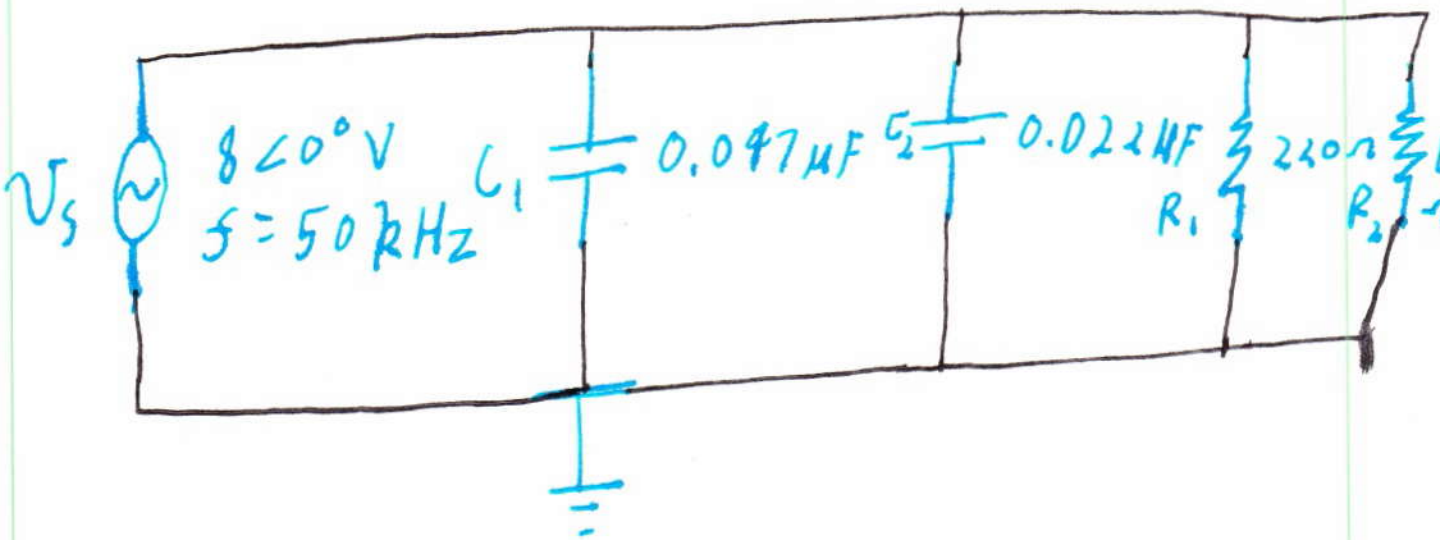
000012

$V_{b_1 \text{ and } b_2} = 6.164 \times 10^{-1} \angle 72.049°$

element label	
$\dot{I}_T$	$12.328 \times 10^{-3} \angle 72.049$ A
V_{C_1}	$1.308 \angle -17.951°$
V_{C_2}	$0.59457 \angle -17.951°$
V_{b_1} & b_2	$0.6164 \angle 72.049°$



46) For the parallel circuit in Figure 15-97, find the magnitude of each branch current and the total current. What is the phase angle between the applied voltage and the total current?



$$R_{1112} = \frac{220 \times 180}{220 + 180} = 99.0\ \Omega$$

$$C_{1112} = (0.047 + 0.022) \times 10^{-6}$$

$$C_{1112} = 6.9 \times 10^{-2} \times 10^{-6}$$

$$C_{1112} = 6.9 \times 10^{-8}\ F$$

$$X_C = \frac{-j}{2\pi f C}$$

$$X_C = \frac{-j}{2\pi (50 \times 10^3)(6.9 \times 10^{-8})}$$

$$X_C = -46.131\,j$$

$$X_{C_1} = \frac{-j}{2\pi fC} = \frac{-j}{2\pi (50\times10^3)(4.7\times10^{-8})}$$

$$X_{C_2} = \frac{-j}{2\pi fC} = \frac{-j}{2\pi (50\times10^3)(2.2\times10^{-8})}$$

$$X_{C_1} = -67.725j$$

$$X_{C_2} = -1.446\times10^2 j$$

$\frac{V}{Z} = i$ Since all branches receive the same voltage

$$\frac{8\angle 0^\circ}{-67.725j} = i_{C_1} = \cancel{0.1181\times10^{-1}\angle 90}$$

$$0.1181\angle 90^\circ$$

$$\frac{8\angle 0^\circ}{-144.6j} = i_{C_2} = \cancel{55.325\angle 90^\circ\times10^{-3}}$$

$$55.325\times10^{-3}\angle 90^\circ$$

$$\dot{i}_{R_1} = \frac{V}{R_1} = \frac{8}{220} = 36.363 \times 10^{-3}\ A$$

$$\dot{i}_{R_2} = \frac{V}{R_2} = \frac{8}{180} = 49.444 \times 10^{-3}\ A$$

$$\dot{i}_T = \dot{i}_{R_1} + \dot{i}_{R_2} + \dot{i}_{E_1} + \dot{i}_{C_2}$$

$$\dot{i}_T = 10^{-3} \times (36.363 + 44.444 + 55.325\angle 90^\circ)$$

$$+ 0.1181\angle 90^\circ$$

$$\boxed{\dot{i}_T = 0.191\angle 65.00^\circ}$$

$$V_\theta - i_\theta = 0 - 65$$

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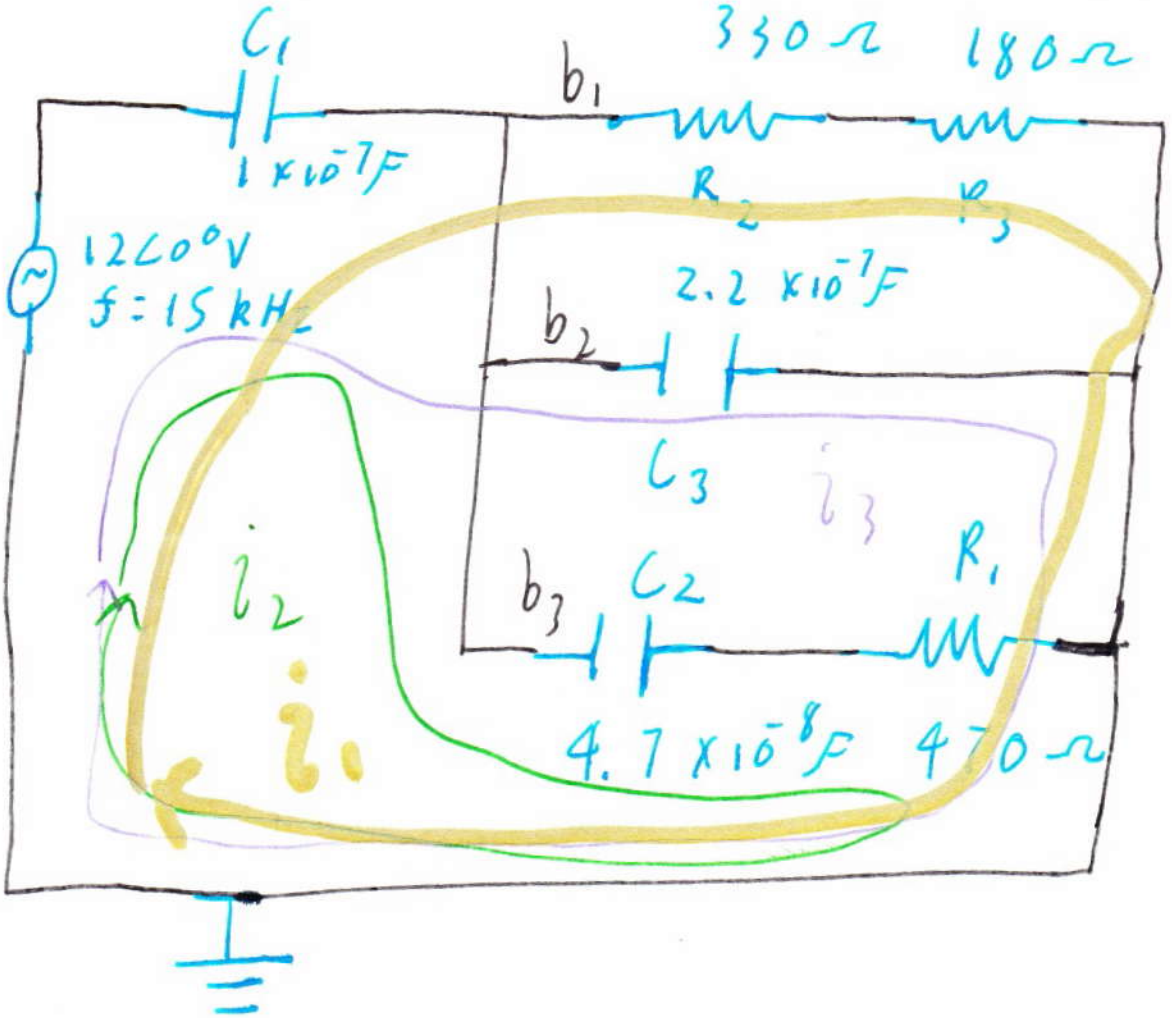
$$\boxed{\Delta_{\theta\, v-i} = -65.00^\circ}$$

51) Determine the voltages in polar form across each element in Figure 15-101. Draw the voltage phasor diagram.



$$X_{C_1} = \frac{-j}{2\pi f C_1} = \frac{-j}{2\pi (15\times10^3)(10^{-7})}$$

$$X_{C_1} = -106.103j$$

$$X_{C_2} = \frac{-j}{2\pi f C_2} = \frac{-j}{2\pi (15\times10^3)(10^{-7})}$$

$$X_{C_2} = -48.228j$$

$$X_{C_3} = \frac{-j}{2\pi f C_3} = \frac{-j}{2\pi (15\times10^3)(4.7\times10^{-8})}$$

$$X_{C_3} = -225.751j$$

$\Sigma V_{\text{in loop}} = 0$

Voltage divider per loop

$$V_{C_1} = V_S \frac{X_{C_1}}{X_{C_1} + X_{C_3}}$$

$$V_{C_3} = V_S \frac{X_{C_3}}{X_{C_1} + X_{C_3}}$$

$$V_{C_2} = V_S \frac{X_{C_2}}{X_{C_2} + X_{C_1} + R_1}$$

$$V_{R_1} = V_S \frac{R_1}{X_{C_2} + X_{C_1} + R_1}$$

$$V_{R_3} = V_S \frac{R_3}{R_2 + R_3 + X_{C_1}}$$

$$V_{R_2} = V_S \frac{R_2}{R_2 + R_3 + X_{C_1}}$$

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$$V_{C_1} = 12\angle 0^\circ \frac{-106.103j}{-106.103j + -225.751j}$$

$$V_{C_1} = 3.836\angle 0^\circ$$

$$V_{C_3} = 12\angle 0^\circ \frac{-225.751j}{-106.103j - 225.751j}$$

$$V_{C_3} = 8.163\angle 0^\circ$$

$$V_{R_2} = 12\angle 0^\circ \frac{330}{330 + 180t - 106.103j}$$

$$V_{R_2} = 7.601\angle 11.752^\circ$$

$$V_{R_3} = 12\angle 0^\circ \frac{180}{330 + 180 + -106.103j}$$

$$V_{R_3} = 4.146 \angle 11.752^\circ$$

$$V_{C_2} = 12\angle 0^\circ \frac{-48.228j}{-48.228j + 470 + -106.103j}$$

$$V_{C_2} = 1.169 \angle -71.821^\circ$$

$$V_{R_1} = 12\angle 0^\circ \frac{470}{-48.228j + 470 - 106.103j}$$

$$V_{R_1} = 11.401 \angle 18.178^\circ$$