Q1

$i_s = 5\cos(10t + 40°) = 5\angle 40°$
$Z_L = j\omega L = j2 \ \Omega$
$Z_C = \frac{1}{j\omega C} = -j \ \Omega$

$Zeq = \left(\frac{1}{4} + \frac{1}{j2} + \frac{1}{3-j}\right)^{-1}$

According to ohm's law, $V = IR = I_s \cdot Zeq$.

$V_0 = i_s \cdot Zeq$

$i_0 = \frac{V_0}{3-j}$ A $= i_0 \cdot \frac{1}{3-j} \cdot \frac{1}{\frac{1}{4} + \frac{1}{j2} + \frac{1}{3-j}} = i_s \cdot \frac{1}{3-j} \cdot \underbrace{\left(\frac{44}{37} + j\frac{32}{37}\right)}_{Zeq}$

$i_0 = 2.325\cos(10t + 94.46°)$ A

Q2. $V_s(t) = 20\sin(100t - 40°) = 20\cos(100t - 130°) = 20\angle -130°$ V
$Z_L = j\omega L = j20 \ \Omega$ $\quad Z_C = \frac{1}{j\omega C} = -j20 \ \Omega$

$Z_1 = 30 - j20 \ \Omega$
$Z_2 = Z_1 \parallel Z_L = (30 - j20) \parallel j20 = \frac{40}{3} + j20 \ \Omega$.

Apply voltage divider rule:
$V_x = V_s(t) \cdot \frac{Z_2}{Z_2 + 10} = 20\angle -130° \cdot \frac{64}{85} + j\frac{18}{85} = 15.64\angle -114$ V

$i_x = \frac{V_x}{Z_1} = \frac{15.64\angle -114}{30 - j20}$

$i_x = 0.4338\cos(100t - 80.6°)$ A

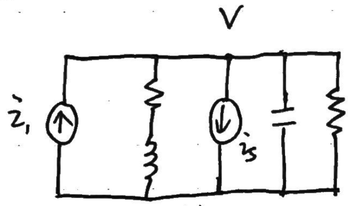
Q3. Apply nodel analysis at node V.

$$\frac{V-(120\angle -15^\circ)}{40+j20} + 6\angle 30^\circ + \frac{V-0}{-j30} + \frac{V-0}{50} = 0$$

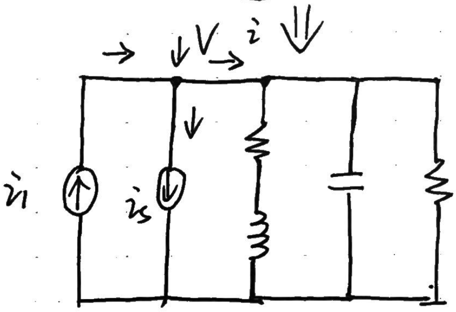
$$\left(\frac{1}{40+j20} + \frac{1}{-j30} + \frac{1}{50}\right)V = \frac{\cancel{6}120\angle -15}{40+j20} - 6\angle 30$$

$$V = \left(\frac{1}{40+j20} + \frac{1}{-j30} + \frac{1}{50}\right)^{-1} \cdot \left[\frac{120\angle -15}{40+j20} - 6\angle 30\right]$$

Thus, by observation, $V = (Z_{eq}) \cdot [i_1 - i_s]$



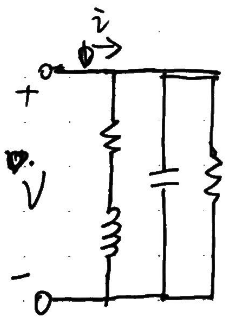
using source transformation. Circuit shows the new relation-~~sh~~ships of two sources.



Focus on the current flow of node A, we could find that the current flow to three components is equal to $i_1 - i_s$.

$(i + i_s = i_1)$.

Thus,



I hope it can help u have more understanding of these kind of question.

Q4 $Z_L = j4\ \Omega$ $\quad Z_C = -j2\ \Omega$.

Apply KVL, $\begin{cases} 10\cos 2t = 4i_1 - j2(i_1+i_2) & -① \\ 6\sin 2t = j2 i_2 - j2(i_1+i_2) & -② \end{cases}$

①+②, get,

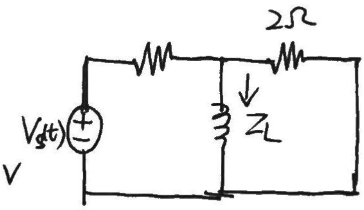
$$10\angle 0° + 6\angle -90° = 4i_1 - j4 i_1$$

$$i_1 = \frac{10\angle 0° + 6\angle -90°}{4-j4} = 2+j0.5\ A$$

$i_2 = -1+j0.5\ A$

$$i = i_1 + i_2 = 1+j = 1.414\cos(2t+45°)\ A$$

For this question, u can also use sources transformation, that trans two voltage sources into two current sources with 3 components (pratlel to each other).



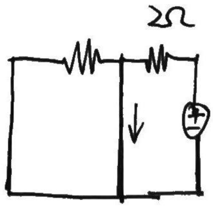
Q5. For AC source,

$V_s(t) = 10\cos 4t \quad V = 10\angle 0°\ V$

$Z_L = j4\ \Omega$

$$i_1 = V_{s(t)} \frac{2\Omega \| Z_L}{Z_{eq}} \cdot \frac{1}{Z_L} = 10\angle 0° \cdot \frac{2\|j4}{2\|j4+4} \cdot \frac{1}{j4} = \frac{1}{40} - j\frac{3}{40}\ A$$

$$= 0.079\cos(4t-71.57°)$$

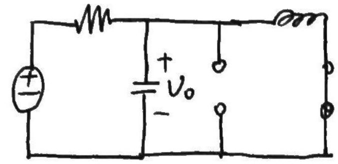


For DC source,

$$i_2 = \frac{V_{DC}}{2\Omega} = \frac{8}{2} = 4V$$

$$i_o = i_2 + i_1 = 4 + 0.079\cos(4t - 71.57°)\ A$$

Q6 For AC voltage source only.



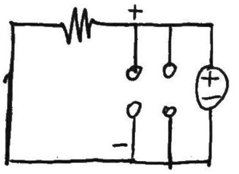
$V_{AC} = 12\cos 3t = 12\angle 0^\circ$ V

$Z_C = \frac{1}{j\omega C} = -j4\ \Omega$

$Z_L = j\omega L = j6\ \Omega.$

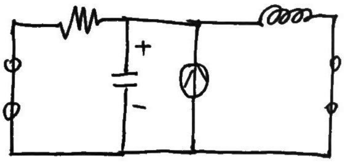
$$V_1 = V_{AC} \cdot \frac{Z_C \| Z_L}{6\Omega + Z_C \| Z_L} = 12\angle 0^\circ \cdot \frac{-j12}{6-j12} = 10.73\cos(3t-26.57^\circ)\ V$$

For DC voltage source only.



$V_2 = V_{DC} = 10\ V$

For AC current source only.



(cosine wave)

$\rightarrow 4\cos(2t-90^\circ) = 4\angle -90^\circ$

$I_{AC} = 4\sin 2t = 4\angle 0^\circ$ (This is sine wave)

$Z_L = j4\Omega$, $Z_C = -j6\Omega$.

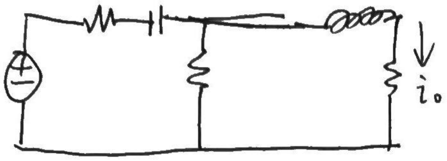
$$Z_{eq} = \left(\frac{1}{6} + \frac{1}{j4} + \frac{1}{-j6}\right)^{-1} = \cancel{3.6 + j1.2\Omega}\ 4.8 + j2.4\ \Omega$$

$$V_3 = Z_{eq} \cdot I_{AC} = (\cancel{3.6}^{4.8} + j\cancel{1.2}^{2.4})4\angle -90^\circ = 21.47\cos(2t-63.43^\circ)$$
$$= 21.47\sin(2t+26.57^\circ)\ V$$

$$V_o = V_1 + V_2 + V_3 = 10 + 10.73\cos(3t-26.57^\circ) + 21.47\sin(2t+26.57^\circ)$$

Q7

For AC voltage source only.



(sinwave).

$V_{AC} = 10\sin(t-30^\circ) = 10\angle -30^\circ$

$Z_L = j\omega L = j2\ \Omega$.

$Z_C = -j6\ \Omega$

$Z_1 = 4 + Z_L = 4 + j2\ \Omega$

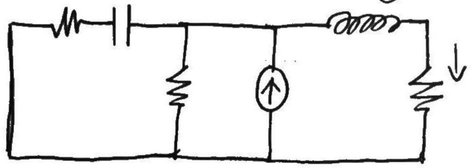
$Z_2 = 1 + Z_C = 1 - j6\ \Omega$.

$V_1 = V_{AC} \cdot \dfrac{Z_1 \| 2\Omega}{Z_1\|2\Omega + Z_2} = \dfrac{1.4+j0.2}{2.4-j5.8} = \overset{1.575+j1.61}{\cancel{\dfrac{11}{197} + j\dfrac{43}{197}}}\ V$

$\cancel{i_1 = \dfrac{V_1}{Z_1} = \dfrac{\left(\frac{11}{197} + j\frac{43}{197}\right)}{4+j2} = 0.05\sin(t+49.09^\circ)}$

$i = \dfrac{V_1}{Z_1} = \dfrac{1.575+j1.61}{4+j2} = 0.504\sin(t+19.1^\circ)\ A$

For AC current source only.



$I_{AC} = 2\cos 3t = 2\angle 0^\circ\ A$

$Z_L = j6\Omega \quad Z_C = -j2\Omega$

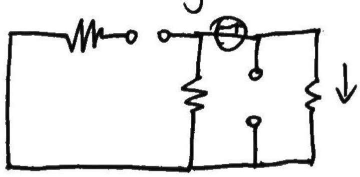
$Z_1 = 4 + j6\ \Omega$

$Z_2 = 1 - j2\ \Omega$

Apply current divider rule: $i_2 = \dfrac{\frac{1}{Z_1}}{\frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{2}} \cdot I_{AC}$

$i_2 = \dfrac{\frac{1}{4+j6}}{\frac{1}{4+j6} + \frac{1}{1-j2} + \frac{1}{2}} \cdot 2\angle 0^\circ = 0.335\cos(3t - 76.429^\circ)\ A$

For DC only.



$i_3 = \dfrac{V}{R_{eq}} = \dfrac{24}{2+4} = 4\ V$.

$i_o = i_3 + i_2 + i_1 = 4 + 0.335\cos(3t - 76.43^\circ) + 0.504\sin(t+19.1^\circ)\ A$ //