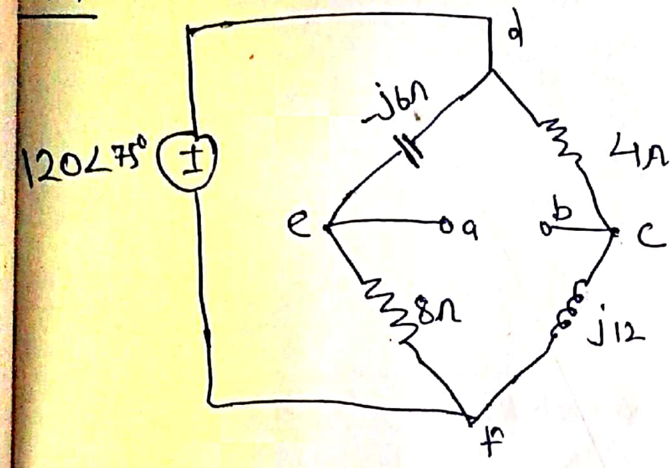
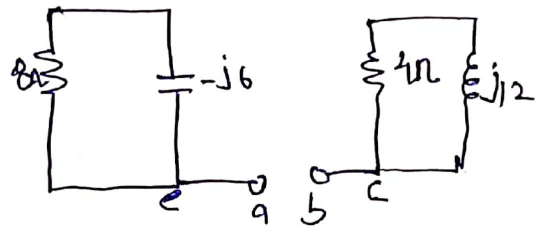
Soln. Tute - 7

ln. 1



$\Leftrightarrow$

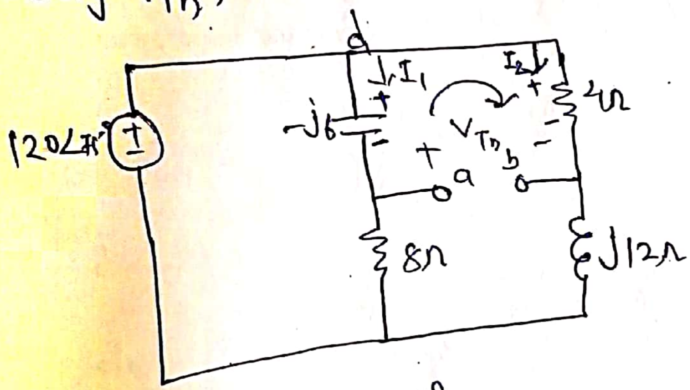


Finding Z_{Th}

$$Z_{Th} = (-j6 \| 8\Omega) + (j12 \| 4\Omega)$$

$$Z_{Th} = 2.88 - j3.84 + 3.6 + j1.2\,\Omega = 6.48 - j2.64\,\Omega$$

Finding V_{Th},



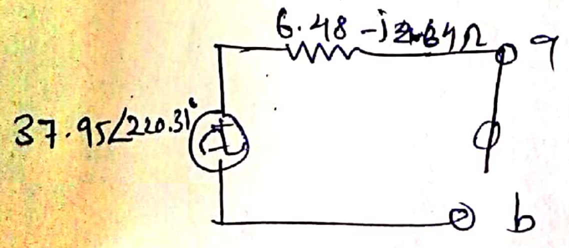
$$I_1 = \frac{120\angle 75^\circ}{8 - j6}, \quad I_2 = \frac{120\angle 75^\circ}{4 + j12}$$

Applying KVL

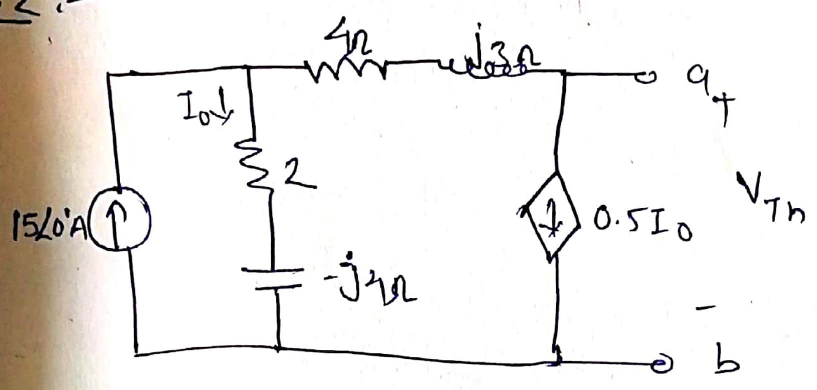
$$V_{Th} + I_1(-j6) - 4I_2 = 0$$

$$\Rightarrow V_{Th} = 4I_2 + j6I_1 = \frac{480\angle 75^\circ}{4+j12} + \frac{720\angle 75+90}{8-j6}$$

$$V_{Th} = 37.95\angle 220.31^\circ\,V$$



Qn.2 :-



Finding Thevenin's Voltage V_{Th} :-

$$15\angle 0° = I_0 + 0.5I_0$$

$$15\angle 0° = 1.5I_0$$

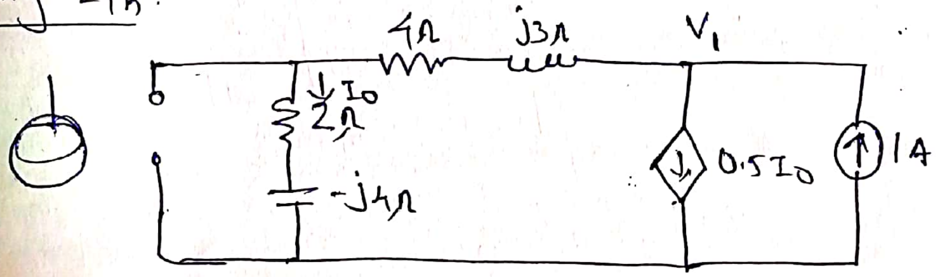
$$\Rightarrow I_0 = \frac{15}{1.5} = 10 \Rightarrow \boxed{I_0 = 10\,A}$$

Applying KVL to the loop,

$$-(2-j4)I_0 + 0.5I_0(4+j3) + V_{Th} = 0$$

$$\Rightarrow V_{Th} = 55\angle -90°$$

Finding Z_{Th} :-



$$1A = 0.5I_0 + \frac{\cancel{V_1 - 0}}{(4+\cancel{j3})+(2-j4)} \quad 9 I_0$$

$$\Rightarrow 1A = \cancel{0.5I_0} + \frac{V_1}{6-j1} \qquad \boxed{I_0 = 2/3\,A}$$

$$1A = 0.5I_0 + \frac{V_1 - 0}{(4+j3+2-j4)}$$

$$1A = 0.5I_0 + \frac{V_1}{6-j1}$$

$$1 = \frac{1}{3} + \frac{V_1}{6-j1}$$

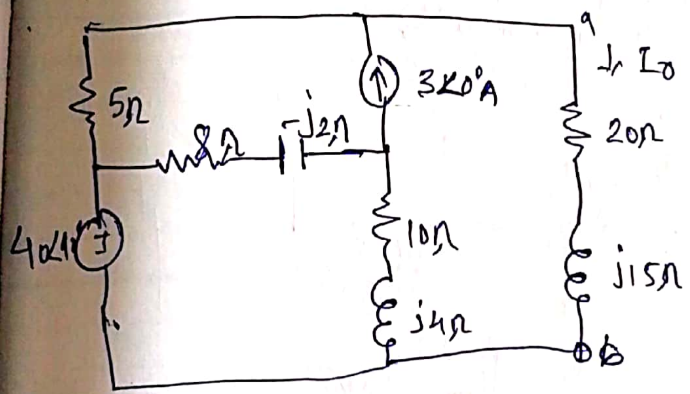
$$V_1 = \frac{2}{3}(6-j1)$$

$$V_1 = 4 - \frac{2}{3}j1$$

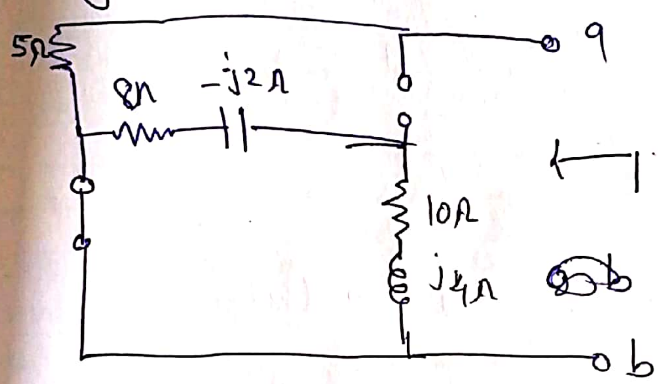
$$Z_{Th} = \frac{V_1}{1} = 4 - \frac{2}{3}j$$

$$\boxed{Z_{Th} = 4 - j0.6667\,\Omega}$$

Q.-3



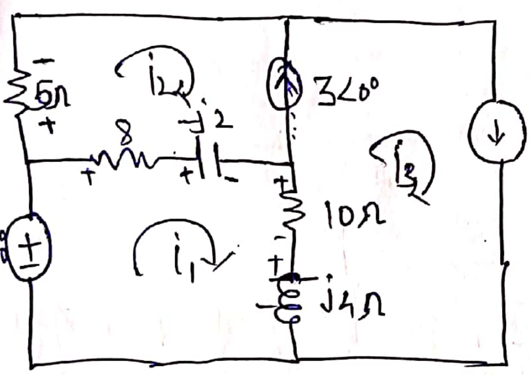
Finding Z_{Th} :-



As evident from fig. (8-j2) & (10+j4), Impedences are short circuited. So that,

$$\boxed{Z_N = 5\Omega}$$

Finding V_{Th}



Applying KVL in Loop (1)

$$40\angle 90^\circ = (8-j2)\,i_1 - (8-j2)\,i_2 + (10+j4)\,i_1 - (10+j4)\,i_3$$

$$40\angle 90^\circ = (18+j2)\,i_1 - (8-j2)\,i_2 - (10+j4)\,i_3 \quad -(1)$$

Loop 2, Consists of one current source, therefore

$$i_1(10+j4) - (10+j4)\,i_3 + (8-j2)\,i_1 - (8-j2)\,i_2 - 5i_2 = 0$$

$$\Rightarrow \cancel{(10-j4)\,i_1 + (8-j2)\,i_2 - (18-j6)\,i_3 = 0}$$

$$\cancel{(18-j6)\,i_1 - (13-j2)\,i_2 - (10-j4)\,i_3}$$

$$(18+j2)\,i_1 - (13-j2)\,i_2 - (10+j4)\,i_3 = 0 \quad -(2)$$

Also,

$$i_2 + 3 = i_3 \quad -(3)$$

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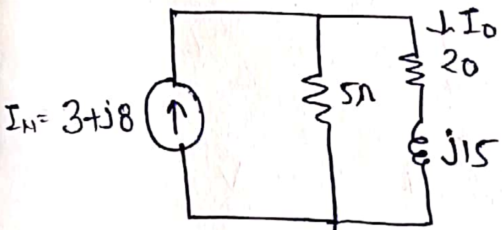
Solving 3 Equations,

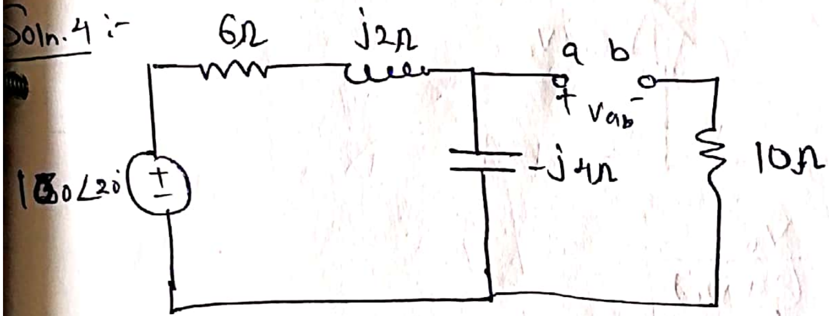
$$i_3 = 3+j8$$

$$\text{So, } i_N = i_3 = (3+j8)\,A$$

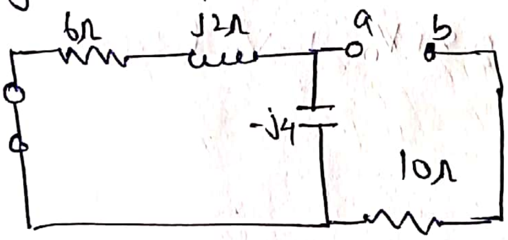


$$I_o = \frac{5(3+j8)}{5+20+j15} = \frac{\cancel{5}(3+j8)}{\cancel{5}(5+j3)} = 1.465\angle 38.48°$$

Soln. 4 :-



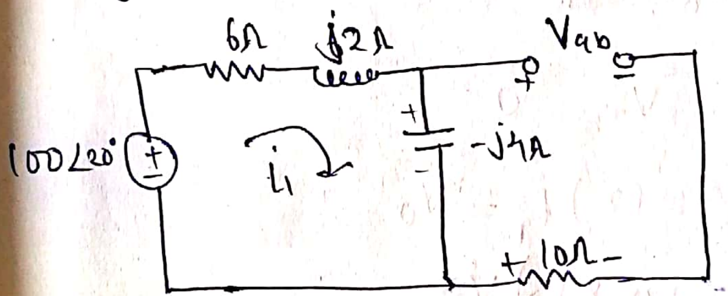
Finding R_{Th}



$$R_{Th} = \frac{(6+j2)\,||\,-j4}{(6-j2)} + 10$$

$$Z_{Th} = 12.4 - j3.2\,\Omega$$

Finding Thevenin's Voltage (V_{Th})



$$100\angle 20 = (6+j2)i_1 + (-j4)\,i_1 - \cancel{j4 i_2} \quad (1)$$

$$\Rightarrow \cancel{100\angle 20 = (6-j2)i_1 + j4 i_2} \quad (1)$$

$$i_1 = \frac{100\angle 20}{6-j2}$$

$$\boxed{i_1 = 12.38 + 9.82j}$$

$$V_{ab} = j4(i_1 - i_2) \quad \cancel{= \ldots} \quad (2)$$

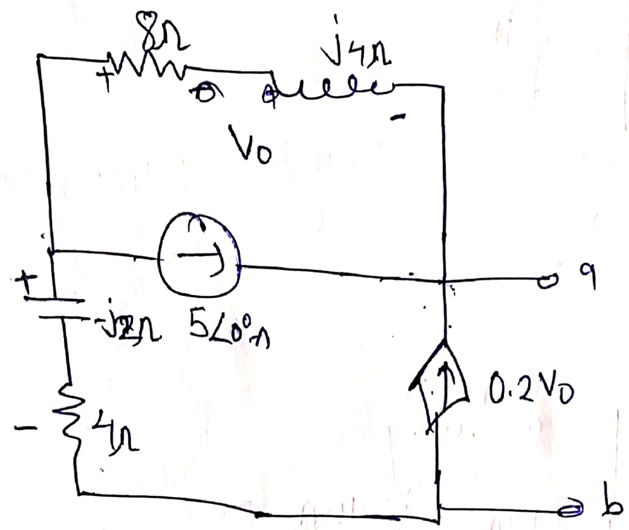
$$\Rightarrow \cancel{V_{ab} = j4 i_1 + (j4+10)i_2\ (10-j4)i_2} \quad (2)$$

$V_{ab} = -j4(12.38 + 9.82j)$

$\boxed{V_{ab} = 63.20\angle -51.57^\circ}$

$\boxed{V_{ab} = 39.28 - 49.52 j}$

<u>Soln. 5 :-</u>



$5\angle 0^\circ = -0.2V_0 - \dfrac{V_0}{(8+j4)}$

$(8+j4)(5+j0) = -1.6V_0 - 0.8jV_0 - V_0$

$\Rightarrow \cancel{40+j20 = -3.4V_0 - 2.6V_0 - 0.8jV_0} \Rightarrow -V_0(2.6+$

$\Rightarrow \cancel{\boxed{V_0 = -\frac{200}{17} + \frac{100}{17}j}}$

$\cancel{(4-j2)\ V_0} \quad \cancel{V_1 - V_0 - V_{Th} = 0}$

$\Rightarrow (4-j2)i_1 - V_0 - V_{Th} = 0$

$\Rightarrow V_{Th} = (4-j2)i_1 - V_0$

$40 + j20 = (-2.6 - 0.8j)V_0$

$\Rightarrow V_0 = \dfrac{(40+j20)}{(-2.6-0.8j)}$

$\boxed{V_0 = -600/37 - \dfrac{100}{37}j} \Rightarrow \boxed{V_0 = 16.43\angle -170}$

Also,

$$\frac{V_1}{4-j2} + 5\angle 0^\circ + \frac{V_0}{8+j4} = 0$$

$$\Rightarrow \frac{V_1}{4-j2} + 5\angle 0^\circ + \frac{(-16.21-2.70j)}{(8+j4)} = 0$$

$$\frac{V_1}{4-j2} = -5-j0+1.75+0.5405j$$

$$\Rightarrow \frac{V_1}{(4-j2)} = -\cancel{6.75}^{\,3.25}+0.54j$$

$-14.057+4.32j$ $14.707\angle 162.89$

$\cancel{11.92}$ $\cancel{8.66}$ $\cancel{14.73\angle 144}$

$$\Rightarrow \boxed{V_1 = \cancel{-28.08}+\cancel{11.34}j = \cancel{30.28}\angle 158^\circ}$$

X

Applying KVL in Supermesh,

$$V_1 - V_0 - V_{Th} = 0$$

$$\Rightarrow V_{Th} = V_1 - V_0 \quad 14.707\angle 162.89$$

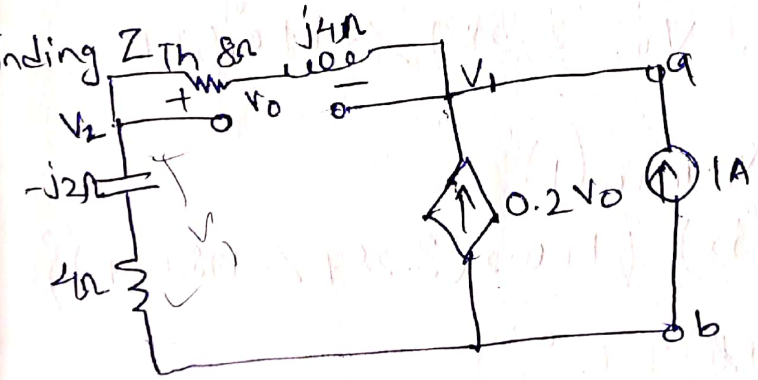
$$V_{Th} = \cancel{14.73\angle 144} \quad \cancel{30.28\angle 158^\circ} - 16.43\angle -170.53$$

$12.144\angle \cancel{69.31}^\circ$

$$\boxed{V_{Th} = \cancel{18.38\angle 130^\circ}}$$

$$\boxed{V_{Th} = 7.35\angle 72.9^\circ}$$

Finding Z_{Th}



$1A = 0.2V_0 + \frac{V_1 - \cancel{(12+j2)}\ 0}{12+j2}$

$= \cancel{0.2}$

$V_1 - (12+j2)(1 + 0.2V_0) = 0$

$\Rightarrow \quad V_1 = (12+j2)(1+0.2V_0) \quad -(1)$

but $V_0 = \cancel{(8+j4)} - (8+j4)(1+0.2V_0)$

$\cancel{V_0 = -[8 + 1.6V_0 + j4 + 0.8V_0 j]}$

$\cancel{\Rightarrow \ -V_0 - 1.6V_0 - 0.8jV_0 = 8+j4}$

$\cancel{\Rightarrow \ -2.6(V_0 + 0.8j)}$

$\cancel{\Rightarrow \ (-2.6+0.8j)V_0 = -(8+j4)}$

$\cancel{V_0 = 3.287\angle 43.66^\circ} \quad -(2)$

$\cancel{V_1 = (12+j2)(1+0.2}$

$\cancel{= 18.78\angle}$

$\frac{1+0.2V_0}{V_0} = \frac{-1}{8+j4}$

$\Rightarrow \quad \frac{1}{V_0} + 0.2 = -\frac{1}{8+j4}$

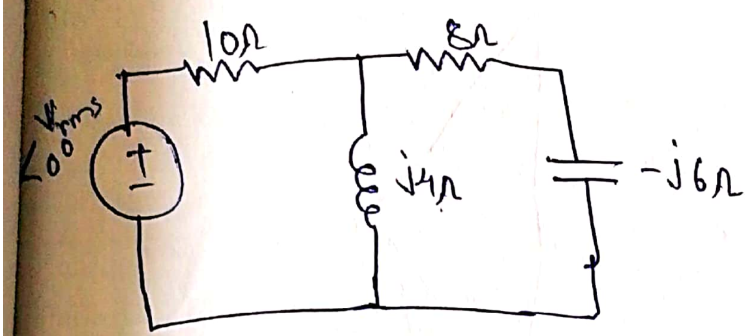
$\Rightarrow \quad \frac{1}{V_0} \Rightarrow \boxed{V_0 = 3.287\angle -170^\circ.537}$

Substituting V_0 into (1)

$V_1 = (12+j2)\{1 + 0.2(3.287\angle -170.537)\}$

$\boxed{V_1 = 4.47\angle -7.62^\circ}$

6.6.



Soln:

$$Z_{in} = 10 + \{ j4 \parallel (8-6j) \}$$

$$= 10 + \frac{j4(8-6j)}{8-j2}$$

$$Z_{in} = 12.695\angle 20.61^\circ = 11.88 + 4.47j$$

$$i = V/Z_{in} = \frac{165\angle 0^\circ}{12.69\angle 20.66} = 13.00\angle -20.61^\circ$$

$$P_{ave} = \frac{1}{2} V_m I_m \cos\{0 - (-20.61^\circ)\} \times \sqrt{2} \times \sqrt{2}$$

$$= \frac{1}{2} \times 165 \times 13.00 \times \cos 20.61^\circ \times 2$$

$$\boxed{P_{ave} = 1003.85\,\text{Watt}} \times 2 = 1.003\,\text{KW} \times 2 = 2\,\text{KW}$$

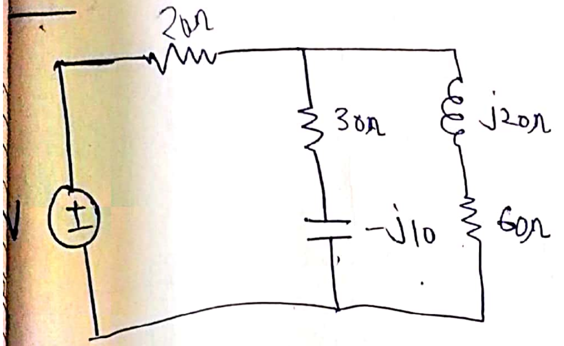
$$\cos\theta = \cos(20.61) = 0.936 \text{ (lagging)}$$

$\cancel{\theta = \theta_v - \theta_i}$

Since Current is lagging by 20.61°, therefore Power factor is lagging.

Proof.

Prob. 7



Soln :-

60Ω absorbs 240 watt of average power.

$$P_{ave} = \frac{1}{2} |I^2| R$$

$$\cancel{240}^{4} = \frac{1}{2} \times |I|^2 \times \cancel{60}$$

$$\Rightarrow \boxed{I_1 = 2\sqrt{2} A}$$

$$I_1 = \frac{(30-j10)\, I}{(30-j10+60+j20)}$$

$$2\sqrt{2} = \frac{30-j10}{90+j10} = 0.3492 \angle -24.77 \; I$$

$$\Rightarrow \boxed{I = 8.099 \angle 24.77^\circ}$$

$$Z = \frac{(30-j10) \,||\, (60+j20)}{90+j10} + 20$$

$$\boxed{Z = \cancel{20.31 \angle -0.4125}} \; 42.0222 \angle -3.32$$

$$V = 8.099 \angle 24.77 \times \cancel{20.31 \angle -0.4125} \; 42.02 \angle -3.32$$

$$\boxed{V = 340.31 \angle 21.45^\circ}$$

Complex power :-

$$\text{overall Complex power} = V_{rms} \times I^*_{rms}$$

$$= \frac{340.31}{\sqrt{2}} \times \frac{8.099}{\sqrt{2}} \angle 21.45 - 24.77^\circ$$

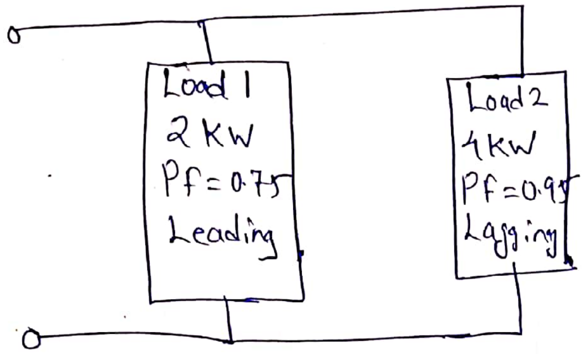
$$= 1378.08 \angle -3.32$$

$$= 1378.08 \{ \cos(3.32) - j \sin(3.32) \}$$

$$= 1378.08 \, (0.99 - 0.05 j)$$

$$\boxed{= 1376 - 79.80j}$$ Ans

Prob. 8 :- T:



Soln :- Complex power for Load 1, :-

$$\cancel{S_1 = P_T \cos\theta}$$
$$\cancel{= 2 \times 0.75}$$
$$\theta_1 = \cos^{-1}(0.75)$$
$$\boxed{\theta_1 = 41.40^\circ}$$
$$S_1 = P_1 \angle\theta_1$$
$$S_1 = 2\angle 41.40^\circ = 1.50 + j1.32 \text{ kW}$$

Similarly Complex Power for Load 2, :-

$$\theta_2 = \cos^{-1}(0.95)$$
$$\boxed{\theta_2 = 18.19^\circ}$$
$$S_2 = P_2 \angle\theta_2$$
$$S_2 = 4\angle 18.19 = 3.80 + 1.248j \text{ kW}$$

Resulting Complex Power :-

$$S = S_1 + S_2$$
$$= 1.50 + j1.32 + 3.80 + 1.248j$$
$$S = 5.3 + j2.568 \text{ kW}$$
$$\boxed{S = 5.9\angle 25.85^\circ}$$

Resulting Power Factor :-

$$\cos\theta = \cos 25.85^\circ$$
$$\cos\theta = 0.9 \text{ (leading)}$$

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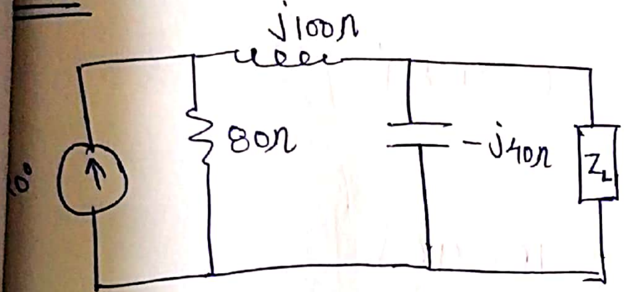
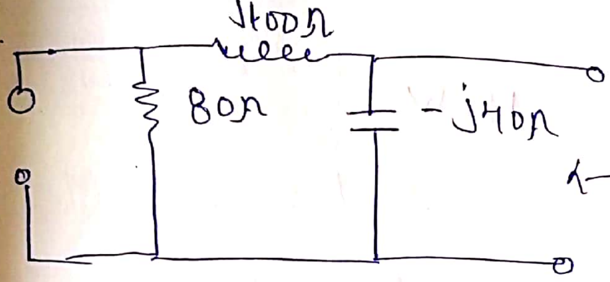
.9:-



Soln:- Finding Z_{Th}

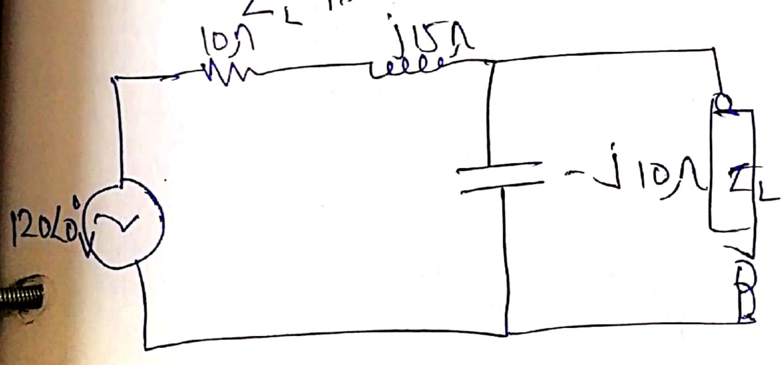


$Z_{Th} = (80+j100) \parallel -j40$

Z_{Th} $\boxed{Z_{Th} = 12.8 - 49.6j}$

$\boxed{Z_L = Z_{Th}^{*} = 12.8 + 49.6j}$

Prob.10 :- In the Circuit of fig. the max. power absorbed by Z_L is -



Soln:- Finding Z_{Th} :-

$Z_{Th} = -j10 \parallel (10 + j15\Omega)$

$\boxed{Z_{Th} = 8 - 14j}$

$\boxed{R_{Th} = 8}$

Finding V_{Th} :-

$$I = \frac{120\angle 0^\circ}{10 + j5} = 9.6 - 4.8j$$

$$\boxed{V_{Th} = -j10 \times (I) = -48 - 96j}$$

$$\boxed{= 107.33\angle -116.56}$$

$$\boxed{P_{max} = \frac{|V_{Th}|^2}{8R_{Th}} = 180W}$$