Name: **Student ID:**

Pre-tutorial 7 Questions (to be attempted before class on July 26th, 2019)

Chapter 10, Ex 33: Phasors

Assuming the passive sign convention and an operating frequency of 314 rad/s, calculate the phasor voltage **V** which appears across each of the following when driven by the phasor current **I** = 10 ∠0° mA.

a) A 2 Ω resistor.

$$\bar{V}_R = \bar{I}R$$
$$= 10\times10^{-3}\angle 0^\circ \times 2$$
$$= 20\angle 0^\circ \text{ mV}$$

b) A 1 F capacitor.

$$\bar{V}_c = \frac{1}{c}\int \bar{I}\,dt$$
$$= \frac{1}{j\omega c}\bar{I}$$
$$= \frac{1}{314\angle 90^\circ}\, 10\times10^{-3}\angle 0^\circ$$
$$= 0.03\angle -90^\circ \text{ mV}$$

c) A 1 H inductor.

$$\bar{V}_L = L\,d\bar{I}/dt$$
$$= j\omega L\bar{I}$$
$$= 314\times 1\angle 90^\circ \times 10\times10^{-3}\angle 0^\circ$$
$$= 3.14\angle 90^\circ \text{ V}$$

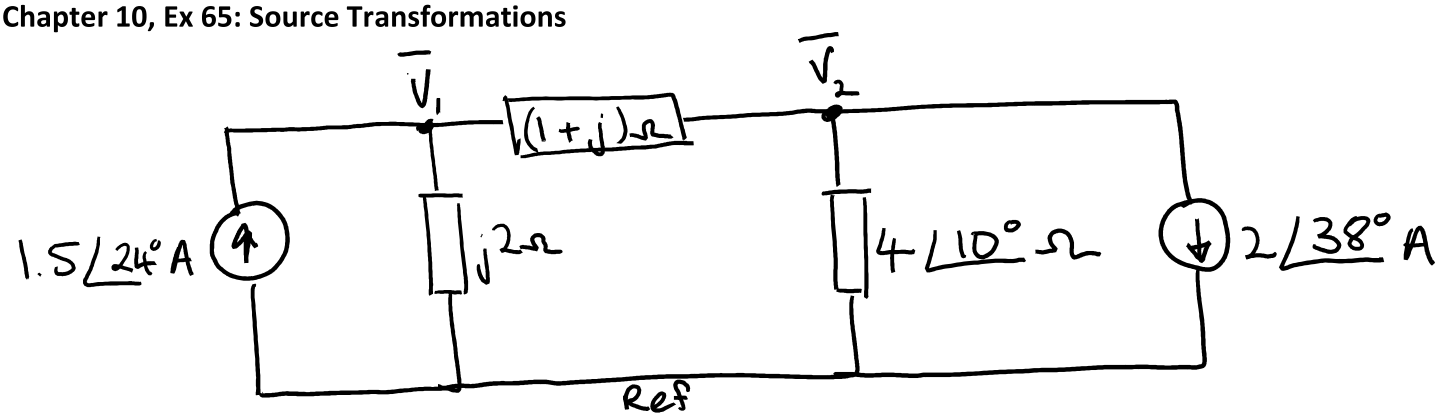
d) A 2 Ω resistor in series with a 1 F capacitor.

$$\bar{V}_{RC} = \bar{V}_R + \bar{V}_c$$
$$= (20\angle 0^\circ + 0.03\angle -90^\circ)\times10^{-3}$$
$$= (20 - j0.03)\times10^{-3}$$
$$= 20\angle -0.09^\circ \text{ mV}$$

e) A 2 Ω resistor in series with a 1 H inductor.

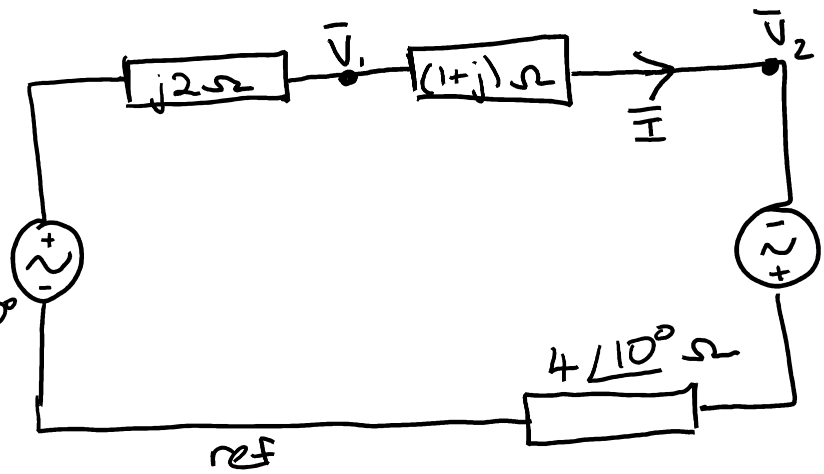
$$\bar{V}_{RL} = \bar{V}_R + \bar{V}_L$$
$$= 20\times10^{-3}\angle 0^\circ + 3.14\angle 90^\circ$$
$$= 20\times10^{-3} + j\,3.14$$
$$= 3.14\ \angle 89.6^\circ \text{ V}$$

Chapter 10, Ex 65: Source Transformations



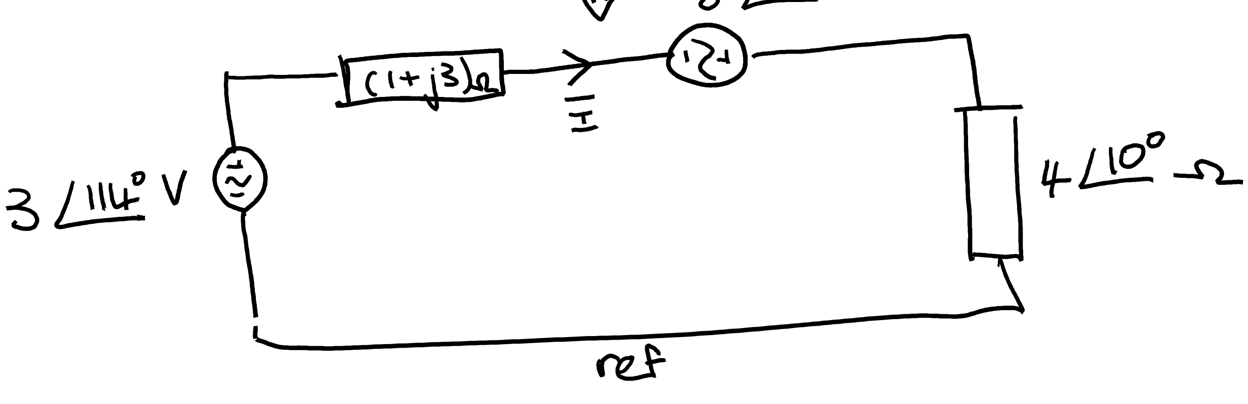
For the circuit above, perform a source transformation on each source, simplify the resulting circuit as much as possible, and calculate the current flowing through the (1 + *j*) Ω impedance.

$$\bar{V}_{s1} = \bar{I}_{s1} Z$$
$$= 1.5\angle 24^\circ \times 2\angle 90^\circ$$
$$= 3\angle 114^\circ \text{ V}$$



$$\bar{V}_{s2} = \bar{I}_{s2} Z$$
$$= 2\angle 38^\circ \times 4\angle 10^\circ$$
$$= 8\angle 48^\circ \text{ V}$$

$\Downarrow$



$$-3\angle 114° + \bar{I}(1+j3) - 8\angle 48° + \bar{I}(4\angle 10°) = 0$$

$$\bar{I}(1+j3+4\angle 10°) = 3\angle 114° + 8\angle 48°$$

$$\bar{I}(1+j3+3.94+j0.69) = -1.22+j2.74+5.35+j5.95$$

$$\bar{I}(4.94+j3.69) = 4.13+j8.69$$

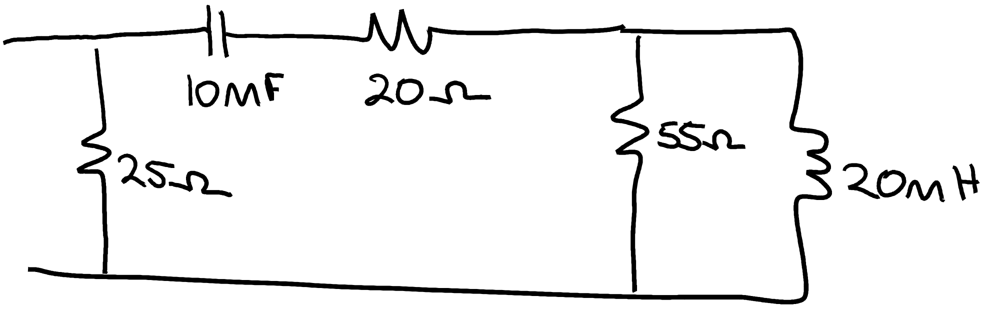
$$\bar{I} = \frac{9.62\angle 64.6°}{6.17\angle 36.8°}$$

$$= 1.56\angle 27.8° \text{ A}$$

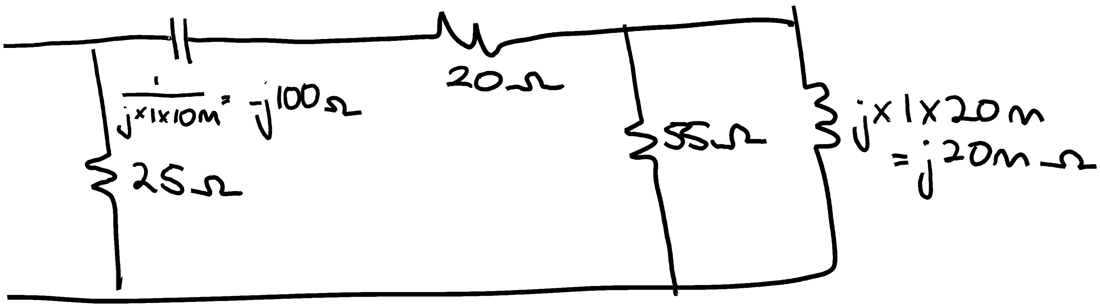
At Tutorial 7 – Marked Question (26th July 2019)

Chapter 10, Ex 40a: Impedance and Admittance

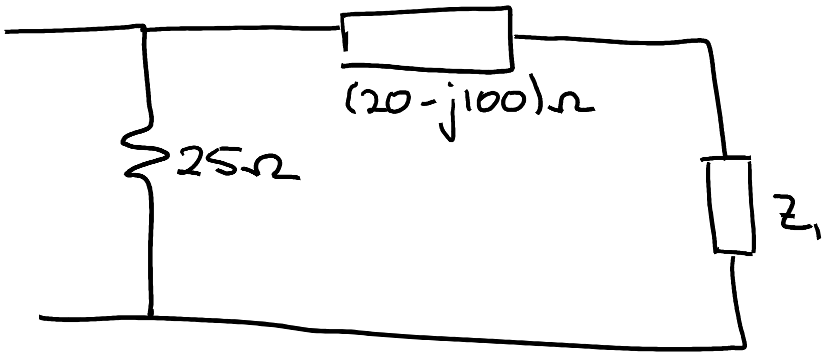
Consider the network below, and determine the equivalent impedance seen looking into the open terminals if ω = 1 rad/s.



$\Downarrow$



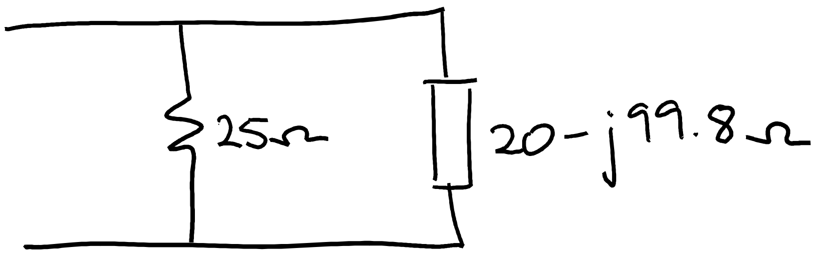
$\Downarrow$



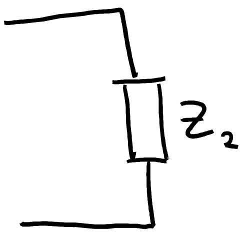
$$Z_1 = \frac{55 \times 20m \angle 90^\circ}{55 + j20m}$$

$$= \frac{1.1 \angle 90^\circ}{55 \angle 0.02}$$

$$= 0.02 \angle 89.98^\circ \ \Omega = 7.27 \times 10^{-6} + j0.02 \ \Omega$$



$\Downarrow$



$$Z_2 = \frac{(20 - j99.98)25}{20 - j99.98 + 25}$$

$$= \frac{500 - j2{,}499.5}{45 - j99.98}$$

$$= \frac{2549 \angle -78.69^\circ}{109.6 \angle -65.77^\circ}$$

$$= 23.26 \angle -12.92^\circ \ \Omega$$

At Tutorial 7 – Unmarked Questions (26th July 2019)

Chapter 10, Ex 28: Phasors

The following complex voltages are written in a combination of rectangular and polar form. Rewrite each, using conventional phasor notation (i.e. a magnitude and angle):

a) $\frac{2-j}{5\angle 45^0}$ V

$$\frac{2-j}{5\angle 45^\circ} = \frac{2.24\angle -26.6^\circ}{5\angle 45^\circ}$$

$$= 0.45\angle -71.6^\circ \text{ V}$$

b) $\frac{6\angle 20^0}{1000} - j$ V

$$\frac{6\angle 20^\circ}{1000} - j = 6\times 10^{-3}\angle 20^\circ - j$$

$$= 5.64\times 10^{-3} + j2.05\times 10^{-3} - j$$

$$= 5.64\times 10^{-3} - j0.998$$

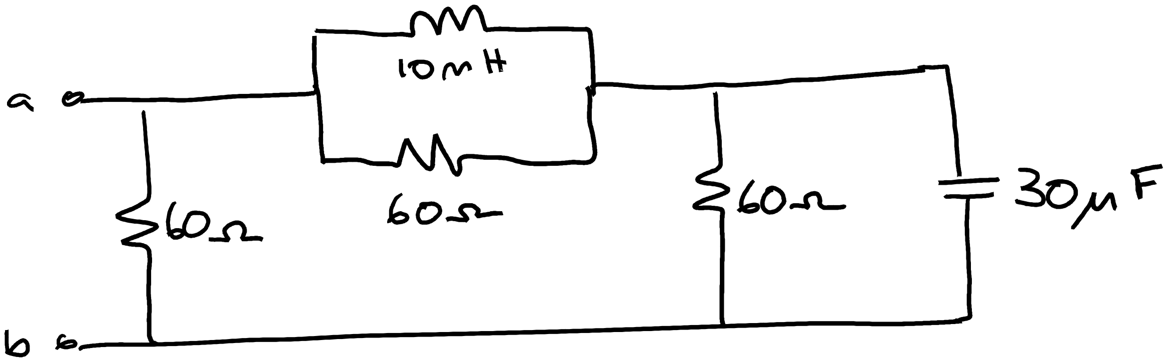
$$= 0.998\angle -89.7^\circ \text{ V}$$

c) $(j)(52.5\angle -90^\circ)$ V

$$(j)(52.5\angle -90^\circ) = \angle 90^\circ \times 52.5\angle -90^\circ$$

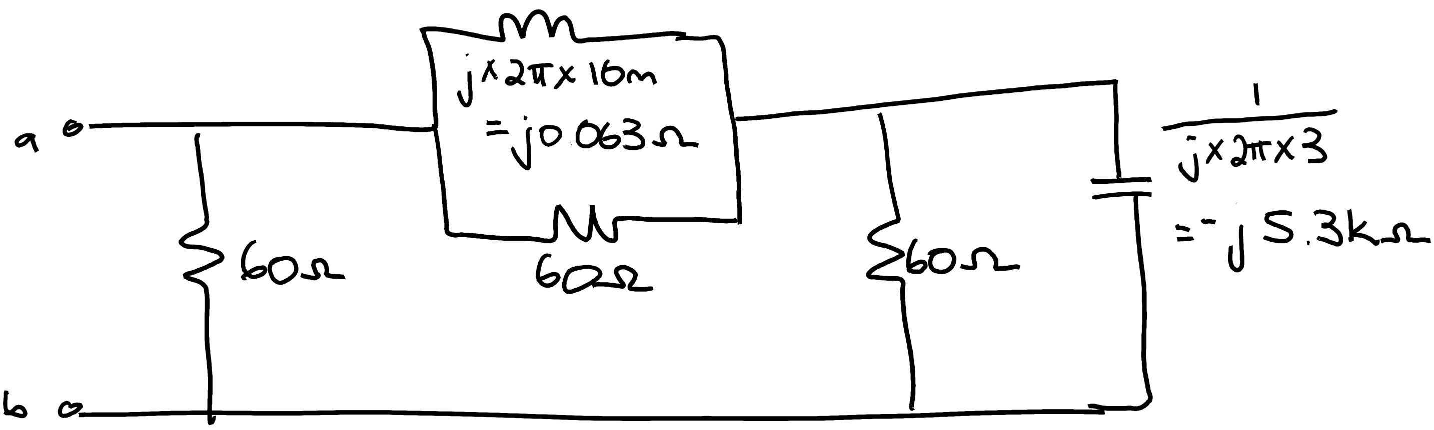
$$= 52.5\angle 0^\circ \text{ V}$$

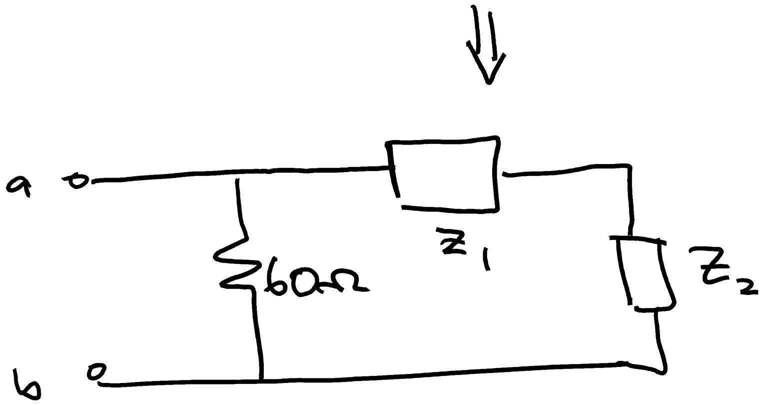
Chapter 10, Ex 43a: Impedance and Admittance



Calculate the equivalent impedance seen at the open terminals of the network shown above if *f* is equal to 1 Hz.

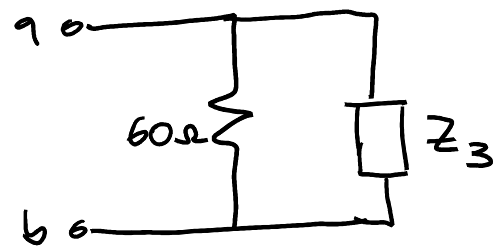
$$f = 1\,Hz, \quad \omega = 2\pi f$$
$$= 2\pi \text{ rad/s}$$



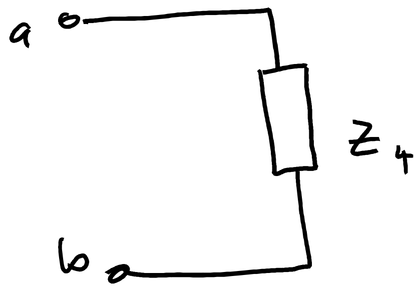


$$Z_1 = \frac{j0.063 \times 60}{j0.063 + 60}$$
$$= \frac{3.78 \angle 90^\circ}{60 \angle 0.06^\circ}$$
$$= 0.063 \angle 89.9^\circ \,\Omega$$

$$Z_2 = \frac{60 \times -j5.3k}{60 - j5.3k}$$
$$= \frac{318k \angle -90^\circ}{5.3k \angle -89.4^\circ} = 60 \angle -0.6^\circ \,\Omega$$

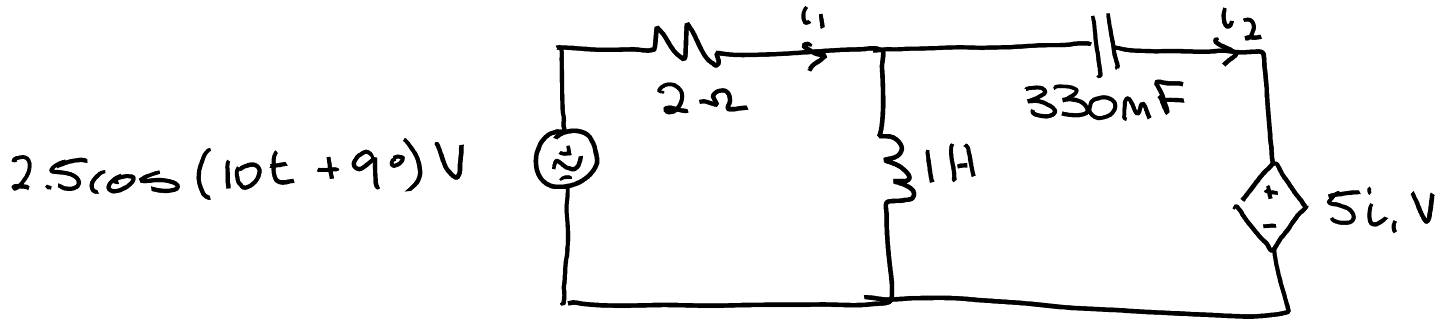


$$Z_3 = 60\angle{-0.6^\circ} + 0.063\angle{89.94^\circ}$$
$$= 60 - j0.63 + 65.9\mu + j0.063$$
$$= 60 - j0.567$$
$$= 60\angle{-0.54^\circ}\ \Omega$$



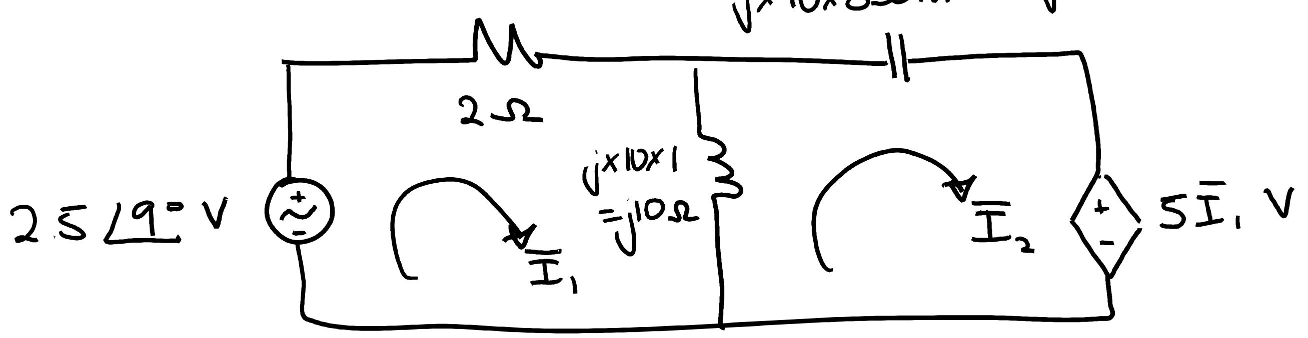
$$Z_4 = \frac{60\angle{-0.54^\circ} \times 60}{60 + 60 - j0.567}$$
$$= \frac{3600\angle{-0.54^\circ}}{120 - j0.567}$$
$$= \frac{3600\angle{-0.54^\circ}}{120\angle{-0.27^\circ}}$$
$$= 30\angle{-0.27^\circ}\ \Omega$$

Chapter 10, Ex 52: Nodal and Mesh Analysis



Employ phasor analysis techniques to obtain expressions for the two mesh currents i_1 and i_2 as shown in the figure above.

$$\frac{1}{j\times 10\times 330m} = -j0.303\Omega$$



mesh 1

$$-2.5\angle 9° + 2\bar{I}_1 + j10(\bar{I}_1 - \bar{I}_2) = 0$$

$$(2+j10)\bar{I}_1 - j10\bar{I}_2 = 2.5\angle 9° \quad (1)$$

mesh 2

$$j10(\bar{I}_2 - \bar{I}_1) - j0.303\bar{I}_2 + 5\bar{I}_1 = 0$$

$$(5-j10)\bar{I}_1 + j9.697\bar{I}_2 = 0$$

$$j9.697\bar{I}_2 = (-5+j10)\bar{I}_1$$

$$\bar{I}_2 = \frac{(-5+j10)\bar{I}_1}{j9.697}$$

$$= -j0.103(-5+j10)\bar{I}_1$$

$$= (j0.516 + 1.03)\bar{I}_1 \quad (2)$$

(2) into (1):

$$(2+j10)\bar{I}_1 - j10(1.03+j0.516)\bar{I}_1 = 2.5\angle 9^\circ$$

$$(2+j10)\bar{I}_1 + (-j10.3+5.16)\bar{I}_1 = 2.5\angle 9^\circ$$

$$(7.16-j0.3)\bar{I}_1 = 2.5\angle 9^\circ$$

$$\bar{I}_1 = \frac{2.5\angle 9^\circ}{7.16-j0.3}$$

$$= \frac{2.5\angle 9^\circ}{7.17\angle -2.4^\circ}$$

$$= 0.35\angle 11.4^\circ \text{ A}$$

$$\bar{I}_2 = (j0.516+1.03)\bar{I}_1$$

$$= 1.15\angle 26.7^\circ \times 0.35\angle 11.4^\circ$$

$$= 0.40\angle 38.1^\circ \text{ A}$$

$$i_1 = 0.35\cos(10t+11.4^\circ) \text{ A}$$

$$i_2 = 0.40\cos(10t+38.1^\circ) \text{ A}$$