ENEL 487 | Winter 2020 | Quiz 1

Name: SOLUTION ID:

1) [6 marks] A single-phase, 220 V, 60Hz source delivers 50 kW to a bank of induction motors operating at a power factor of 0.7 lagging. If a power factor correction capacitor is added in parallel to the load to improve the power factor to 0.9 lagging, what is the new reactive power consumed by the bank of induction motors (in kVA). Also, draw the power triangle for the load before and after the capacitor addition. Label all sides in the power triangle. You can assume the voltage remains constant at the load side.

Before capacitors

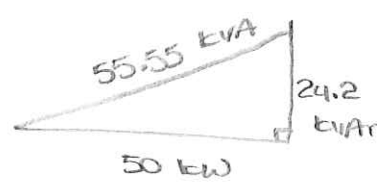
$$S_{old} = \frac{P}{PF_{old}} = \frac{50 \text{ kW}}{0.7} = 71.43 \text{ kVA}$$

$$Q_{old} = \sqrt{S_{old}^2 - P^2} = 51.01 \text{ kVAr}$$

After capacitors

$$S_{new} = \frac{P}{PF_{new}} = \frac{50 \text{ kW}}{0.9} = 55.55 \text{ kVA}$$

$$Q_{new} = \sqrt{S_{new}^2 - P^2} = 24.2 \text{ kVAr}$$



2) [9 marks] A three-phase, 208V, 60 Hz source is connected to a line with an impedance of 1+j5 Ω/phase, which feeds the following three loads that are connected in parallel:

- Load 1: A balanced, Y-connected load with an impedance of 7+j6 Ω per phase
- Load 2: A balanced, Delta-connected load with an impedance of 21 Ω per phase
- Load 3: A resistive, Y-connected load that absorbs 12A per phase when the line to neutral voltage in its terminals is 120 V

a) Draw the single-phase diagram for this system, labelling all the impedances and all the known voltages/currents (if any) on the diagram. [6 marks]

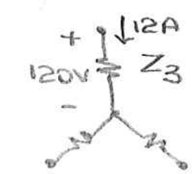
b) Calculate the magnitude of the current drawn from the source in Amps [2 marks]

This is NOT saying the l-n voltage of load 3 is 120 V in THIS circuit. It only says it draws a current of 12A WHEN the voltage is 120V. In fact, it's not possible for the load voltage to be 120V in this circuit if the source voltage is also 120 V

a) Load 1: $7+j6$ Ω (no conversion req'd!)

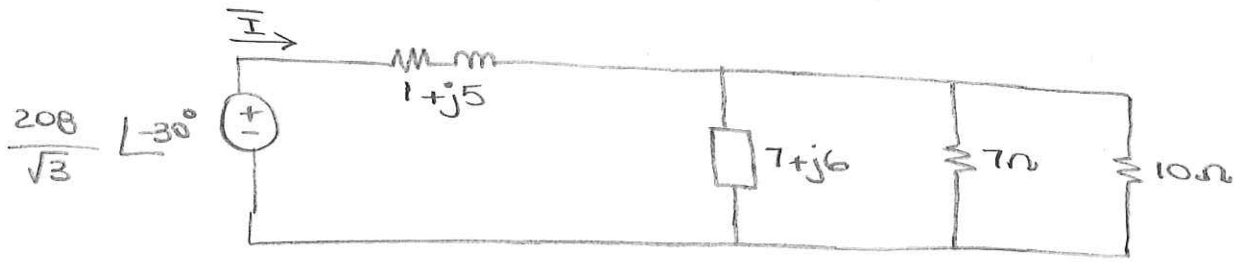
Load 2: $Z_{2Y} = \frac{21\,\Omega}{3} = 7\ \Omega$

Load 3:



$Z_3 = \frac{120V}{12A} = 10\ \Omega$

$208\angle 0^\circ$ line-to-line $\rightarrow$ $\frac{208}{\sqrt{3}}\angle -30^\circ$ line-to-neutral



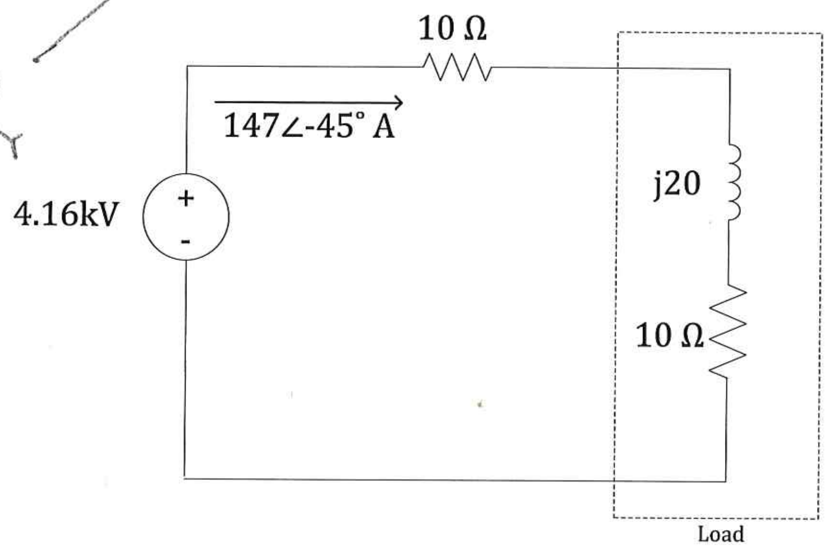
b) $$\bar{I} = \frac{\frac{208}{\sqrt{3}}\angle -30^\circ}{(1+j5) + \left[(7+j6) \parallel 7 \parallel 10\right]} = \frac{120\angle -30^\circ}{3.94 + j\,5.64}$$

$$= 17.45 \angle -85.08^\circ \text{ A}$$

magnitude

3) [2 marks] The following is the $\boxed{\text{single-phase circuit}}$ for a three-phase system with a Y-connected source and a delta-connected load.

everything converted to equivalent Y



Magnitude of the phase voltage in the source is ____4.16____ kV

Magnitude of the phase current in the load is ____$147/\sqrt{3}$ = 84.88____ A

Single Phase $\overline{\text{S}}$:	$\overline{S} = \overline{V} \cdot \overline{I}^*$
Q for L and C:	$Q_L = \frac{V^2}{X_L}$ $\qquad Q_C = \frac{V^2}{X_C}$
Y Connection:	$\overline{V_{ll}} = \sqrt{3}\angle 30^o \cdot \overline{V_\phi}$
Δ Connection:	$\overline{I_l} = \sqrt{3}\angle{-30^o} \cdot \overline{I_\phi}$
3 Phase Power:	$\overline{S_{3\phi}} = 3 \cdot \overline{V_\phi} \cdot \overline{I_\phi^*}$
	$S = \sqrt{3} \cdot V_{ll} \cdot I_l$
	$P = S \cdot pf$ $\qquad S^2 = P^2 + Q^2$