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BATCH: B10

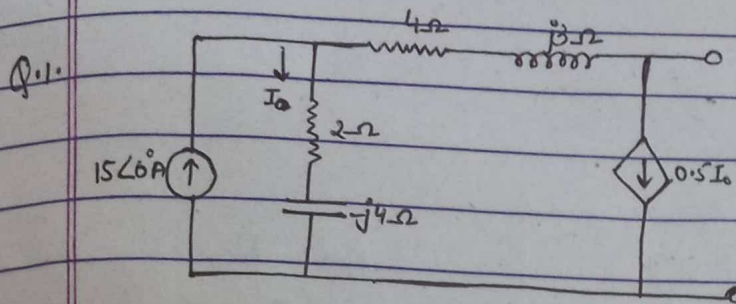
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Electrical Science - I (15B116C111)

Tutorial - 9



for V_{th} :

$$15\angle 60^\circ = I_0 + 0.5I_0$$

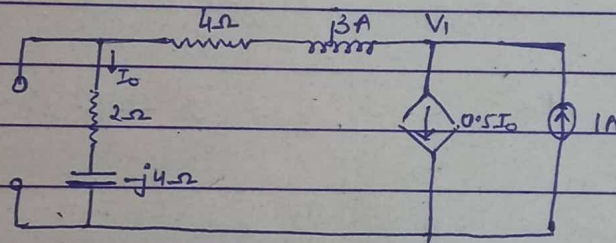
$$I_0 = \frac{150}{1.5} = 10 \text{ A}$$

Applying KVL to the loop :

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

$$V_{th} = 55\angle -90^\circ \text{ A}$$

For Z_{th} :



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

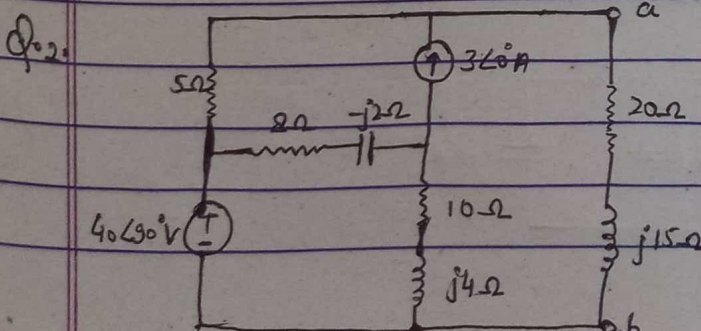
$$1 = 0.5I_0 + I_0$$

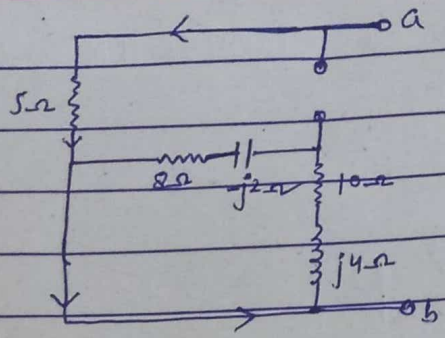
$$I_0 = \frac{10}{1.5} = \frac{20}{3} \text{ A}$$

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

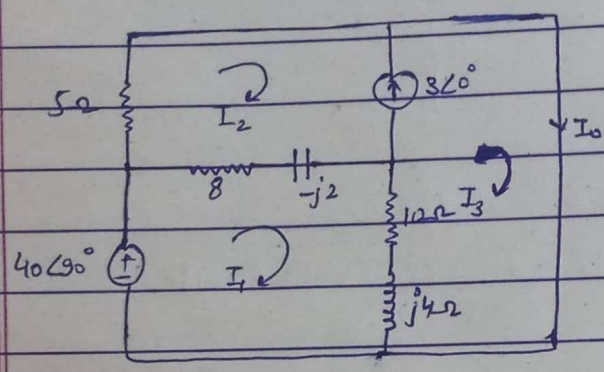
$$V_1 = \frac{2(6-j)}{3} = 4 - \frac{2j}{3}$$

$$Z_{th} = \frac{V_1}{1} = 4 - \frac{2}{3}j = 4 - 0.667j \text{ } \Omega$$





$$Z_{th} = 5 \Omega \quad \checkmark$$



Applying KVL in loop ①

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

$$40 \angle 90^\circ = (18 + j2)i_1 - (8 - j2)i_2 - (10 + j4)i_3 \quad \text{--- (i)}$$

Loop ② super mesh :

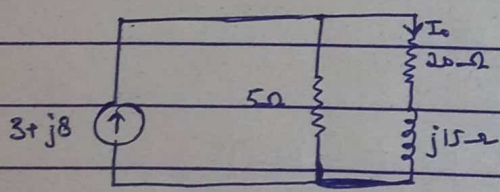
$$i_1(10 + j4) - (10 + j4)i_3 + (8 - j2)i_1 - (8 - j2)i_2 - 5i_2 = 0$$

$$(18 + j2)i_1 - (13 - j2)i_2 - (10 + j4)i_3 = 0 \quad \text{--- (ii)}$$

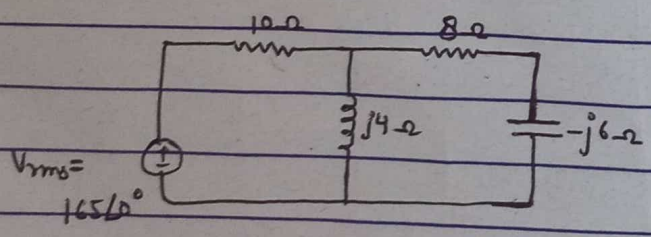
Also, $I_2 - I_3 = 3 \quad \text{--- (iii)}$

On solving (i), (ii) & (iii) $I_3 = 3 + j8 = I_N$

$$I_N = (3 + j8) A \quad \checkmark$$



$$I_0 = \frac{5 \times (3 + j8)}{5 + 20 + j15} = 1.465 \angle 38.48^\circ A \quad \checkmark$$



$$Z_{eq} = 10 + \frac{j4 \times 8 - j6}{(j4 + 8 - j6)} = \frac{12.695 \angle -20.61^\circ}{(j4 + 8 - j6)}$$

$$= 11.88 + j4.47$$

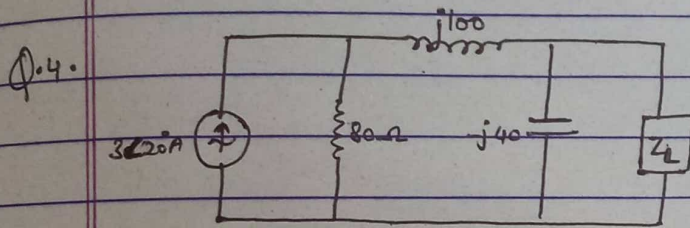
$$I_{rms} = \frac{V_{rms}}{Z_{eq}} = \frac{165 \angle 0^\circ}{12.69 \angle 20.61^\circ} = 13.00 \angle -20.61^\circ$$

$$P_{avg} = V_{rms} I_{rms} \cos \phi$$

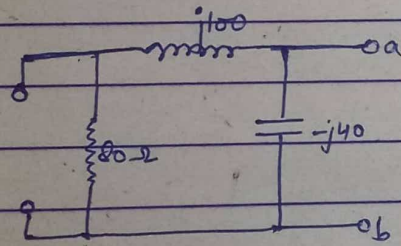
$$= 165 \times 13 \times \cos(0 + 20.61)$$

$$= 165 \times 13 \times \cos(20.61) = 1003.85 \text{ watt}$$

Current is lagging by 20.61° .



for maximum power $Z_L = Z_{th}$

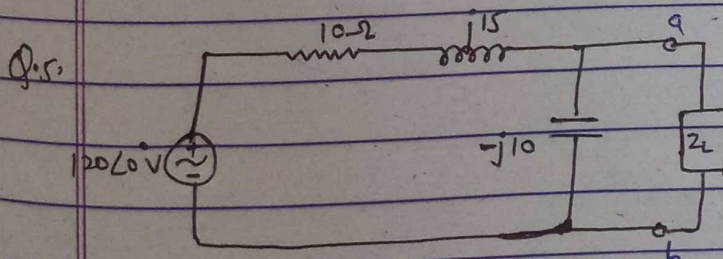


$$Z_L = Z_{ab} = \frac{(j100 + 80) \times -j40}{j100 + 80 - j40}$$

$$= \frac{4000 - j3200}{80 + j60}$$

$$= \frac{4000 - j3200}{8 + j6}$$

$$Z_L = (12.8 - j49.6) \Omega$$



for Z_m : $Z_{ab} = \frac{(10 + j15)(-j10)}{(10 + j5)} = (8 - j14) \Omega$

$$\text{for } V_{th} : \quad \vec{I}_{ev} = \frac{120 \angle 0^\circ}{10 + j15 - j10} = \frac{120}{10 + j5}$$

$$= (9.6 - j4.8) \text{ A}.$$

$$V_{th} = (-j10)(9.6 - j4.8) = (-48 - j96) \text{ V}.$$

$$P = \frac{|V_{th}|^2}{4R_{th}} = \frac{(48)^2 + (96)^2}{4 \times 10} = 360 \text{ watt} //$$