EE 380 Class -

Just to confirm, the brief take-home problem that is due by the end of the day (I'll be checking the in-box at approx 8pm this evening) is given below. Note that this is a review of one of the EE280 prelab, with a flavor from the last computer interfacing problem H4.1.

Refer to handout on 3-phase wattmeter connections and homework problem H4.1. Assume that we will use a 2-element meter, and that the load that we are going to measure is 480-volt, 37.5 kW, PF 0.75 LAG. We will use the 100:5 CTs.

a) Calculate the phasor values of the two voltages V12 and V32, and the two currents I1 and I3 that are being monitored by the meter (assume positive phase sequence).

b) Calculate the individual power measured by Element 1 and Element 2 of the wattmeter.

c) Compare the total power of element 1 + element 2 to the power being consumed by the load. Explain the difference.

DONE. Drop off in 7th floor box by 8pm this evening.
EE 380 - Quiz 2/16 - 00

2 - Element Meter/Transducer

Above diagram gives basic connection. Current elements are, however, fed from 100:5 CT's, so their currents are actually only \( \frac{1}{20} \)th that of the lines.

a) If we assume positive sequence voltage,

\[
\begin{align*}
\tilde{V}_{12} &= 480 \angle 30^\circ \text{ V} \\
\tilde{V}_{32} &= 480 \angle 90^\circ \text{ V}
\end{align*}
\]
The line currents are

$$|\bar{I}_1| = \frac{37,500}{\sqrt{3 \times 480 \times 75}} = 60.14 \text{ A}$$

The angles take a bit of thought.

If we visualize our "black box" load as a Y-connected 3-phase impedance, it becomes clear that line currents are associated with L-N voltages.

So,

Further, PF, $\Theta = \angle \bar{V} - \angle \bar{I}$, etc., are all defined for an impedance of passive sign convention.
Therefore, since $PF = 0.75 \angle 0$ 

$\Theta = + \cos^{-1} 0.75 = +41.41^\circ$

The power triangle looks like:

And the V-I relationship (everywhere) for corresponding V's & I's looks like:

Therefore since $\overline{\text{V}_{AN}} = 0^\circ \Rightarrow \overline{\text{I}_A} = \overline{\text{I}_r} = -41.41^\circ$

and, $\overline{\text{V}_{CN}} = +120^\circ \Rightarrow \overline{\text{I}_C} = \overline{\text{I}_3} = 120 - 41.41 = 78.59^\circ$

$\Rightarrow \overline{\text{I}_1} = \frac{60.14}{20} \angle -41.41^\circ = \boxed{3.01 \angle -41.41^\circ \text{A}}$

$\overline{\text{I}_3} = \boxed{3.01 \angle 78.59^\circ \text{A}}$
The total power

\[ P_{\text{Tot}} = P_1 + P_2 \]

\[ = \frac{(480)(3.01) \cos(30^\circ + 41.4^\circ)}{1876.84 \text{ W}} \]

\[ = 460.6 + 1416.25 \]

\[ = 1876.84 \text{ W} \]

As a double-check, if we "undo" the 100:5 CT scaling, then

\[ P_{\text{Tot}, \text{ Pri}} = 1876.8 \times 20 = 37,500 \text{ W} \]

Referring back to H4.1, the scaling factor for our transducer was 83.14 kW/6.988V or 12 kW/volt.

The DAC card would thus be receiving

\[ 37,500 \times \frac{10}{12} = 3125 \text{ V} \]

Additional notes, on above, if PF = Unity

Each element \((P_1 \& P_2)\) read an equal amount. When PF = 0.5 LAG (\(\theta = 60^\circ\)) then \(P_1 = 0\) and \(P_2 = P_{\text{Total}}\). For PF < 0.5, one meter (element) reads negative. (See next page).
### Two-Meter Method of Measurement for 3-Wire System

**V-LL** 480 Volts  
**PTOT** 37.5 kW

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<th>Theta</th>
<th>PF</th>
<th>I-Line</th>
<th>Ang_I1</th>
<th>Ang_I3</th>
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<th>P2</th>
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#### Two-Wattmeter Measurement Method

![Graph showing Power Factor Angle vs Power](image)

- $P_{tot} = P_1$
- $P_1 = P_2$
- Unity PF

**Legend:**
- **LAG**: Lagging
- **LEAD**: Leading