ECE 4501 Power Systems UMD S.Norr

AC CIRCUITS

Sinusoidal Waveforms:	$v(t) = V_{max}Cos(\omega t + \alpha)$ Volts	$i(t) = I_{max}Cos(\omega t + \beta)$ Amps
Phasors	$V = V_{rms} \angle \alpha$ Volts	$I = I_{rms} \angle \beta$ Amps
Angular Frequency, ω	$\omega = 2\pi f$ Radians/Second $\omega = 377$ Rad/sec in North America $\omega = 314$ Rad/sec where 50 Hz is std.	In North America: $f = 60$ Hz Elsewhere, usually: $f = 50$ Hz
Effective Value (RMS)	$V_{rms} = V_{max} / \sqrt{2}$ Volts	$I_{rms} = I_{max} / \sqrt{2}$ Amps
Ohm's Law	for DC Circuits: $V = IR$	AC: $V = IZ$; Where V, I and Z are complex phasors.
Complex Impedance, Z	$Z = R + jX$ $Z = \lvert Z \rvert \angle \theta$	$jX_L = j\omega L$ (L in Henries) $-jX_C = 1/j\omega C$ (C in Farads)
Complex Loads in Parallel	$Zeq = \dfrac{1}{\frac{1}{Z1} + \frac{1}{Z2}} = \dfrac{Z1Z2}{Z1 + Z2}$	

AC POWER

Instantaneous Power, p(t)	$p(t) = v(t)\, i(t)$ Volt-Amperes	Product of sinusoidal signals
Real Power (Effective Power)	$P = V_{rms} I_{rms} Cos\, \theta$ Watts	V_{rms} and I_{rms} are the <u>magnitudes</u> of the voltage and current phasors
Power Factor, pf	$pf = Cos\, \theta$ (no units) Either expressed as Per Unit or as Percent.	θ = Angle(V) – Angle(I) = tan-1 (X/R) = tan-1 (Q/P) = Angle (Z)
Power Angle, θ	If θ is Positive: pf is lagging, I lags V, and Q is Inductive	If θ is Negative: pf is leading, I leads V, and Q is Capacitive
Reactive Power, Q	$Q = V_{rms} I_{rms} Sin\, \theta$ VARs	Volt-Amperes – Reactive (VAR)
Apparent Power, | S |	$\lvert S \rvert = \lvert V \rvert \lvert I \rvert$ Volt-Amperes	Product of Voltage and Current magnitudes
Complex Power, S	$S = V I^*$ or $S = P + j Q$	Product of Voltage Phasor and the complex conjugate of the Current Phasor: $I^* = I_{rms} \angle -\theta_I$

3-PHASE AC CIRCUITS and POWER:

Note: Always assume a given Voltage is Line Voltage, unless otherwise specified.

Phase Voltage, V_{Phase}	$V_{Phase} = V_{L-N}$ (Phase Voltage is often called the Line-to-Neutral Voltage)	In a WYE system. Phase Voltage is the voltage of a phase with respect to the neutral point of the WYE.
Line Voltage, V_{Line}	$V_{Line} = V_{L-L}$ (Line Voltage is often called the Line-to-Line Voltage)	In a WYE or a DELTA system the Line Voltage is measured at one phase with respect to another phase.
WYE Source or Load:	$V_{Line} = \sqrt{3}\, V_{Phase} \angle +30°$	$I_{Line} = I_{Phase}$
DELTA Source or Load:	$V_{Line} = V_{Phase}$	$I_{Line} = \sqrt{3}\, I_{Phase} \angle -30°$
3-Phase Power, $P_{3\phi}$	$P_{3\phi} = \sqrt{3} \lvert V_{Line} \rvert \lvert I_{Line} \rvert Cos\, \theta$ Watts	$Q_{3\phi} = \sqrt{3} \lvert V_{Line} \rvert \lvert I_{Line} \rvert Sin\, \theta$ VARs
3-Phase Apparent Power, $\lvert S_{3\phi} \rvert$	$\lvert S_{3\phi} \rvert = \sqrt{3} \lvert V_{Line} \rvert \lvert I_{Line} \rvert$ Volt-Amperes	