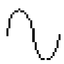
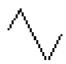
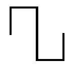
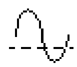
ECE 3600 Exam 1 Information

 $\frac{V_p}{\sqrt{2}}$  $\frac{V_p}{\sqrt{3}}$  V_p  $\sqrt{V_{rmsAC}^2 + V_{DC}^2}$

$$V_{rms} = \sqrt{\frac{1}{T}\cdot\int_0^T (v(t))^2\,dt}$$

Square / **M**ean (average) / **R**oot

<u>All voltages and current are RMS unless given as peak or as time function</u>

$pf = \cos(\theta) = \frac{P}{|\mathbf{S}|}$

Efficiency $\eta = \frac{P_{out}}{P_{in}}\cdot 100\cdot\% = \frac{P_{in} - P_{loss}}{P_{in}}\cdot 100\cdot\% = \frac{P_{out}}{P_{out} + P_{loss}}\cdot 100\cdot\%$

$P = \left(|\mathbf{I_R}|\right)^2\cdot R = \frac{\left(|\mathbf{V_R}|\right)^2}{R}$ for resistors. OR $P = |\mathbf{V}|\cdot|\mathbf{I}|\cdot\cos(\theta) = (|\mathbf{I}|)^2\cdot|\mathbf{Z}|\cdot\cos(\theta) = \frac{(|\mathbf{V}|)^2}{|\mathbf{Z}|}\cdot\cos(\theta)$

$= |\mathbf{S}|\cdot pf$ $\qquad$ pf $\qquad$ pf

capacitors -> **-** Q $\quad Q_C = \left(|\mathbf{I_C}|\right)^2\cdot X_C = \frac{\left(|\mathbf{V_C}|\right)^2}{X_C} = -\left(|\mathbf{V_C}|\right)^2\cdot(\omega\cdot C)$ $\quad X_C = -\frac{1}{\omega\cdot C}$ and is a negative number causes leading pf

inductors -> + Q $\quad Q_L = \left(|\mathbf{I_L}|\right)^2\cdot X_L = \frac{\left(|\mathbf{V_L}|\right)^2}{X_L}$ $\quad X_L = \omega\cdot L$ and is a positive number causes lagging pf

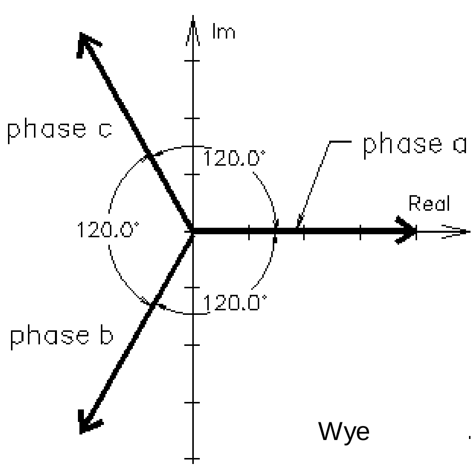
or Q = Reactive "power" $= |\mathbf{V}|\cdot|\mathbf{I}|\cdot\sin(\theta)$ $\qquad$ units: VAR, kVAR, etc. "volt-amp-reactive"

S = Complex "power" = $\mathbf{V}\cdot\bar{\mathbf{I}}$ (complex congugate) $= P + jQ$ = $|\mathbf{V}|\,|\mathbf{I}|\,\underline{/\theta}$ = $|\mathbf{S}|\,\underline{/\theta}$ $\qquad$ units: VA, kVA, etc. "volt-amp"

S = Apparent "power" $= |\mathbf{S}| = |\mathbf{V}|\cdot|\mathbf{I}| = \sqrt{P^2 + Q^2}$ $\qquad$ units: VA, kVA, etc. "volt-amp"

3-Phase

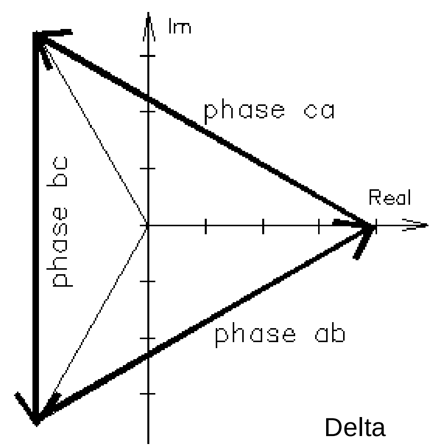
<u>Wye connection</u>:
Connect each load or generator phase between a line and ground.



Wye

$V_{LN} = \frac{V_{LL}}{\sqrt{3}}$ $\qquad I_L = \sqrt{3}\cdot I_{LL}$ (Δ-connection)

<u>Delta connection</u>:
Connect each load or generator phase between two lines.



Delta

$V_{LL} = \sqrt{3}\cdot V_{LN}$ $\qquad I_{LL} = \frac{I_L}{\sqrt{3}}$

I_L is always the line current, same as would flow in a Y-connected device.

V_L The line voltage, is always the line-to-line voltage, same as across a Δ-connected device.
Unless otherwise stated, assume voltage given for a 3-phase system is the line voltage (V_{LL}).

When a single phase is taken from a 3-phase panel, then the line voltage (V_L) of that single phase is the line-to-neutral voltage of the 3-phase input to that panel, so the value of V_L changes in the panel.

Powers (all types) are are for all 3 phases, unless clearly ststed otherwise.

To get equivalent line currents with equivalent voltages $\qquad \mathbf{Z_Y} = \frac{\mathbf{Z_\Delta}}{3} \qquad \mathbf{Z_\Delta} = 3\cdot\mathbf{Z_y}$

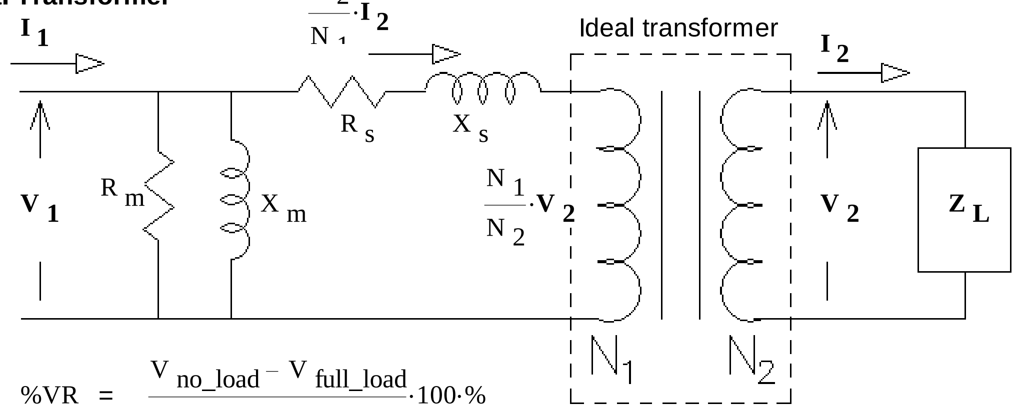
Ideal Transformer: $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ $\qquad$ $\mathbf{Z_{eq}} = \left(\frac{N_1}{N_2}\right)^2 \cdot \mathbf{Z_2}$

Both RMS

Transformers are rated in VA $\quad$ Transformer Rating (VA) = (rated V) x (rated I) , on either side.

Don't allow voltages over the rated V , regardless of the actual current.
Don't allow currents over the rated I , regardless of the actual voltage.

Model of non-ideal Transformer



Voltage regulation $\quad \%VR = \frac{V_{no\_load} - V_{full\_load}}{V_{full\_load}} \cdot 100 \cdot \%$

Per Unit $\quad S_{base}$ is the same across the entire system.

V_{base} = The nominal V_L (V_{LL}) in each region of the power system, where regions are regions are separated by transformers.

$I_{base} = \frac{S_{base}}{\sqrt{3} \cdot V_{base}}$ $\qquad$ $Z_{base} = \frac{V_{base}^2}{S_{base}}$ $\qquad$ <u>Base changes</u> $\quad Z_{pu} = Z_{pu\_device} \cdot \frac{S_{base} \cdot (V_{rated})^2}{S_{rated} \cdot (V_{base})^2}$

Often the device $V_{rated} = V_{base}$

You may write more on this sheet. You may also use this sheet at future exams