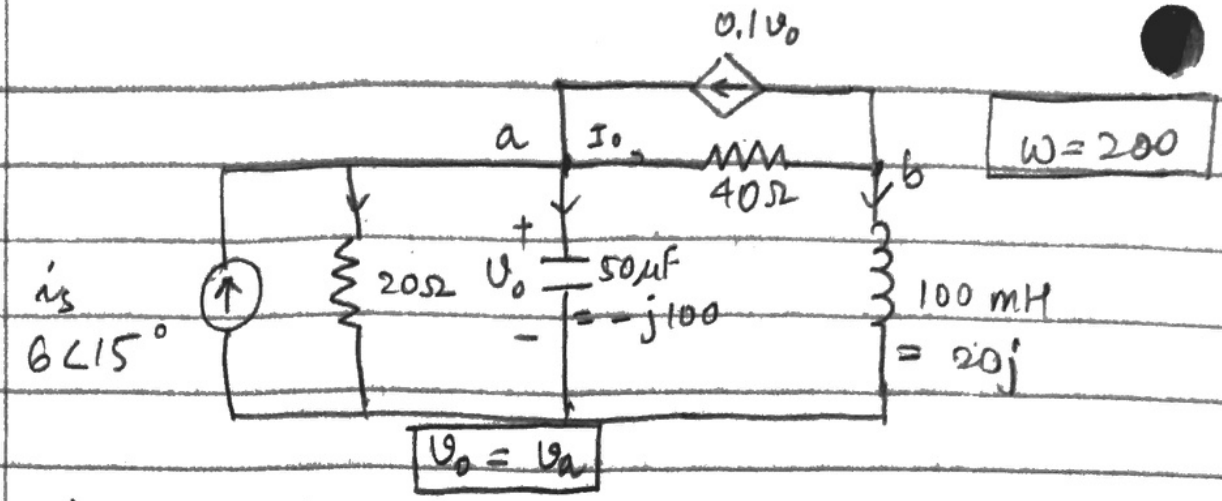
HW #10

* 10.8
* 10.38
* 10.48
* 10.52
* 10.56
* 10.62

10.8



at Node a:

$$6\angle 15^\circ + 0.1 v_a = \frac{v_a}{20} + \frac{v_a}{-100j} + \frac{v_a - v_b}{40}$$

(½) or $5.8 + 1.55j = (-0.025 + 0.01j) V_a - 0.025 V_b$ — (1)

at node b:

$$\frac{V_a - V_b}{40} = \frac{v_b}{20j} + 0.1 v_a$$

(½) or $3 v_a + (1 - 2j) v_b = 0$ — (2)

Solving eqn. (1) & (2):

(1) $v_a = -2.45 + 145.5\, j$ V

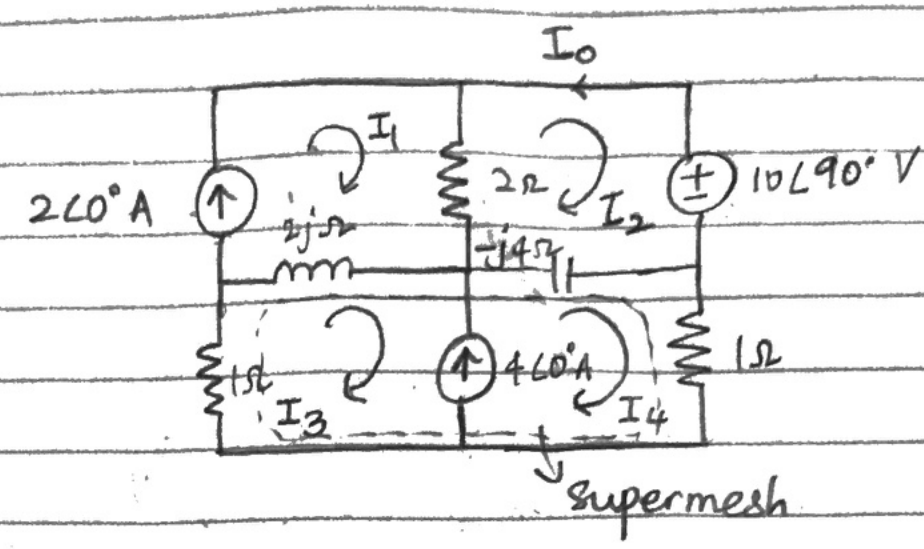
$v_b = -176.07 + 84.36\, j$ V

$\therefore I_o = \frac{v_a - v_b}{40}$.

(½) $= 7.27\angle -52.129$ A

$= 7.27 \cos(200t - 52.129)$ A

10.38



First, $I_1 = 2A$

For Mesh 2:

$$2(I_2 - 2A) + 10\angle 90° + (-4j)(I_2 - I_4) = 0$$

$$\Rightarrow 2(1-2j)I_2 + (4j)I_4 = 4 - 10j$$

(½) $$\Rightarrow (1-2j)I_2 + (2j)I_4 = 2 - 5j \quad -(1)$$

For supermesh:

$$(1+2j)I_3 - 2(2j) + (1-4j)I_4 + (4j)I_2 = 0$$

(½) $$\Rightarrow (1+2j)I_3 + (1-4j)I_4 + (4j)I_2 = 4j \quad -(2)$$

Constraint eq^n:

(½) $$I_4 - I_3 = 4 \quad -(3)$$

Subsitute (3) in (2):

(½) $$(2-2j)I_4 + (4j)I_2 = 4j + 4 + 8j$$

$$(1-j)I_4 + (2j)I_2 = 2 + 6j \quad -(4)$$

Solving ① & ④ :

① $I_2 = 3.33 - 0.33j$ A

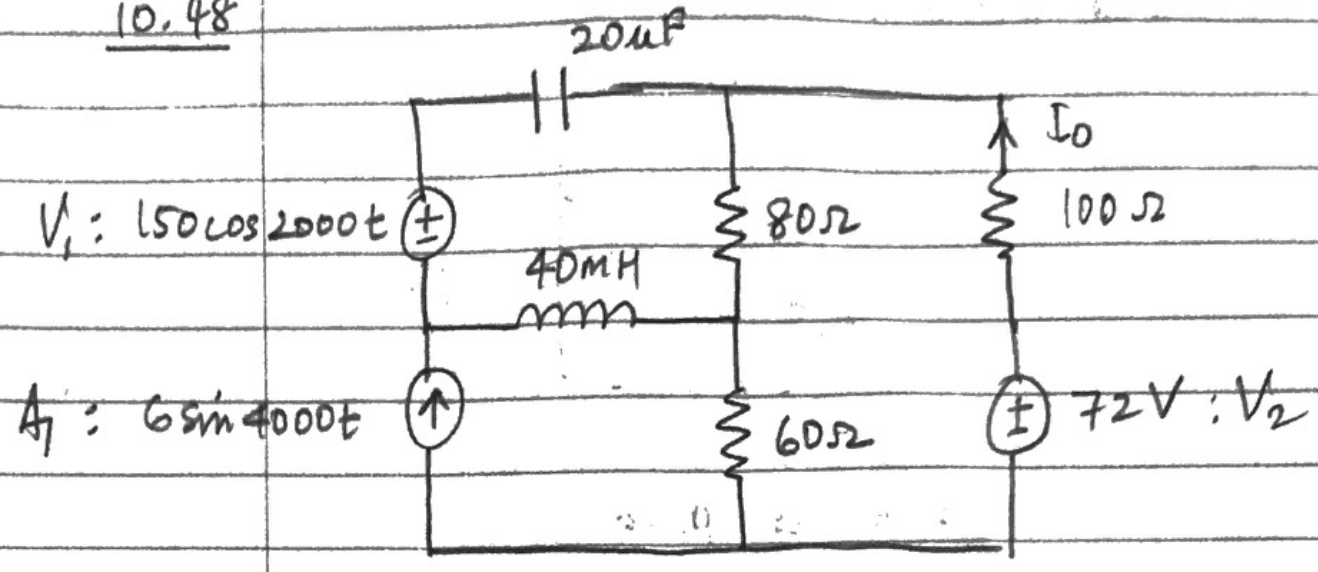
$\because I_0 = -I_2$,

$\therefore I_0 = (-3.33 + 0.33j)$ A

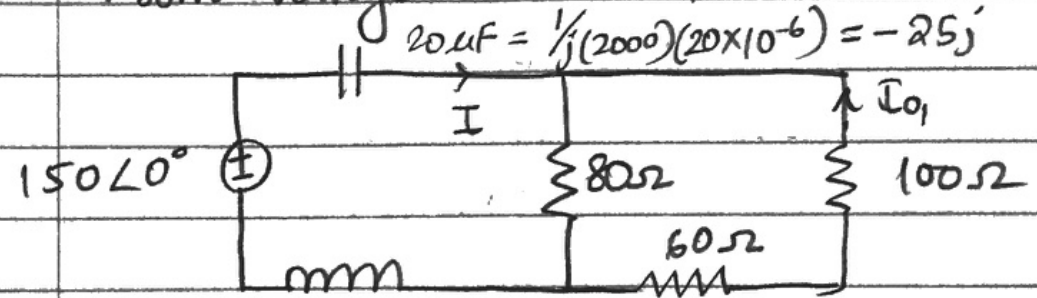
$= 3.34 \angle 174.34$ A

½

10.48



From voltage source V_1 :



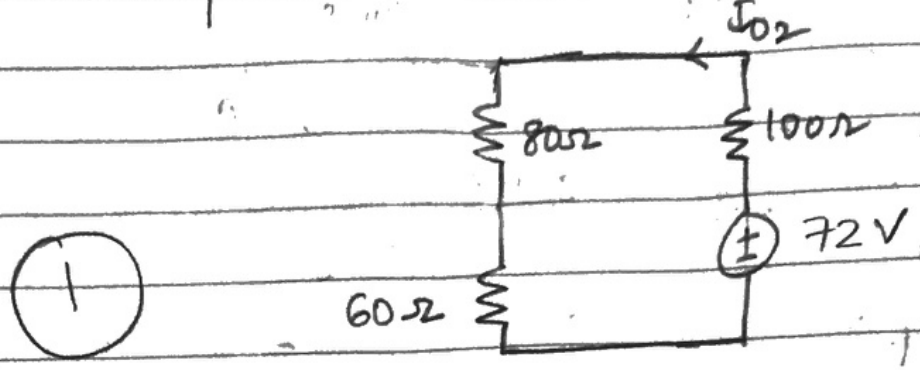
(1) $I_{o_1} = \frac{-80}{(80+160)} I = -\frac{1}{3}\left(150\right)\left(\frac{1}{(80\|160)+55j}\right)$

$= -\frac{1}{3}\left(\frac{90}{32+33j}\right)$

$= -\frac{30}{(32+33j)}$

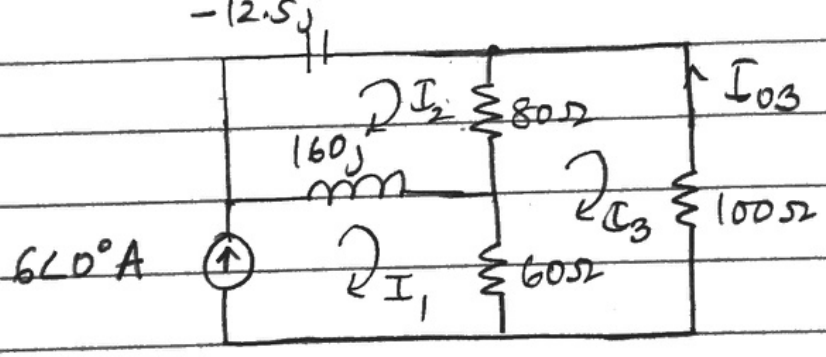
$= 0.652 \angle 134.118^\circ$ A

For voltage source V_o:



$$\therefore I_{02} = \frac{72\,V}{240\,\Omega} = 0.3\,A$$

For current source I_1:



First $I_1 = 6\angle 0°\,A$

Mesh 2:

$$(80 + 147.5j)\,I_2 - 80\,I_3 = (160j)\,6 = 960j \quad - (1)$$

Mesh 3:

$$240\,I_3 - 80\,I_2 = 360$$

$$6\,I_3 - 2\,I_2 = 9 \quad - (2)$$

Solving (1) and (2):

$I_3 = 3.5 + 0.45j$ A

$= 3.52 \angle 7.38°$

(1)

$\therefore I_{03} = -I_3 = 3.52 \angle -172.67°$ A

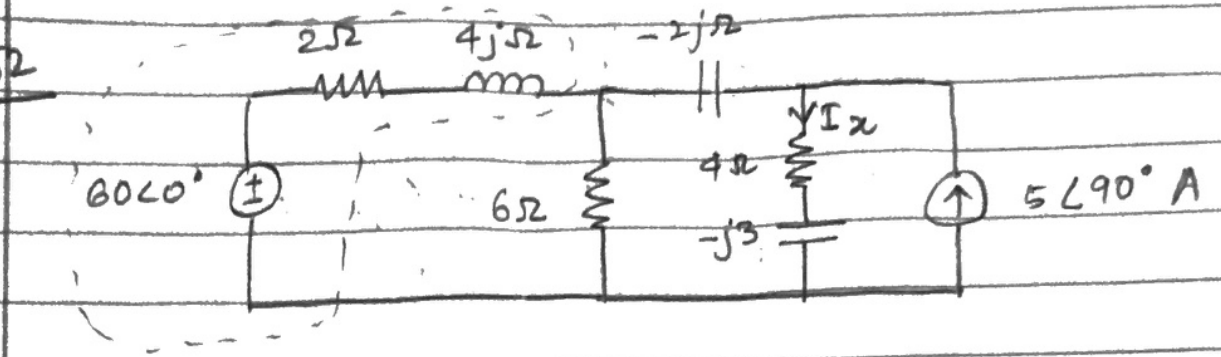
$\therefore I_o = I_{01} + I_{02} + I_{03}$

$= \{0.3 + 0.652 \cos(2000t + 134.118)$

$+ 3.52 \sin(4000t - 172.67)\}$ A

(2)

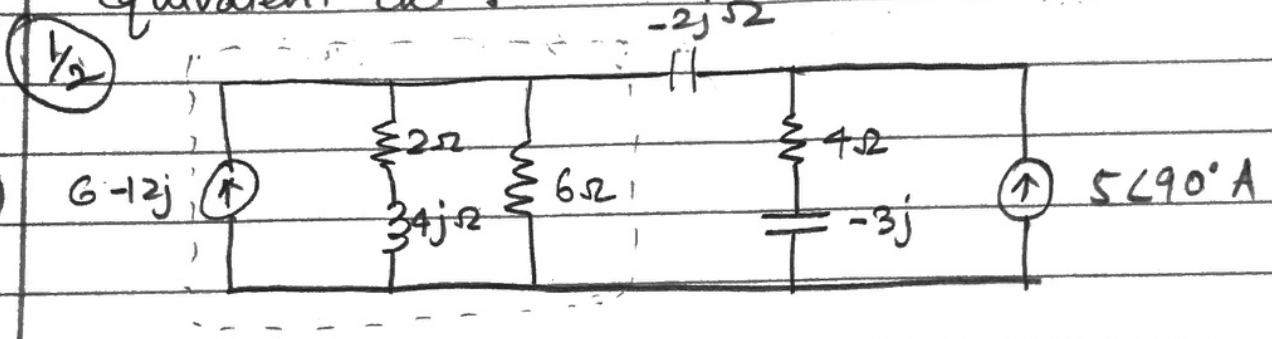
10.52



Source Transformation:

$$I_s = \frac{60}{2+4j} = 6 - 12j \text{ A}$$

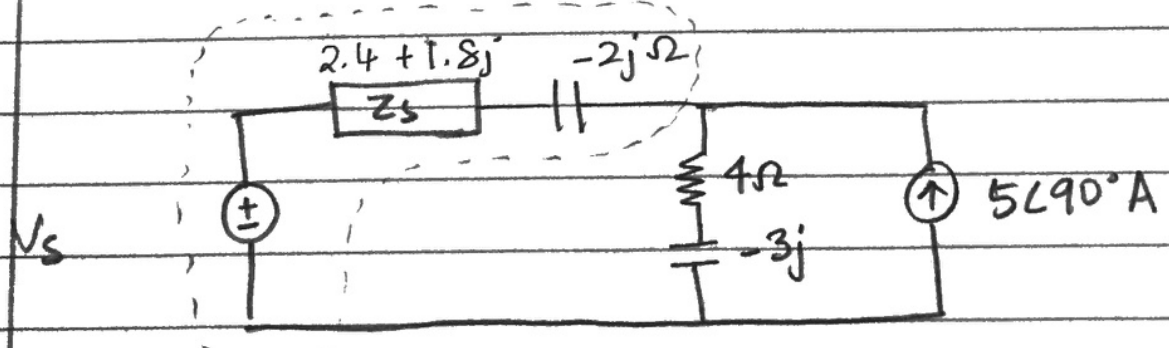
equivalent ckt:



(1/2) $Z_s = 6 \parallel (2+4j) = 2.4 + 1.8j$

(1/2) $V_s = (6-12j)(2.4+1.8j) = 18(2-j)\text{ V}$

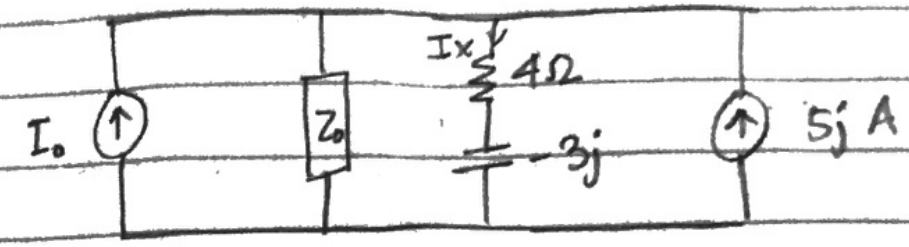
equivalent ckt:



$Z_o = 2.4 - 0.2j$

(1/2) $\therefore I_o = \frac{V_s}{Z_o} = \frac{18(2-j)}{(2.4-0.2j)} = 15.52 - 6.21j \text{ A}$

equivalent ckt:



$$\therefore I_x = \frac{Z_o}{Z_o + 4 - 3j} (I_o + 5j)$$

(1/2)

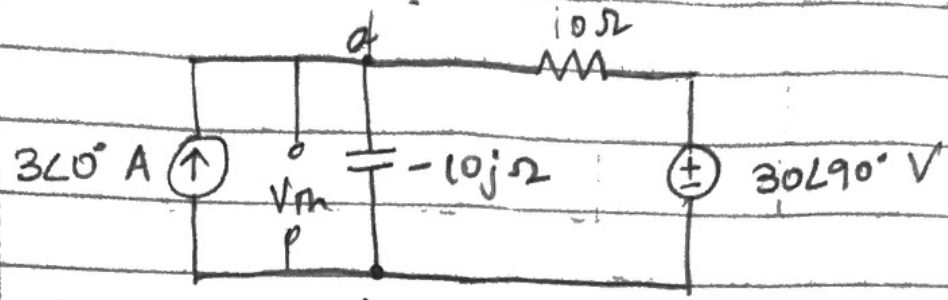
$$= \frac{2.4 - 0.2j}{6.4 - 3.2j} (15.517 - 1.207j)$$

$$= 4.99 + 1.562j \text{ A}$$

$$= 5.23 \angle 17.38^\circ \text{ A}$$

10.58

Approach I :



For V_{Th}

At node a :

$$3 = \frac{V_a - j30}{10} + \frac{V_a}{-10j} \quad (1)$$

$$30 = V_a - 30j + V_a j$$

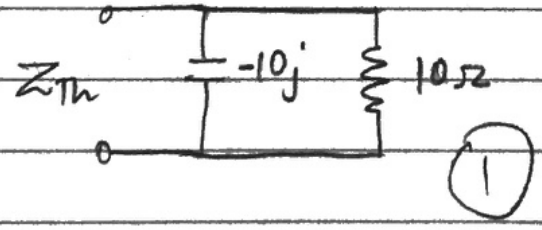
$$\Rightarrow 30 + 30j = V_a(1 + j)$$

$$\Rightarrow 30(1 + j) = V_a(1 + j)$$

$$\therefore V_a = 30\,V$$

$$\therefore V_{Th} = V_{ab} = \underline{30V}$$

Z_{Th} : equivalent ckt :

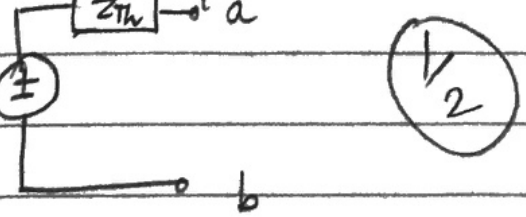


(1)

$$Z_{Th} = (-10j \,||\, 10)$$

$$= \underline{5 - 5j\ \Omega}.$$

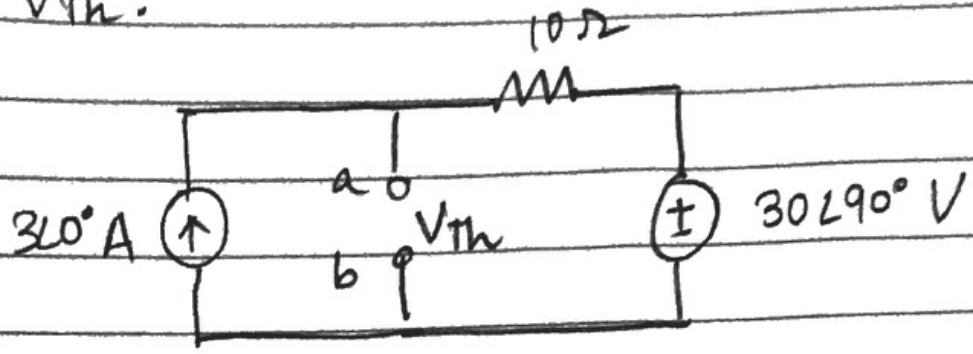
$\therefore$ Thevenin equivalent :



(1/2)

Approach II:

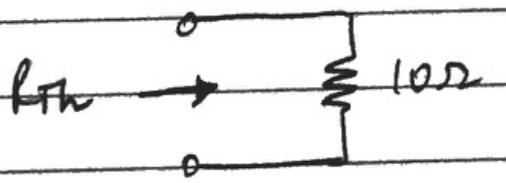
V_{Th}:



$$3 = \frac{V_{Th} - 30j}{10\Omega} \quad (1)$$

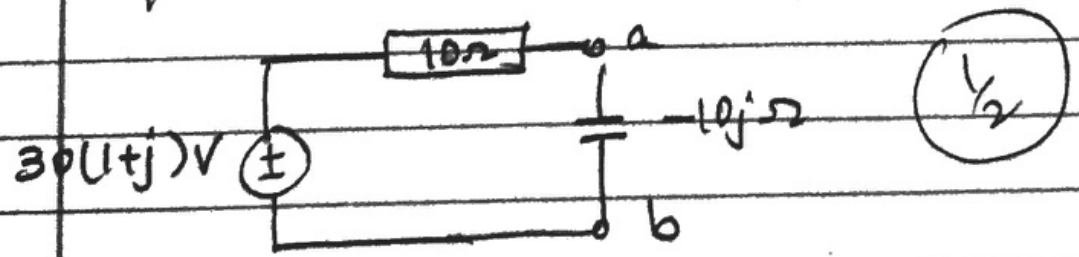
$$\therefore V_{Th} = 30(1+j)\ V$$

Z_{Th}:



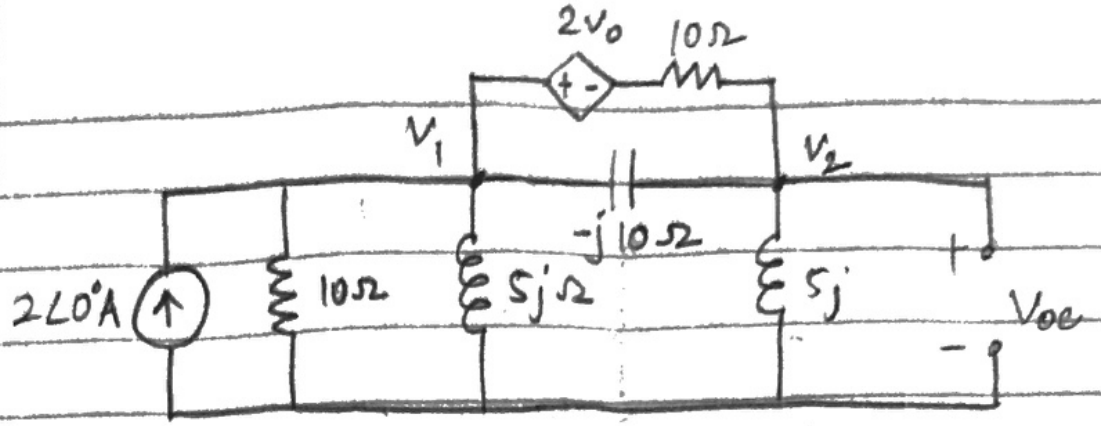
$\therefore R_{Th} = 10\Omega$ (1)

Equivalent ckt:



(½)

10.62



First : $V_0 = V_2$

At node 1 :

$$2 = \frac{V_1}{10} + \frac{V_1}{5j} + \frac{V_1 - V_2}{-j10} + \frac{V_1 - 2V_2 - V_2}{10} = 0$$

$$\Rightarrow 20 = V_1 - 2V_1 j + (V_1 - V_2)j + V_1 - 3V_2$$

$$= 2V_1 - 3V_2 - (V_1 + V_2)j$$

$$= (2 - 1j)V_1 - (3 + 1j)V_2 \quad - (1)$$

V_2

At node 2 :

$$\frac{V_2 - V_1}{(-10j)} + \frac{V_2 + 2V_2 - V_1}{10\Omega} + \frac{V_2}{5j} = 0$$

V_2

$$\Rightarrow (0.1j)(V_2 - V_1) + 0.1(3V_2 - V_1) - 0.2jV_2 = 0$$

$$(-0.1)(1+j)V_1 + (0.3 - 0.1j)V_2 = 0 \quad - (2)$$

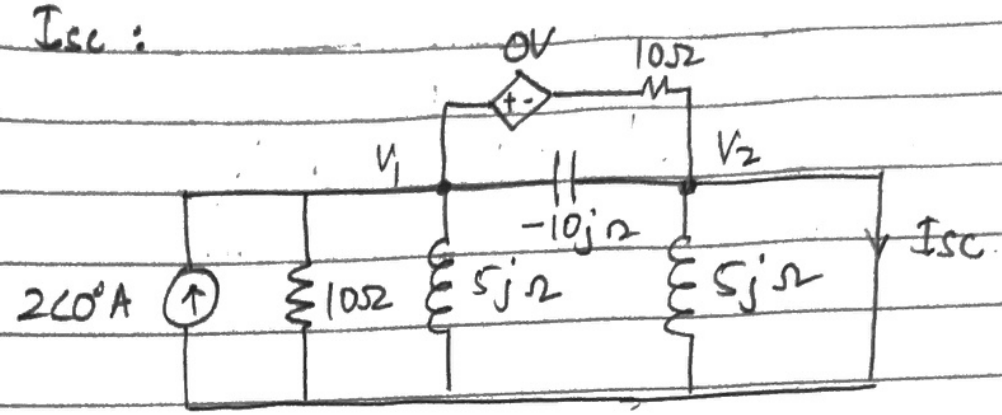
Solving (1) & (2) :

$$V_2 = 2.98 \angle 116.56 V$$

$$= V_{Th}$$

1

I_{sc} :



$\therefore V_2 = 0$.

$\therefore$ Substituting $V_2 = 0$ in (1)

$V_1 = 8 + 4j$ V (½)

At node 2 :

$$\frac{V_2 - V_1}{-(10j)} + \frac{V_2 - V_1}{10} + I_{sc} = 0 \quad (½)$$

$$\therefore I_{sc} = \frac{-V_1}{10j} + \frac{V_1}{10}$$

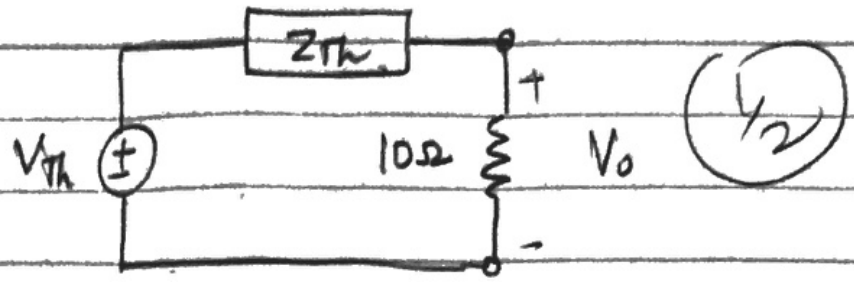
$$= -0.4 + 0.8j + 0.8 + 0.4j$$

$$= 0.4 + 1.2j$$

$$= 1.26 \angle 71.56° \quad (½)$$

$$\therefore Z_{Th} = \frac{V_{Th}}{I_{sc}}$$

$$= 2.357 \angle 45° \ \Omega \quad (½)$$


Zth
+
V_{Th}
±
10Ω
V_o
-
1/2