ENEL 487 | Winter 2019 | Quiz 1

Name: SOLUTION ID:

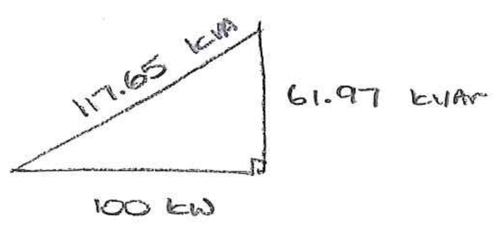
1) [6 marks] A single phase source delivers 100kW to a load operating at 0.85 lagging power factor. If a power factor correction capacitor is added in parallel to the load to improve the power factor to 0.95 lagging, what is the reactive power delivered by the capacitor? Also, draw the power triangle for the load before and after the capacitor addition. Label all sides in the power triangle. You can assume the voltage is constant at the load side.

· capacitor only provides reactive power ; Real power consumed by the load remains at 100 W.

before cap

$$S_{old} = \frac{P}{pf_{old}} = \frac{100\text{ kW}}{0.85} = 117.65 \text{ kVA}$$

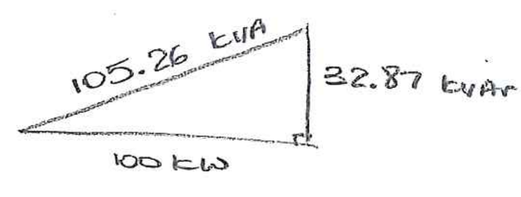
$$Q_{old} = \sqrt{S_{old}^2 - P^2} = 61.97 \text{ kVAr}$$



after cap

$$S_{new} = \frac{P}{pf_{new}} = \frac{100\text{ kW}}{0.95} = 105.26 \text{ kW}$$

$$Q_{new} = \sqrt{S_{new}^2 - P^2} = 32.87 \text{ kVAr}$$



$$\Delta Q = Q_{new} - Q_{old} = -29.1 \text{ kVAr}$$

Cap "supplies" 29.1 kVAr

2) [9 marks] A balanced Δ-connected load with impedance of 6+j12 Ω per phase is connected in parallel with a balanced Y-connected load with impedance of 2-j4 Ω per phase. A line with impedance of 1 Ω per phase connects these loads to a 208V source. Find:

← line-to-line voltage of the source.

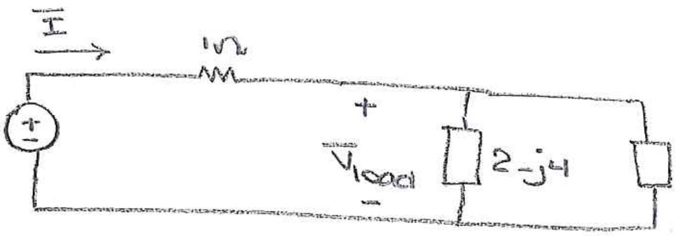
a) Magnitude of the current drawn from the source in Amps [3 marks]
b) Magnitude of the line-to-line voltage at the load side [2 marks]
c) Total real and reactive power consumed by the combined load [2 marks]
d) Power factor of the combined load [2 marks]

• Let's start with the per phase diagram. Need to convert Δ load to equivalent Y

we are not calculating phase current or voltage for the source, so its connection type does not matter. All we know is that it provides a l-l voltage of $208\angle 0^\circ$ V

← phase of zero assigned arbitrarily

$208 \frac{1}{\sqrt{3}} \angle -30^\circ = 120\angle -30^\circ$ V



$\frac{6+j12}{3} = 2+j4\ \Omega$

a) $Z_{eq\,load} = \frac{(2-j4)\cdot(2+j4)}{(2-\cancel{j4})+(2+\cancel{j4})} = \frac{4-j^2 4^2}{4} = \frac{20}{4} = 5\Omega$

$\bar{I} = \frac{120\angle -30^\circ}{1+Z_{eq\,load}} = \frac{120\angle -30^\circ}{6\ \Omega}\ \text{V} = \boxed{20}\angle -30^\circ$ A

b) $\bar{V}_{load} = 120\angle -30^\circ - \bar{I}\cdot(1) = 100\angle -30^\circ$ V

$|V_{load}|_{l\text{-}l} = 100\cdot\sqrt{3} = \boxed{173.2}$ V

c) $P_{load,3\phi} = \left(\frac{V_{load}^2}{5\Omega}\ \text{or}\ I^2 \times 5\ \Omega\right)\times 3 = 2\ \text{kW} \times 3 = \boxed{6\ \text{kW}}$

$Q_{load,3\phi} = \boxed{0\ \text{kVAr}}$ since $Z_{eq,load}$ is purely resistive

can also use $\bar{S}_{load,3\phi} = 3\times \bar{V}_{load}\times \bar{I}^*$

d) PF $= \boxed{1}$ Since $Q=0$