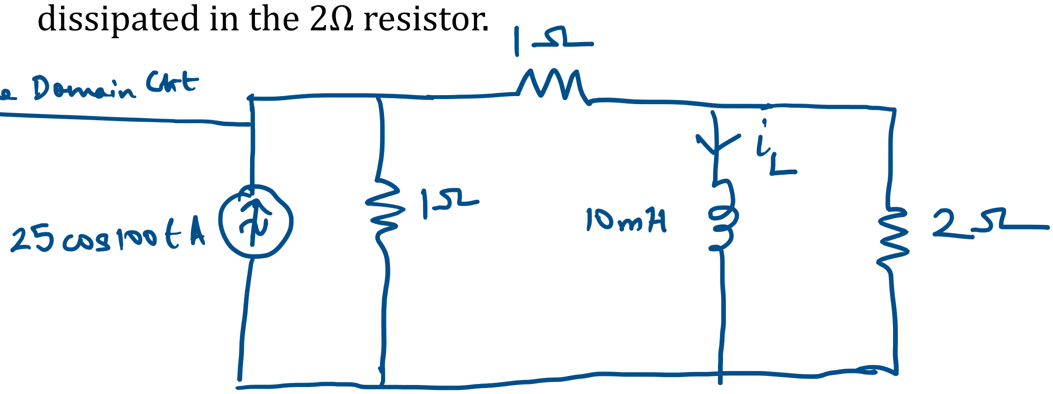
Mesh Analysis

- Assuming there are no longer any transients present, determine the current labeled i_L in the following circuit. Also calculate the power dissipated in the 2Ω resistor.

Time Domain Ckt



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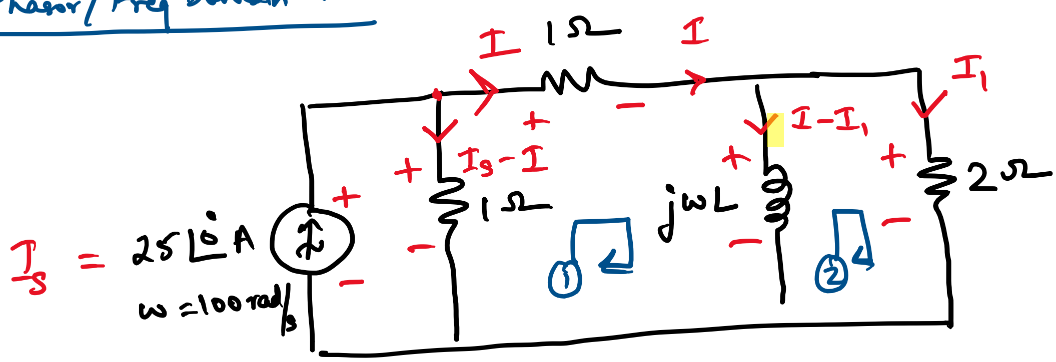
Phasor / Freq Domain Ckt



Mesh 1

$$+(I_s - I)(1) - I(1) - (I - I_1)(j\omega L) = 0$$

$$\Rightarrow I(-1-1-j\omega L) + I_1(+j\omega L) = -I_s$$

$$\Rightarrow I(2+j\omega L) + I_1(-j\omega L) = +I_s \quad \text{— (1)}$$

Mesh 2

$$+(I - I_1)(j\omega L) - (I_1)(2) = 0$$

$$\Rightarrow I(j\omega L) + I_1(-2-j\omega L) = 0 \quad \text{—— (2)}$$

$$\Rightarrow \begin{bmatrix} 2+j & -j \\ j & -2-j \end{bmatrix} \begin{bmatrix} I \\ I_1 \end{bmatrix} = \begin{bmatrix} 25 \\ 0 \end{bmatrix}$$

$$\Rightarrow I_1 = 4.419\angle 45^\circ \text{ A}, \quad P_{avg} = \tfrac{1}{2}|I_1|^2 R = 19.53 \text{ W}$$

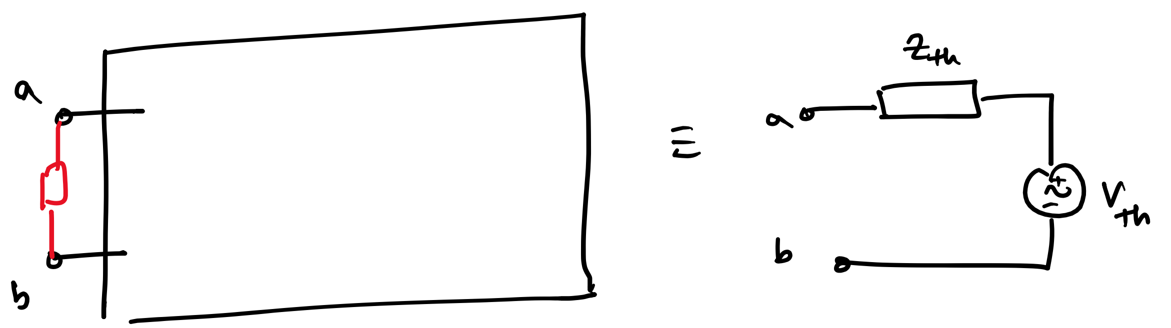
Thevenin's Theorem

I Independent Sources

II Independent + Dependent Sources

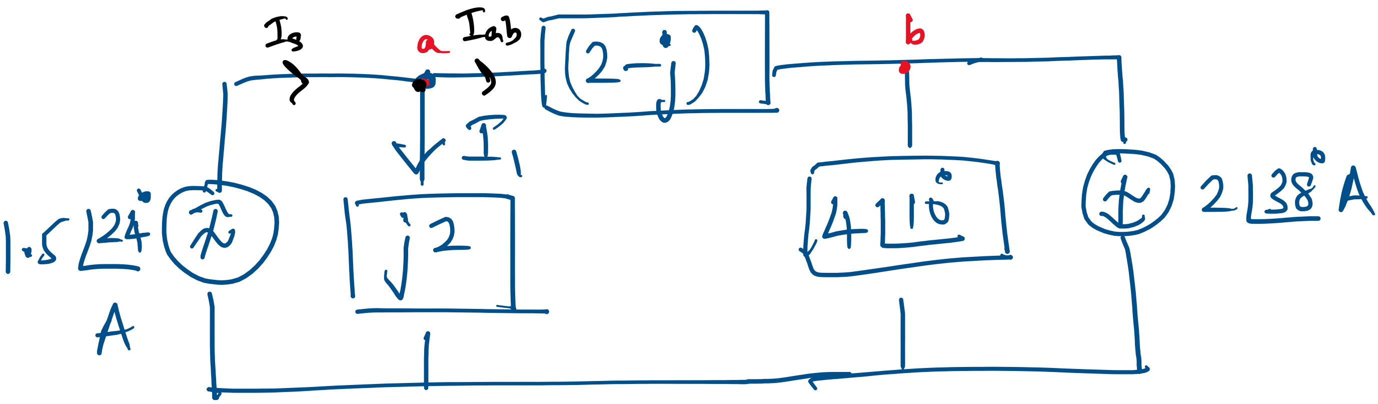
III Only Dependent sources

Thevenin's Equivalent

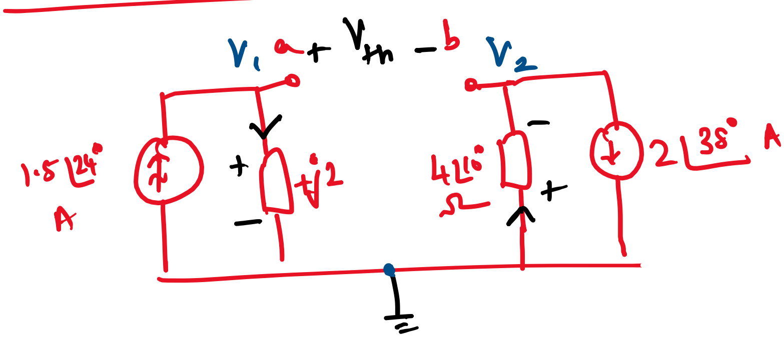


Step-1 Find V_{th}. → Open terminals ab & find V_{oc}

- Obtain the Thevenin equivalent seen by the $(2-j)\Omega$ impedance and employ it to determine the current I_1.



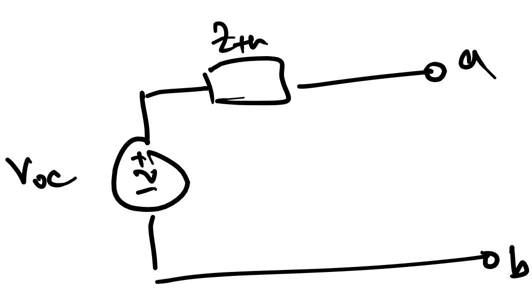
I Find V_{th}



$$\frac{V_1 - 0}{j2} = 1.5\angle 24^\circ \text{ A} \Rightarrow V_1 = j2 \times 1.5\angle 24^\circ$$
$$= 3\angle 114^\circ \text{ V}$$

$$\frac{0 - V_2}{4\angle 10^\circ} = 2\angle 38^\circ \text{ A} \Rightarrow V_2 = -2\times 4\angle 38^\circ + 10^\circ$$
$$= 8\angle 180^\circ + 48^\circ$$
$$= 8\angle 228^\circ \text{ V}$$

$$V_{oc} = V_1 - V_2 = \boxed{9.62\angle 64.5^\circ \text{ V}}$$

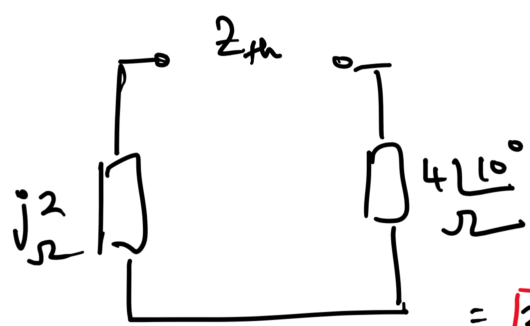


④

II Find Z_{th}

Turn off sources – $V_s \rightarrow$ short

$I_s \rightarrow$ open

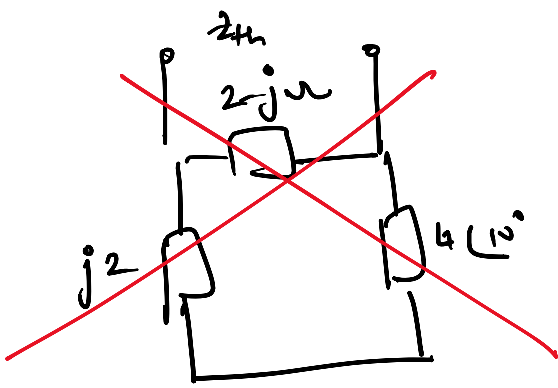


$$Z_{th} = j2 + 4\angle 10^\circ \ \Omega$$

$$= 1 + j2$$

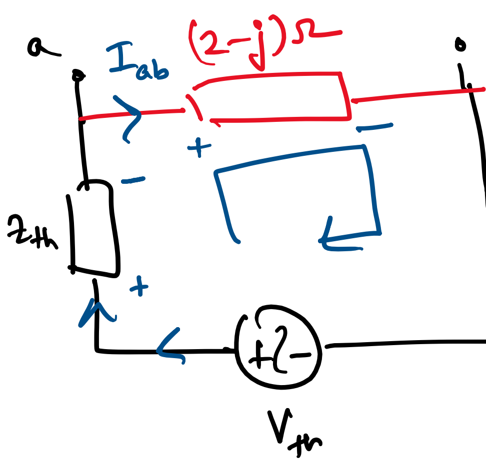
$$+ 4\cos(10^\circ) + j\,4\sin(10^\circ)$$

$$= \boxed{3.94 + j\,2.69\ \Omega}$$



$$\cancel{Z_{th} = (2-j) \parallel (j2 + 4\angle 10^\circ)\ \Omega}$$

$$\cancel{j2 + 4\angle 10^\circ} = \cancel{6\angle 100^\circ}\ \Omega$$

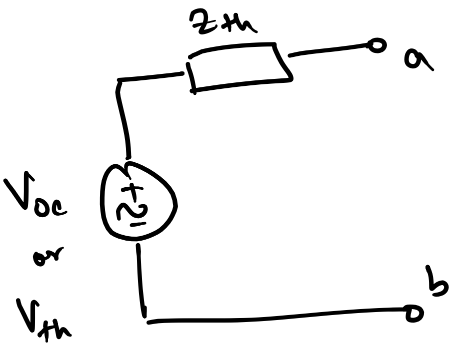


$$-I_{ab}Z_{th} - I_{ab}(2-j) + V_{th} = 0$$

$$I_{ab} = \frac{V_{th}}{Z_{th} + (2-j)} =$$

$$I_1 = I_s - I_{ab} = 0.65\angle -58.6^\circ \ \text{A}$$

Thevenins Equivalent



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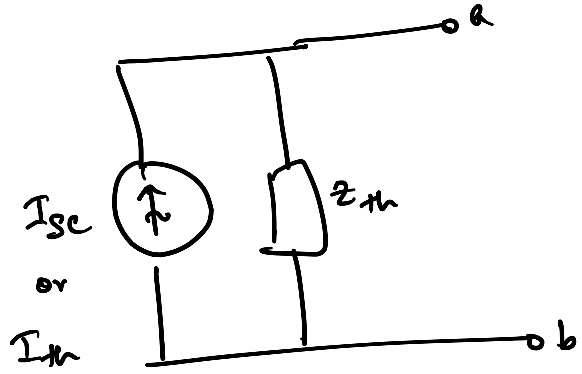
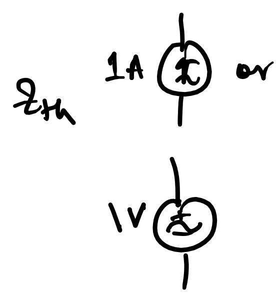
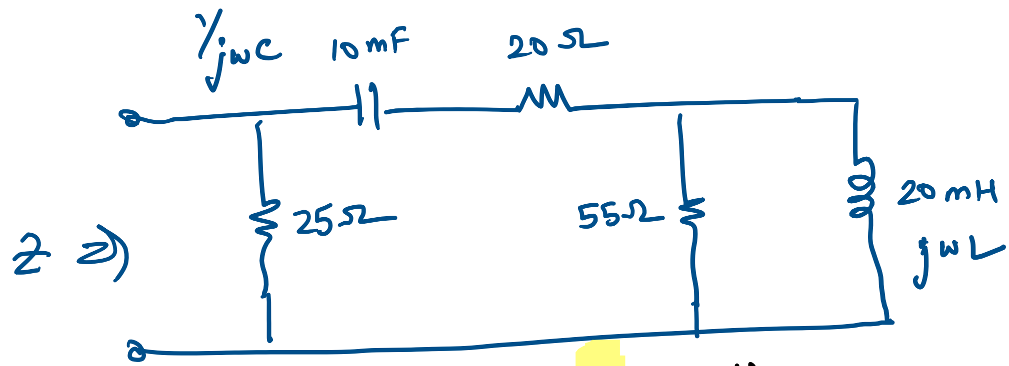


Cases	V_{oc}	I_{sc}	Z_{th}	Dummy source
Independent Sources	✓ ✓	✓ ✓	✓ ✓	
Independent + Dependent source	✓	✓		
only Dependent source				



- Consider the network depicted in the figure, and determine the equivalent impedance seen looking into the open terminals if the angular frequency is 1 rad/s.



rad/s ← $\omega = 2\pi f$ → Hz

pico — p — 10^{-12}	Peta (?)		
nano — n — 10^{-9}	Giga —	G	10^{9}
micro — μ — 10^{-6}	mega —	M	10^{6}
milli — m — 10^{-3}	kilo —	K	10^{3}

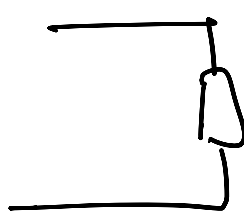
$$Z = \left[\left(j\omega L \parallel 55\right) + \left(20 + \frac{1}{j\omega C}\right)\right] \parallel 25$$

$$\frac{1}{Z_p} = \frac{1}{Z_1} + \frac{1}{Z_2} = \frac{Z_2 + Z_1}{Z_1 Z_2}$$

$$\Rightarrow \quad Z_p = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z = 11.13 + j0.16\ \Omega$$

Thevening



$Z_{th} = Z = 11.13 + j0.16\,\Omega$

$V_{oc} = 0\ V$

$I_{sc} = 0\ A$