

Physics 116A Notes Fall 2004

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Draft v.0.9

- Notes Copyright 2004 David E. Pellett unless stated otherwise.
- References:
 - Text for course:
Fundamentals of Electrical Engineering, second edition, by Leonard S. Bobrow, published by Oxford University Press (1996)
 - Others as noted

Physics 116A, 10/20/04: Outline

- Types of capacitors and how to read values (handout provided Friday)
- Demo of oscilloscope measurement of voltage and phase difference
- Phasors (introduction)

Phasors

- **Phasor:** a representation of an AC quantity at a given ω as a magnitude (or amplitude) A and initial phase angle ϕ , **without the $e^{j\omega t}$ term** (which cancels in an equation involving AC analysis anyway).
- Text uses upper case bold face letters for phasors
- Phasors are complex numbers, usually expressed in polar form, just not functions of t
 - remember that vector addition (or more properly, complex number addition) is required to add phasors
- You can put the time dependence back in by multiplying by $e^{j\omega t}$ where appropriate (or find the real part as fcn of t as $A \cos(\omega t + \phi)$)

- **Example** (capacitor driven by $\mathbf{v}(t) = V_0 e^{j\omega t}$):

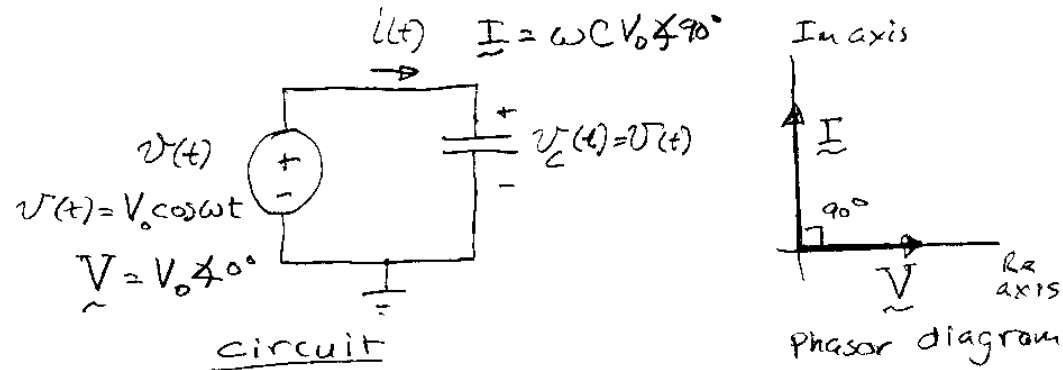
$$\mathbf{i}(t) = \mathbf{v}(t)/\mathbf{Z}_C = j\omega CV_0 e^{j\omega t} = \omega CV_0 e^{j\frac{\pi}{2}} e^{j\omega t}$$

- Current expressed as phasor (text uses upper case bold face letters for phasor variables):

$$\mathbf{I} = \omega CV_0 \angle 90^\circ$$

- And the actual time-dependent current is $i(t) = \omega CV_0 \cos(\omega t + \frac{\pi}{2})$

Phasors (continued)



- The circuit and phasor diagram are shown above
 - We say \mathbf{I} leads $\mathbf{V} = V_0 \angle 0$ by 90° here
 - If \mathbf{I} is considered the output, then this is called a *lead network*
 - Compare with results if C is replaced with R or L
 - * With R, \mathbf{I} and \mathbf{V} in phase; With L, \mathbf{I} lags \mathbf{V} by 90°
- Text refers to phasor analysis as working in the *frequency domain*
 - The analysis assumes sinusoids at a single ω (or $f \equiv \frac{\omega}{2\pi}$)
 - The only dependence left is on ω (or f)
 - Bode plot shows amplitude and phase response as fcn of ω (or f)