# ECE 320: Lecture 3
**Notes**

A. Homework #1 Passed Out

B. ECE 321 Syllabus Passed Out

## Single Phase Power Calculations

### *Power Factor*

- We can also define the **Power Factor** as

  $pf = \cos(pf\_angle)$

- Where (as a result of the limits on the pf_angle):

  $0 \le pf \le 1.0$

- A lagging power factor means "I lags V". This is common with an R-L circuit. This means that the zero crossing for the current waveform appears after (to th right) the current zero for the voltage.
- A leading power factor means "I leads V". This is common with a series R-C circuit. This means that the zero crossing for the current waveform appears before (to the left) the current zero for the voltage.
- Unity power factor: "I in phase with V". pf = 0

### *MathCAD demo:*

See the other files associated with today's lecture

### *Single Phase Instantaneous Power:*

$$v(t) = Vm\cdot\cos\left(\omega\cdot t + \phi_v\right)$$

$$i(t) = Im\cdot\cos\left(\omega\cdot t + \phi_i\right)$$

$$p(t) = v(t)\cdot i(t)$$

$$p(t) = Vm\cdot Im\cdot\left(\cos\left(\omega t + \phi_v\right)\cdot\cos\left(\omega\cdot t + \phi_i\right)\right)$$

We can use the following Trig

$$2\cdot\cos(A)\cdot\cos(B) = \cos(A - B) + \cos(A + B)$$

Therefore we see:

$$p(t) = \frac{Vm \cdot Im}{2} \cdot \left( \cos\left( \phi_v - \phi_i \right) + \cos\left( 2\omega t + \phi_v + \phi i \right) \right)$$

There is a constant term, that is commonly called the Average or Real Power

$$Pave = \frac{Vm \cdot Im}{2} \cdot \left( \cos\left( \phi_v - \phi_i \right) \right)$$

And a pulsating, double frequency term. This pulsating term causes vibration in single phase loads, and often audible noise.

Note also that: $\frac{Vm \cdot Im}{2} = \frac{Vm}{\sqrt{2}} \cdot \frac{Im}{\sqrt{2}} = |V| \cdot |I|$

- If we have a black box with a current entering a box, and a voltage across the terminals, we need to determine whether it is a load (sinking power) or source (generating power).
- If Pave>0 enters the box, then it is a load, if Pave<0 enters the box, it is a source.
- Sometime electric machines are set up to regenerate, so they normally act as a load, but when one wants to slow to the rotation of the mechanical load, they can perform regenerative braking and transfer power in the other direction.