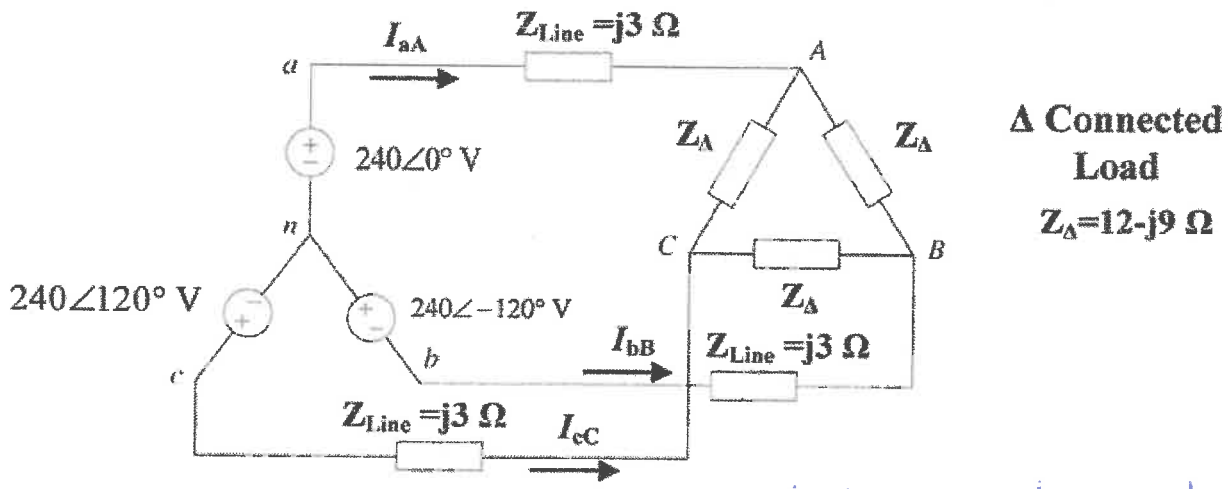
Eastern Mediterranean University
Department of Electrical and Electronic Engineering
EENG 224 Quiz#2

Date : 20 December 2022

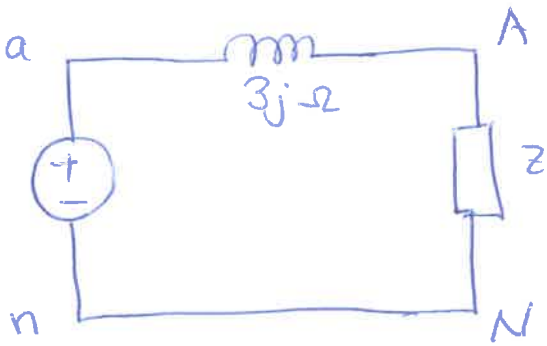
Duration : 45 min.

Q.1 Consider the Y-Δ connected balanced three-phase circuit shown that has line impedance $\boldsymbol{Z_{Line} = 3j\ \Omega}$ and Δ connected balanced load with $\boldsymbol{Z_\Delta = 12 - 9j\ \Omega}$.

a) Calculate I_{aA}
b) Calculate V_{AB}
c) Calculate the total complex power of the Δ connected load.
d) Calculate the total complex power of the line impedance Z_{Line}
e) Calculate the total complex power delivered by the three-phase source.
f) What is the power factor seen by the source



Solution of Question #1 The single phase equivalent circuit is shown below.



V_{an}

$Z_Y = \frac{Z_\Delta}{3} = 4 - 3j$

$V_{an} = 240\angle 0^\circ\ V_{rms}$

(a) $I_{aA} = \dfrac{V_{an}}{Z_Y + Z_{Line}} = \dfrac{240}{4-3j+3j} = 60\ A_{rms}$

(b)

$V_{AN} = V_{an}\dfrac{Z_Y}{Z_Y + Z_{Line}} = 240\ \dfrac{4-3j}{4} = 300\angle -36.9^\circ\ V_{rms}$

$V_{AB} = \sqrt{3}\, V_{AB}\angle 30^\circ = \sqrt{3}\ 300\angle -6.9^\circ = 519\angle -6.9^\circ\ V_{rms}$

OR $I_{AB} = \dfrac{I_{aA}}{\sqrt{3}}\angle 30^\circ = \dfrac{60}{\sqrt{3}}\angle 30^\circ = 34.64\angle 30^\circ\ A_{rms}$

$Z_\Delta = 12-9j = 15\angle -36.86^\circ \Rightarrow V_{AB} = I_{AB}\, Z_\Delta$

$V_{AB} = 34.64\angle 30^\circ \times 15\angle -36.86^\circ$

$V_{AB} = 519.6\angle -6.86^\circ\ V_{rms}$

(c)

$S_\Delta = 3\, V_{AB}\, I_{AB}^* = 3\,(519\angle -6.9^\circ)(34.64\angle -30^\circ)$

$S_\Delta = 53,934.48\angle -36.9^\circ\ VA = (43,130.5 - j\,32,383.3)\ VA$

(d) $S_{Line} = 3|I_{aA}|^2 Z_{Line} = 3\times 60^2 \times 3j = 32.4j\ kVar$

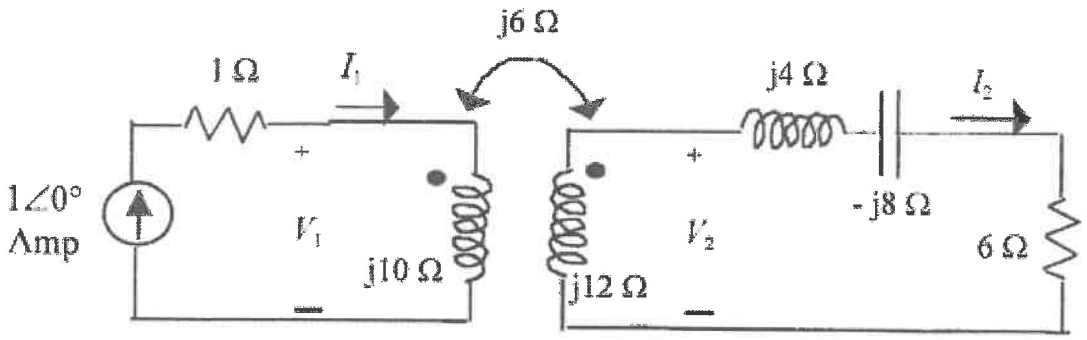
(e) $S_{Source} = 3|I_{aA}|^2 (Z_{Line} + Z_Y) = 3\times 3600\times 4 = 43.2\ kW$

$S_{Source} = P_{Source}$ and $Q_{Source} = 0$

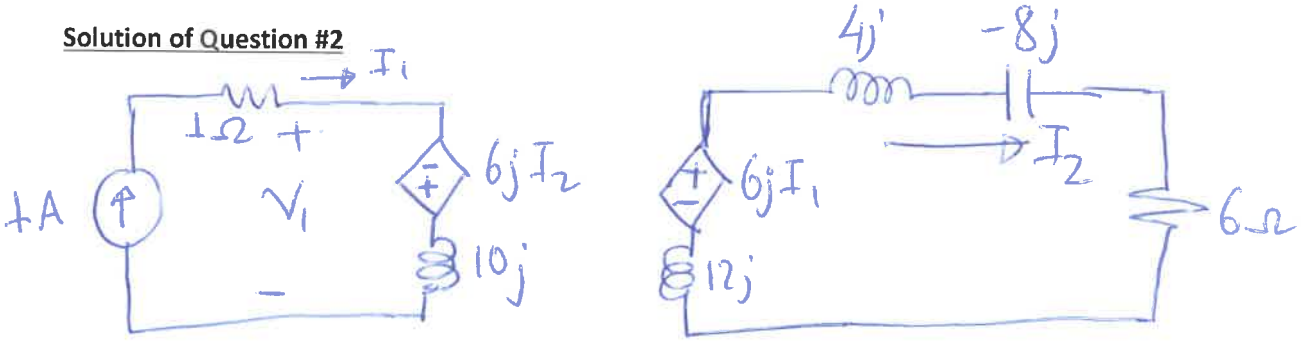
(f) Since $Q_{Source} = 0$ Var, then pf = 1.

Q.2

Find the voltage V_1 (magnitude and phase) indicated on the circuit shown below.



Solution of Question #2



For mesh I; $I_1 = 1\angle 0^\circ = 1$ A

For mesh II; $(12j + 4j - 8j + 6)I_2 - 6jI_1 = 0$

$(6 + 8j)I_2 = 6jI_1$ where $I_1 = 1$ A

$$I_2 = \frac{6j}{6+8j} = \frac{6\angle 90^\circ}{10\angle 53.13^\circ} = 0.6\angle 36.87^\circ \text{ A}$$

From mesh I;

$$V_1 = 10jI_1 - 6jI_2$$

$$V_1 = 10j - (6\angle 90^\circ)(0.6\angle 36.87^\circ)$$

$$V_1 = 10\angle 90^\circ - 3.6\angle 126.87^\circ = 2.16 + 7.48j$$

$$V_1 = 7.78\angle 73.89^\circ \text{ V} \quad *$$