NATIONAL UNIVERSITY OF SCIENES & TECHNOLOGY

Electrical Network Analysis (EE-211)

Assignment # 2

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Class: BEE-12C

Semester: 2nd

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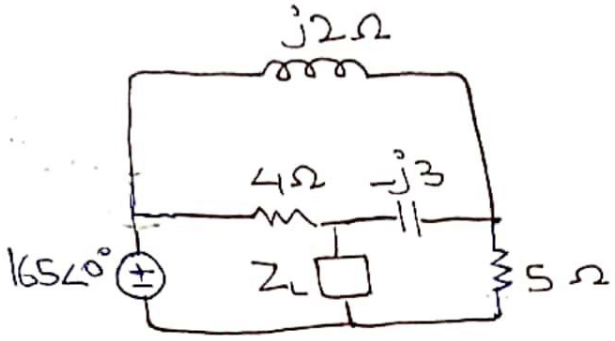
CMS ID: 345834

Assignment 2

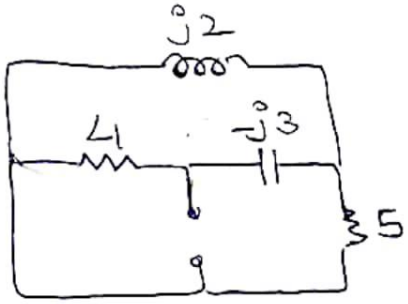
11.12

Z_{TH}, Z_L

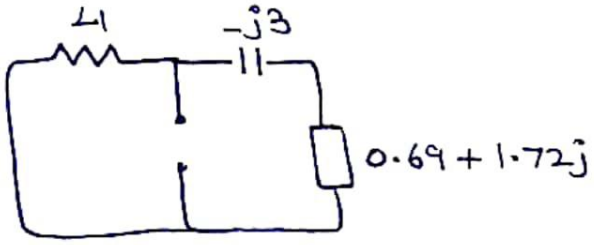
Max Power



For Z_{TH}



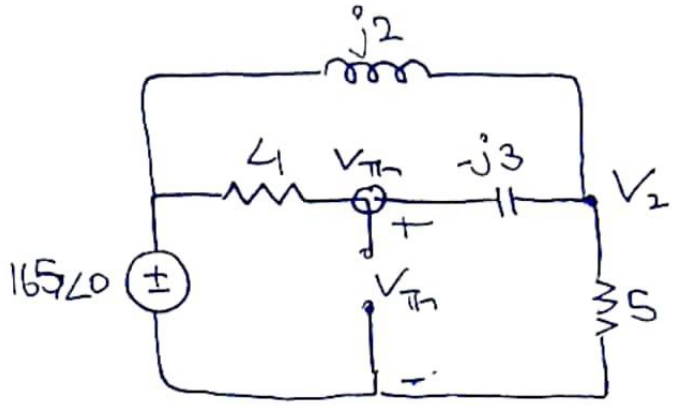
5 and j2 are parallel



$$Z_{TH} = \frac{(0.69 + 1.72j - 3j) \times 4}{(0.69 + 1.72j - 3j) + 4} = \boxed{0.82\angle 4 - j\,0.866\ \Omega}$$

$$Z_L = Z_{TH}^{*} = \boxed{0.82\angle 4 + j\,0.866\ \Omega}$$

For V_{TH}



Applying KCL,

- $\frac{V_{Th} - 165}{4} + \frac{V_{Th} - V_2}{-j3} = 0$

$$(0.25 + 0.333j)V_{Th} + (-0.333j)V_2 = 41.25$$

- $\frac{V_2}{5} + \frac{V_2 - V_{Th}}{-3j} + \frac{V_2 - 165}{2j} = 0$

$$(-0.333j)V_{Th} + (0.2 - 0.1667j)V_2 = -82.5j$$

Upon solving, we get:

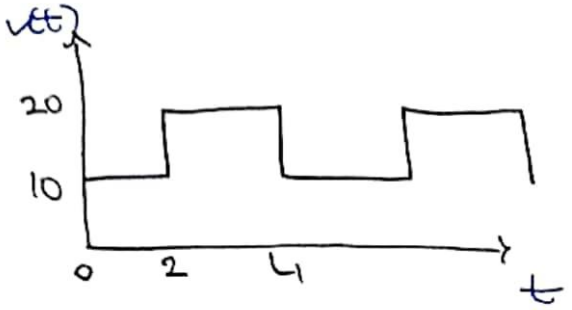
$$V_{Th} = 167.44\angle -17.32^\circ$$

$$V_2 = 129.26\angle -20.63^\circ$$

Max Power is: $\frac{|V_{Th}|^2}{8R_{Th}} \Rightarrow \frac{(167.44)^2}{8(0.824)}$

$$P_{avg} \Rightarrow 4227.56\ W$$

11.26



$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

$$= \sqrt{\frac{1}{4}\left[\int_0^2 (10)^2\,dt + \int_2^4 (20)^2\,dt\right]}$$

$$= \frac{1}{2}\sqrt{100t\Big|_0^2 + 400t\Big|_2^4}$$

$$= \frac{1}{2}\sqrt{200 + 1600 - 800}$$

$$\boxed{V_{rms} = 15.811\ V}$$

11.42

$V_{rms} = 110\,V$, $f = 60Hz$, $|S| = 120\,VA$, $pf = 0.707$ Lag

a) $\cos^{-1}(0.707) = 45° = \phi_v - \phi_i$

$\vec{S} = |S| \angle \phi_v - \phi_i = \boxed{120\angle 45°}$

b) $|I_{rms}| = |S|/|V_{rms}| = 120/110 = \boxed{1.091\ A}$

c) $S = I_{rms}^2 Z \Rightarrow Z = \dfrac{120\angle 45°}{(1.091)^2} = \boxed{71.277 + j\,71.277}$

d) $Z = R + j\omega L = 71.277 + j\,71.277$

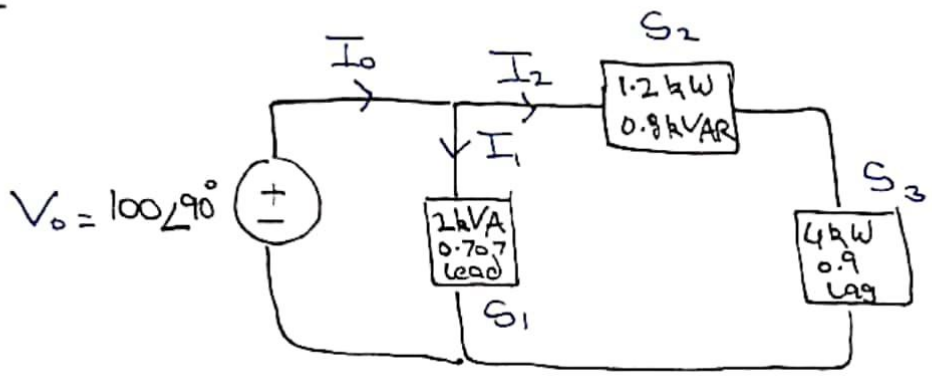
$R = 71.277\,\Omega$

$$\omega L = 71.277$$

$$2\pi f L = 71.277$$

$$L = \frac{71.277}{2\pi(60)} = \boxed{0.189\ H}$$

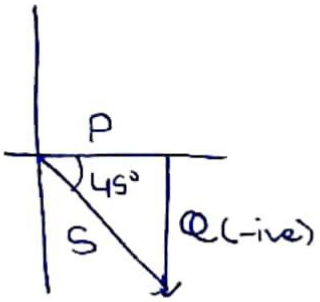
11.61



S_1:

$|S| = 2kVA$; $\theta = \cos^{-1}(0.707)$

$\theta = 45°$



$P = \cos(45) \times S = 0.707 \times 2k$

$P_{avg} = 1414.213\ W$

$Q = -\tan(45) \cdot (1414.213)$

$= -1414.2\ VAR$

$S = P + jQ$

$S_1 = 1414.2 - j\,1414.2\ VA \rightarrow 1.414 - j1.414\ kVA$

S_2 :

$P_{avg} = 1.2\,kW$

$Q = 0.8\,kVAR$

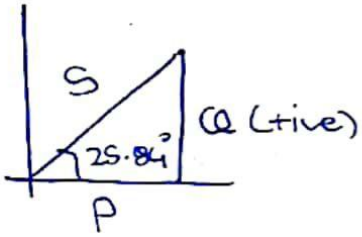
$S_2 = P + jQ$

$= \underline{1.2 + j0.8\ kVA}$

S_3 :

$P_{avg} = 4\,kW$

$\cos^{-1}(0.9) = \theta \Rightarrow \theta = 25.84^\circ$



$\tan(25.84) = Q/P$

$Q = 0.484 \cdot 4 \times 10^3$

$= \underline{1937.28\ VAR}$

$S_3 = P + jQ$

$= \underline{4 + j1.937\ kVA}$

For I_o :

$I_o^* = I_1^* + I_2^*$

$= \frac{S_1}{V_o} + \left(\frac{S_2 + S_3}{V_o}\right)$

$I_o^* = (11.37 - 52j) + (-14.14 - j14.14)$

$I_o^* = -2.77 - 66.14j$

$I_o = -2.77 + 66.14j = \underline{66.19 \angle 92.4}$

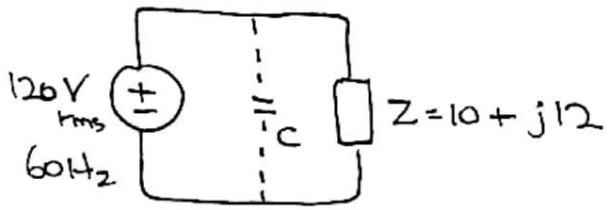
For S_o:

$$S_o = V_{rms} I_o^*$$

$$= (100\angle 90)(-2.77 - 66.14j)$$

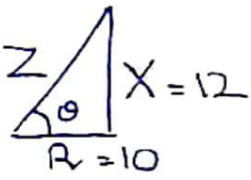
$$= \underline{6.61\angle -2.4^\circ \text{ kVA}}$$

11.69



a) $Z = R + jX$

$Z = 10 + j12$



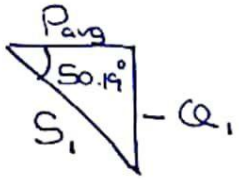
$\tan(\theta) = 12/10$

$\theta = 50.19^\circ$

$pf = \cos(\theta) = 0.6401$

b) Current leads in Capacitive circuit.

$$S = \frac{V_{rms}^2}{Z^*} = \frac{120^2}{10 - j12}$$



$$S_1 = 590 + 708.1j$$

$\underline{P = Re(S) = 590 \text{ W}}$

$\underline{Q = Im(S) = 708.1 \text{ VAR}}$

$$S_2 = S_{New}$$

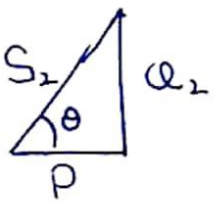
c)

For unity pf,

$\cos(\theta) = 1$

$\theta = 0$

From triangle,



$-Q_2 = \tan(\theta)\, P_{avg} \Rightarrow (0)\, P_{avg}$

$Q_2 = 0$

$S_2 = P_{avg} + jQ_2$

$= 590 + 0$

$\boxed{S_2 = 590 \text{ VA}}$

$S_2 = S_1 + S_c$

$590 = 590 + j708.1 + (0 + jQ_c)$

$jQ_c = -j708.1$

$Q_c = -708.1 \text{ VAR}$

$\frac{V_{rms}^2}{-X_c} = -708.1$

$-\omega C V_{rms}^2 = -708.1$

$C = \frac{708.1}{\omega V_{rms}^2} = \frac{708.1}{2\pi(60)(120)^2}$

$\boxed{C = 130.41\ \mu F}$