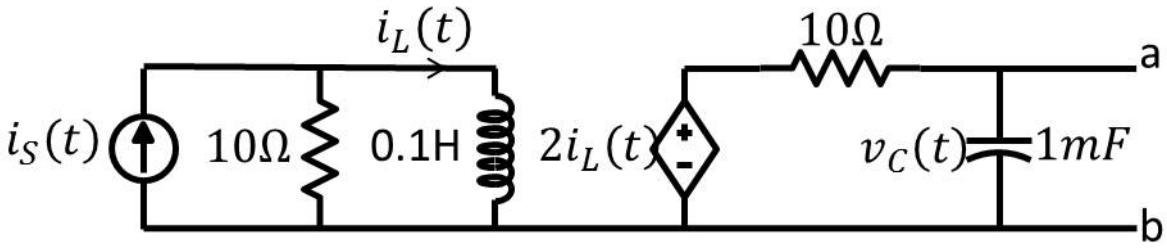
Set 1

Consider the circuit shown below where the excitation is $i_{in}(t) = 10\cos(50t)A$. Assume that none of the elements carry any energy at initial conditions.

1. Find Thevenin's equivalent across the terminals of the capacitor (exclude the capacitor while calculating the Thevenin's equivalent).
2. Using Thevenin's equivalent model, find the time domain current $i_L(t)$ and $v_C(t)$.

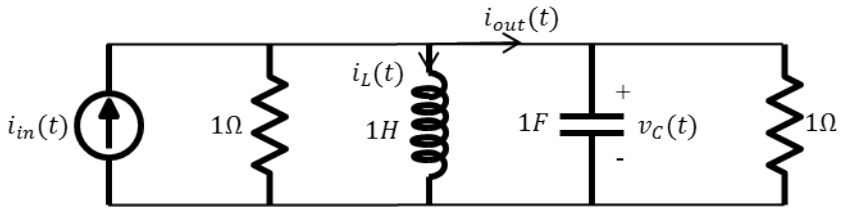


Set-2

Consider the circuit shown below where the excitation is $i_{in}(t) = 2\sin(30t - 50°)A$. Assume that none of the elements carry any energy at initial conditions.

1. Find Thevenin's equivalent across the terminals of the rightmost 1Ω resistor (exclude the resistor while calculating the Thevenin's equivalent).

2. Using Thevenin's equivalent model, find the time domain current $i_{out}(t)$ and $v_C(t)$.



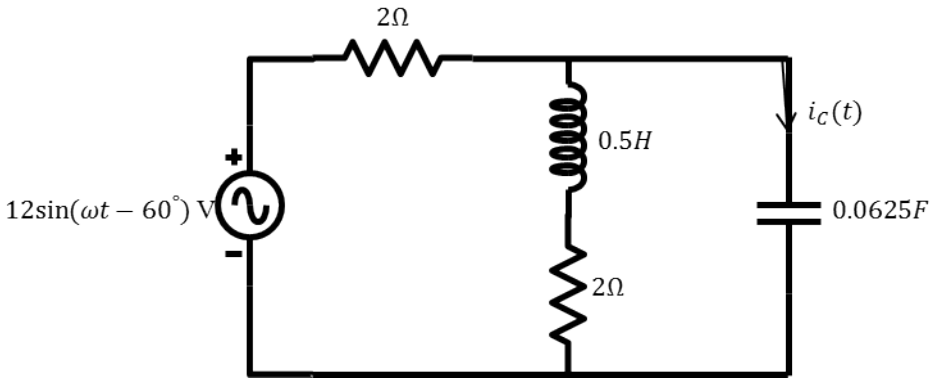
QUIZ-1

Set 3

Questions :

Consider the circuit shown below. Assume that none of the elements carry any energy at initial conditions.

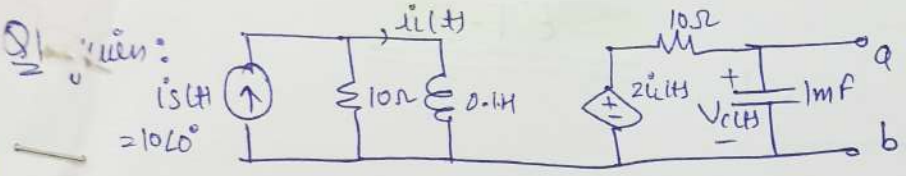
1. Find Thevenin's equivalent across the terminals of the capacitor (exclude the capacitor while calculating the Thevenin's equivalent).
2. Using Thevenin's equivalent model, find the time domain current $i_C(t)$ and $v_C(t)$ across the capacitor.



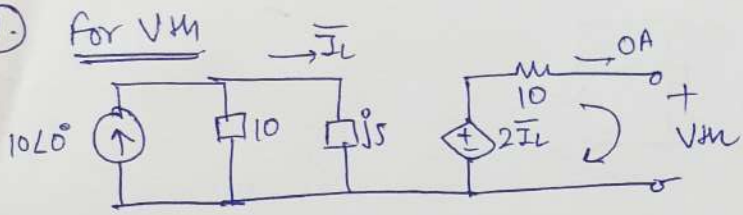
Solutions:

SET-1

Q1. Given:



(a.) For V_{th}



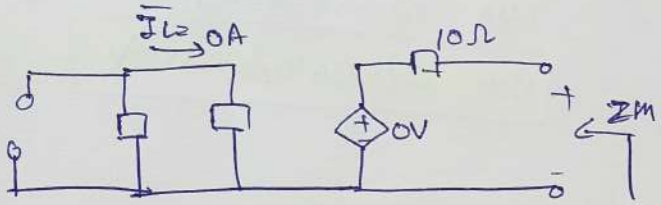
$\Rightarrow \boxed{V_{th} = 2\bar{I}_L}$ ①

$\bar{I}_L = 10\angle 0° \left[\frac{10}{10+j5}\right] = 8.94\angle -26.56° A$

∴ Put value of $\bar{I}_L$ in eq ①: $\bar{V}_{th} = 2[8.94\angle -26.56] V$

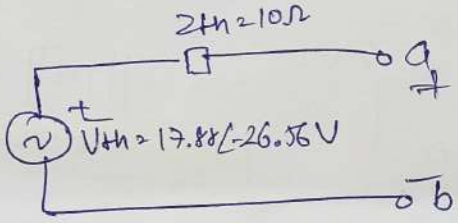
$\boxed{\bar{V}_{th} = 17.88\angle -26.56 V}$ ✓

For Zth:



$\boxed{Z_{th} = 10\Omega}$ ✓

∴ Thevenin ckt is:



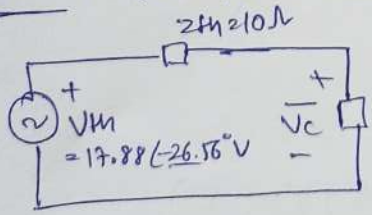
a

(b.) For $i_L(t)$: Use simple current division Rule in the ckt:

$\bar{I}_L = 10\angle 0° \left[\frac{j5}{10+j5}\right] = 8.94\angle -26.56° A$

$\therefore \boxed{i_L(t) = 8.94 \cos(50t - 26.56°) A}$ a ✓

For $V_c(t)$: Use the thevenin ckt in part (a):



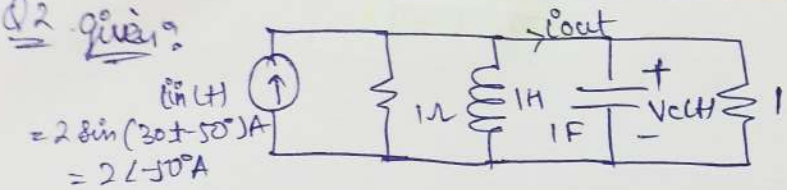
$\frac{-j}{\omega C} = \frac{-j}{50 \times \frac{1}{1000}} = -j20$

$\therefore \bar{V}_c = 17.88\angle -26.56° \left[\frac{-j20}{10-j20}\right] = 15.99\angle -53.12° V$

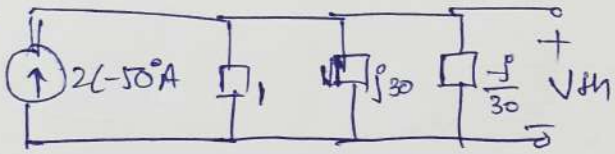
$\therefore \boxed{V_c(t) = 15.99 \cos(50t - 53.12°) \text{ Volts}}$ a ✓

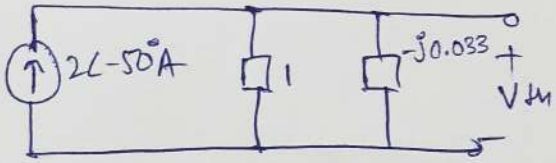
SET-2

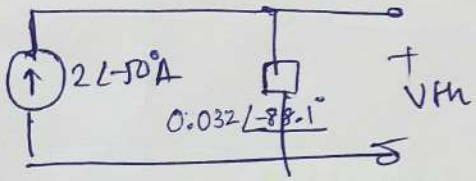
Q2 Given:



(a) For V_{th} & Z_{th}:



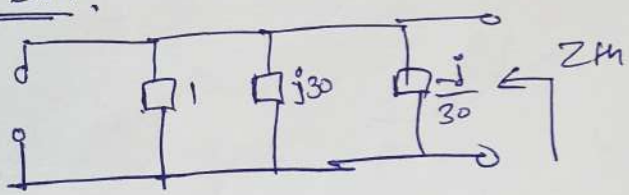




$\therefore V_{th} = (0.032\angle -88.1)(2\angle -50°)V$

$V_{th} = 0.064\angle -138.1°V$ ✓ Ans

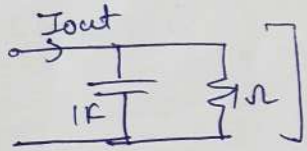
For Z_{th}:



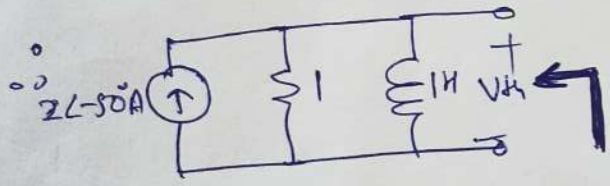
$Z_{th} = 1 \,||\, j30 \,||\, \frac{-j}{30}$

$Z_{th} = 0.032\angle -88.01°$ ✓ Ans

(b) Here

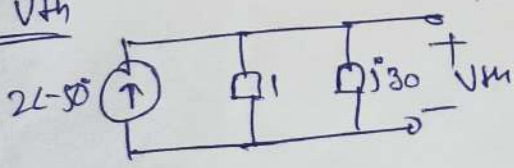


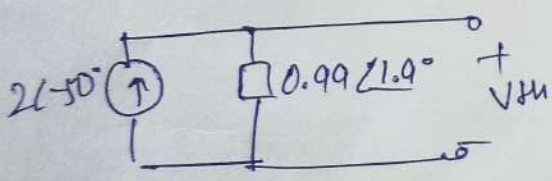
Consider this as load & make the thevenin's ckt across this load.



I need to find V_{th} & Z_{th} of this ckt now.

For V_{th}

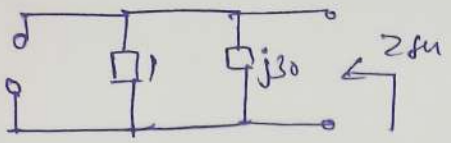




$V_{th} = (0.99\angle 1.9)(2\angle -50)$

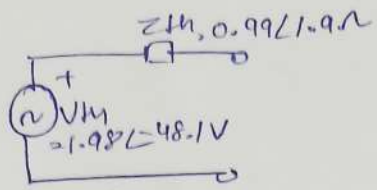
$V_{th} = 1.98\angle -48.1°$ Volts ✓

Zth:

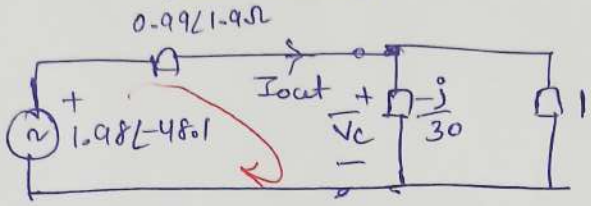


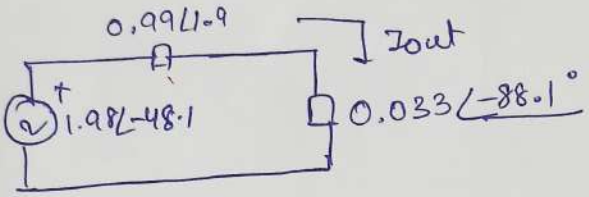
$$Z_{th} = 0.99\angle 1.9^\circ\ \Omega$$

∴ Thevenin ckt is:



For "Iout":



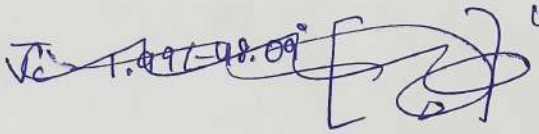


$$I_{out} = \frac{1.98\angle -48.1}{0.99\angle 1.9 + 0.033\angle -88.1}$$

$$\bar{I}_{out} = 1.99\angle -48.09^\circ A$$

$$i_{out}(t) = 1.99\sin(30t - 48.09^\circ)A$$ ✓ Ans

For "$\bar{V}_c(t)$":



Use KVL:

$$-1.98\angle -48.1 + (0.99\angle 1.9)\bar{I}_{out} + \bar{V}_c = 0$$

$$\bar{V}_c = 1.98\angle -48.1 + (0.99\angle 1.9)(1.99\angle -48.09^\circ)$$

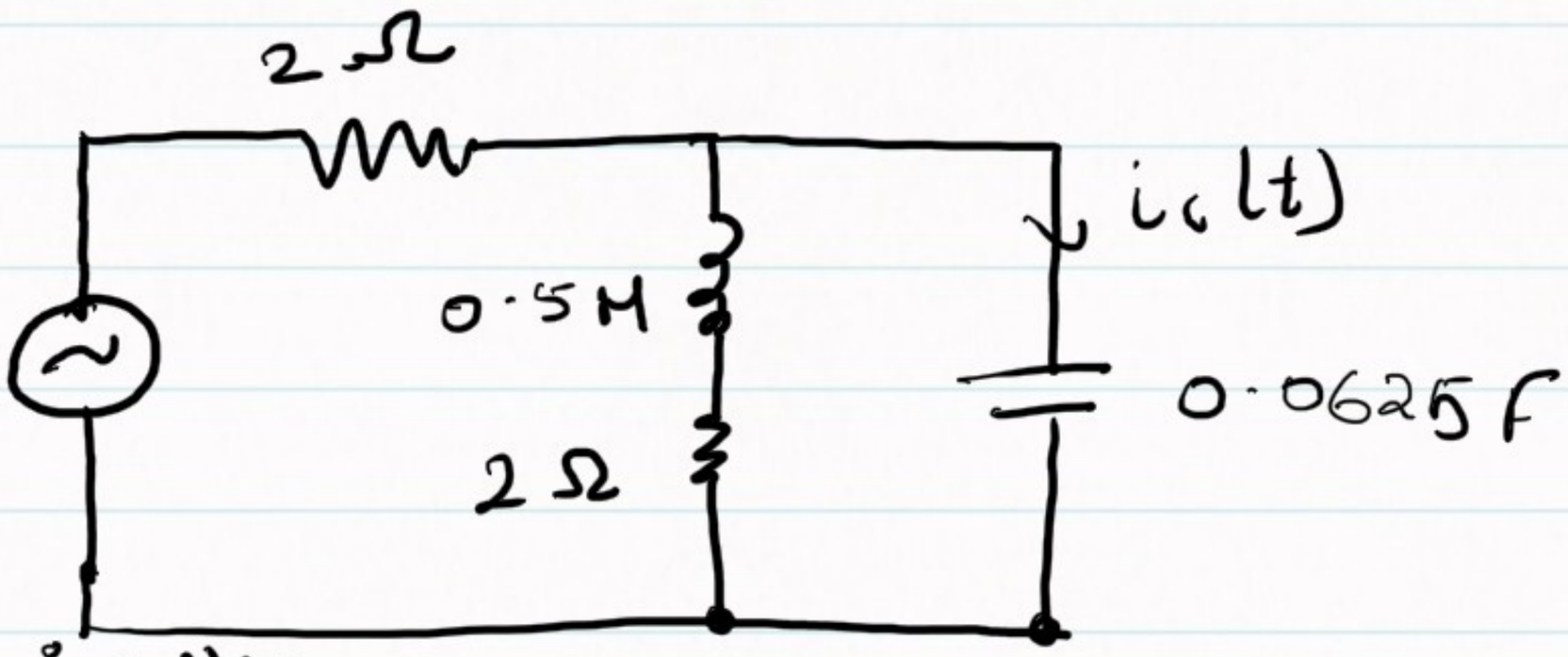
$$= 1.98\angle -48.1 - 1.97\angle -46.19^\circ$$

$$\bar{V}_c = 0.066\angle -128.5^\circ V$$

$$\therefore v_c(t) = 0.066\sin(30t - 128.5^\circ)\ \text{Volts}$$ ✓ Ans

Quiz 1 (set-3)

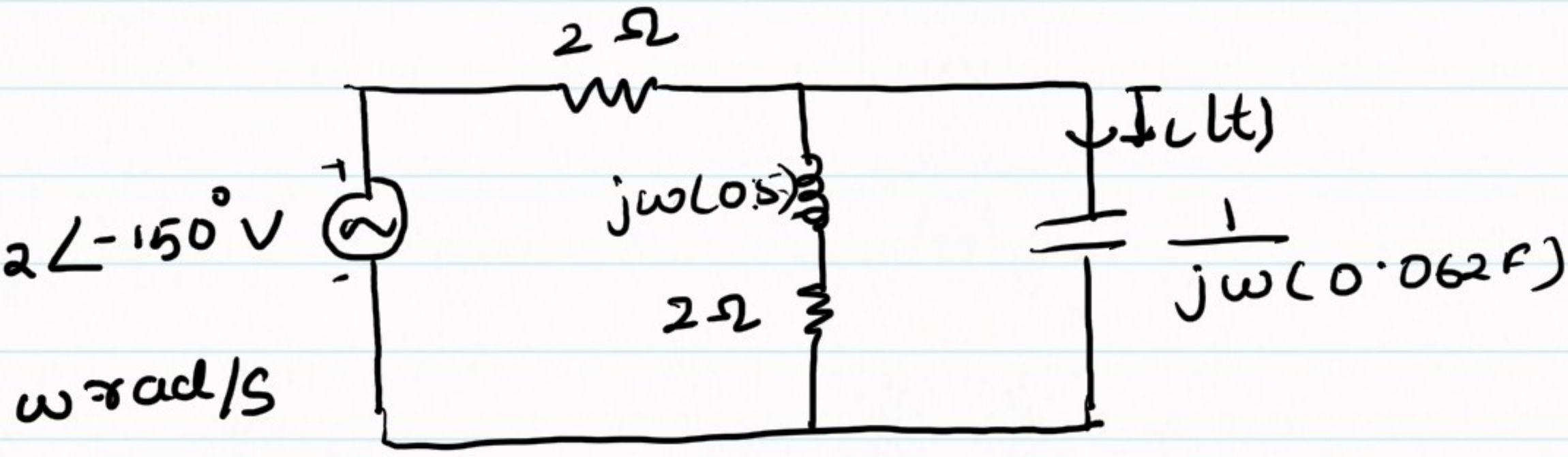
Q1



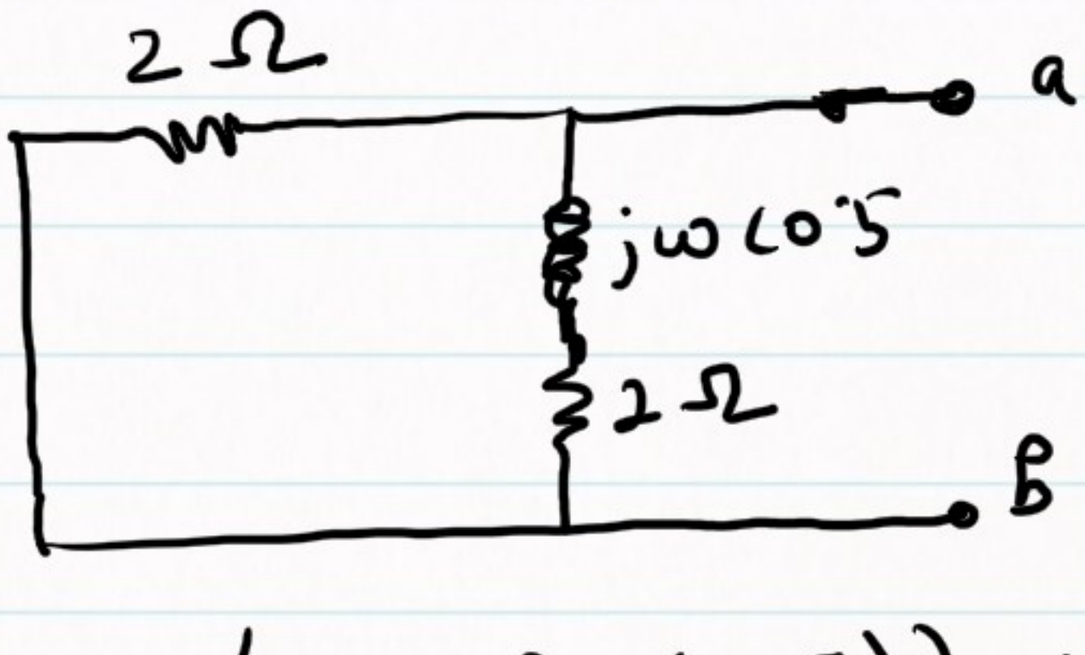
$12\sin(\omega t - 60^\circ)V$

$= 12\cos(\omega t - 60^\circ - 90^\circ)V$

Converting to phasor



Thevenin equivalent



$Z_{th} = (2 + j\omega(0.5)) \parallel 2.$

$$\Rightarrow Z_{th} = \left(2 + \frac{j\omega}{2}\right) \| 2$$

$$= \frac{2 \times \left(2 + \frac{j\omega}{2}\right)}{2 + 2 + \frac{j\omega}{2}} \rightarrow$$

$$= \frac{8 + 2j\omega}{8 + j\omega}$$

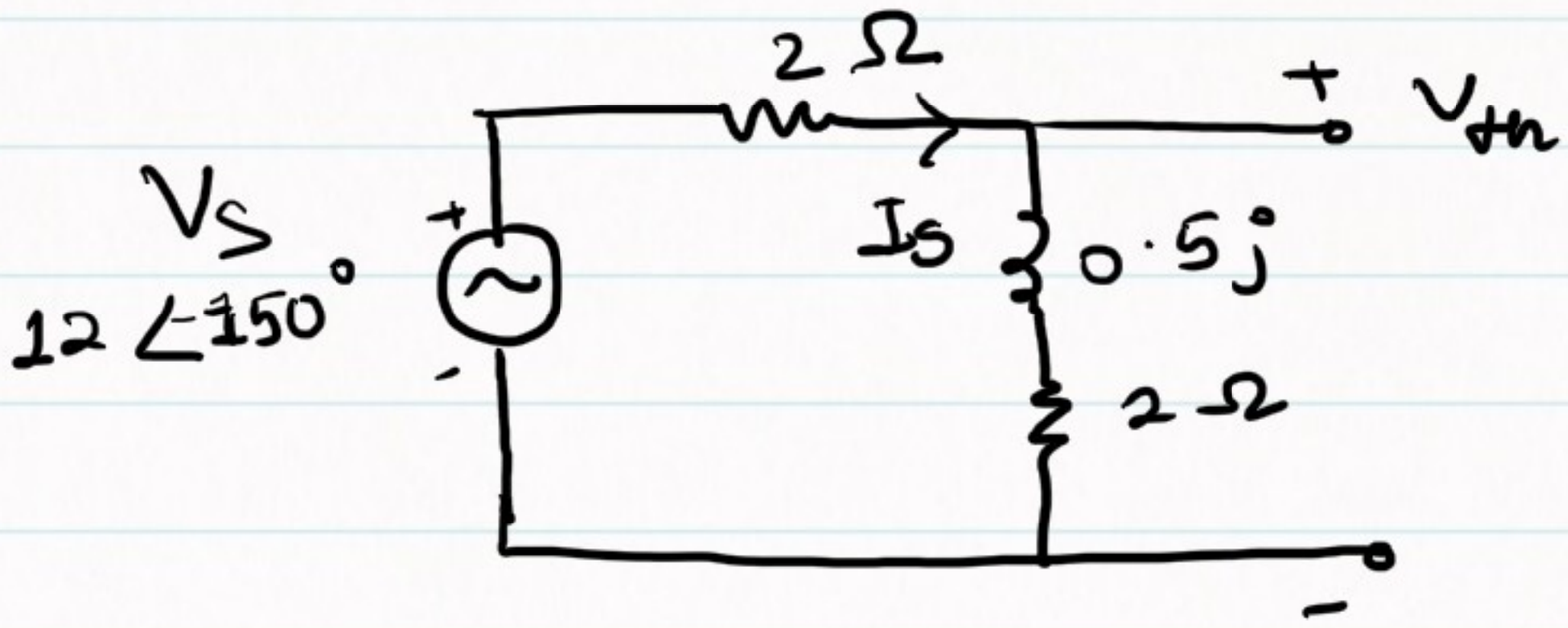
If $\omega = 1$ rad/s

$$= \frac{8.25 \angle 14.04^\circ}{8.06 \angle 7.13^\circ}$$

$$= 1.02 \angle 6.91^\circ$$

$$Z_{th} = 1.09 + j\,0.12\ \Omega$$

For V_{th}



Applying KVL,

$$-V_S + 2I_S + I_S\left(2 + \frac{j\omega}{2}\right) = 0$$

$$\Rightarrow \quad V_S = I_S\left(4 + \frac{j\omega}{2}\right)$$

$$\Rightarrow \quad I_S = \frac{(12 \angle -150^\circ)}{\left(4 + \frac{j\omega}{2}\right)}$$

$$\Rightarrow \quad I_S = \frac{12 \angle -150^\circ}{4.03 \angle 7.13^\circ} = 3 \angle -157.13^\circ \text{ A}$$

$$\Rightarrow I_S = -2.7 - 1.16j \text{ A}.$$

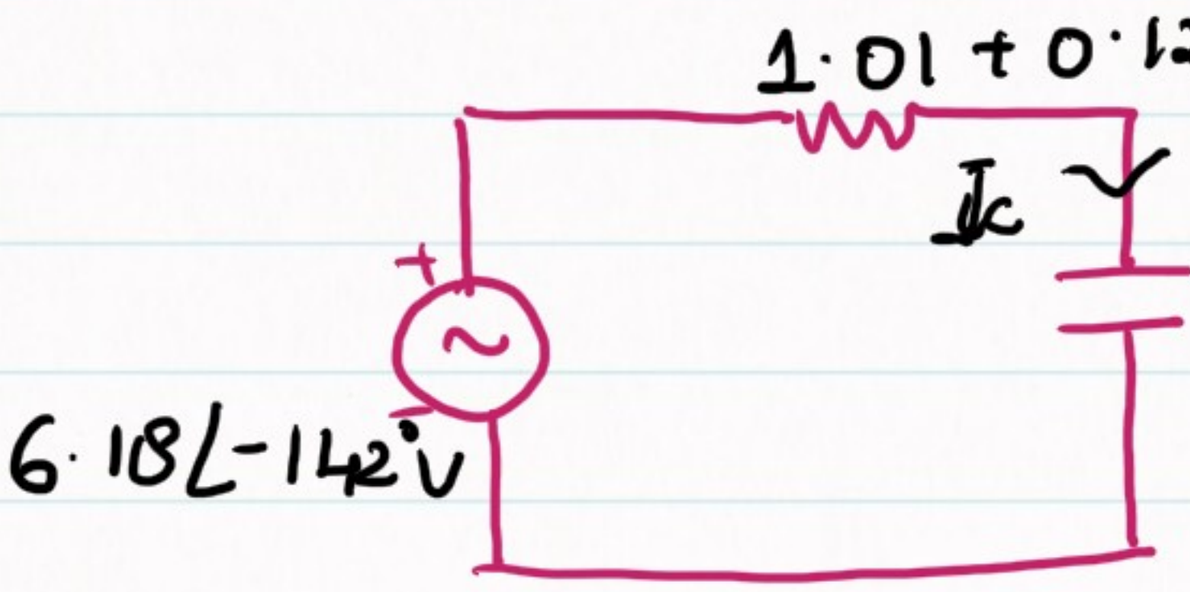
$$\therefore V_{th} = I_S(2 + 0.5j)$$

$$\Rightarrow V_{th} = 3 \angle -157^\circ \times 2.06 \angle 14.04^\circ$$

$$= 6.18 \angle -142.96^\circ$$

$$\boxed{V_{th} = -4.99 - 3.72j}$$

Now Thevenin ckt will be-



$$\frac{1}{j\omega(0.0625)} = \frac{-j}{0.0625}$$

$$= -j16\ \Omega$$

$$I_C = \frac{6.18\angle -142^\circ}{1.01 - 15.88j}$$

$$= \frac{6.18\angle -142^\circ}{15.91\angle -86.36^\circ}$$

$$I_C = 0.388\angle -55.64^\circ$$

$$\Rightarrow \boxed{i_C(t) = 0.388\cos(t - 55.64^\circ)\ A}$$

Also, $V_C = I_C \times Z_C$

$$= 0.388\angle -55.64^\circ \times \underbrace{(-j16)}_{\rightarrow 16\angle -90^\circ}$$

$$= 6.208\angle -145.46$$

$$\therefore \boxed{v_C(t) = 6.208\cos(t - 145.46^\circ)\ V}$$