FAMU-FSU
College of Engineering

Lecture #8:
AC Network Analysis (Part II)

EEL 3003
Introduction to Electrical Engineering
Summer Semseter, 2013

Instructor: Dr. Michael Frank

Administrative Announcements

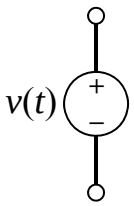
- Outline of Today's Class Session:
  1. Review Quiz #2 Solutions
     - on Chapter 3, Resistive Network Analysis
  2. Continue Chapter 4, AC Network Analysis
     - §4.2 – Time-dependent Signal Sources
     - §4.3 – Solution of Circuits Containing Energy Storage Elements (Dynamic Circuits)
     - §4.4 – Phasor Solution of Circuits with Sinusoidal Excitation
     - §4.5 – AC Circuit Analysis Methods
- Re: Current Homework Assignment (#3):
  - Read Ch. 4 & practice w. these exercises:
    - 4.1*, 4.12*, 4.31, 4.59*, 4.66, 4.68, 4.71, 4.77*
  - Quiz postponed to next Thursday (June 13th).

1. Review Quiz #2 Solutions (Ch. 3, Resistive Network Analysis)

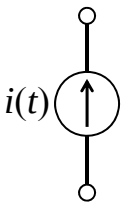
- Quiz grades are improving (vs. 1st quiz)
  - Grade histogram (papers graded so far)
    - A – ####
    - B – ###
    - C – ##
    - D –
    - F – ##
- Go through quiz solutions document

§4.2 - Time-dependent Signal Sources

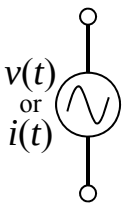
- Types of time-dependent sources:



General time-dependent voltage source



General time-dependent current source

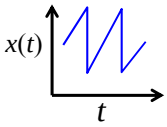


Sinusoidal voltage or current source

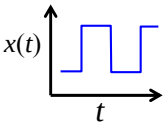
Periodic Signals

- Some common types: [$x(t) = v(t)$ or $i(t)$]

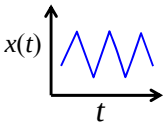
Sawtooth



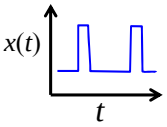
Square



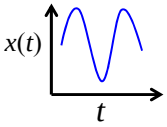
Triangle



Pulse Train



Sinusoidal



Sinusoidal Signal Waveforms

- General form for a sinusoidal voltage waveform:

$$v(t) = V \cdot \sin(\omega t + \phi)$$

  - Where:
    - t = time
    - $\omega = 2\pi(\text{rad}) \cdot f$ is angular frequency
      - Angular amount of "rotation" per unit time
    - $f = 1/T$ = cycle frequency
      - often in cyc/sec (Hz = hertz)
    - ϕ = phase offset (angular units)
    - V (or A) = voltage amplitude

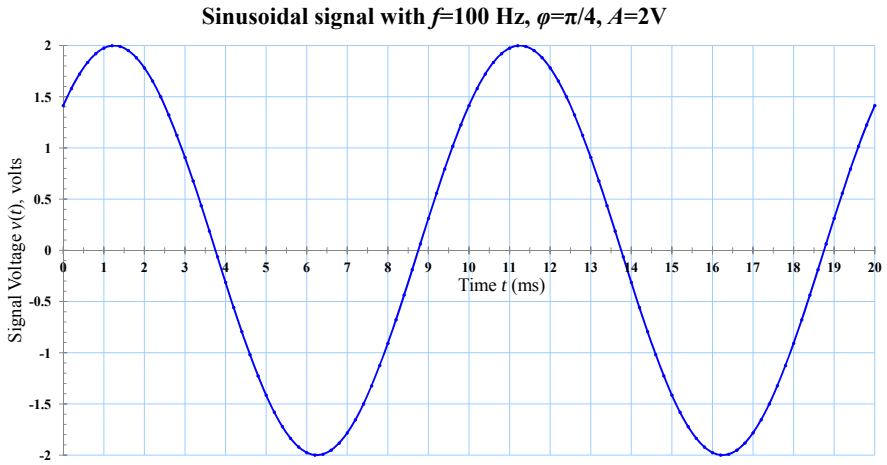
2π rad = 1 cyc = 360°

T = period

Δt = time offset

$\varphi = 2\pi \frac{\Delta t}{T}$ rad

Sinusoidal Waveform Example (see supplemental spreadsheet)



RMS Voltage/Current

- A measure of "average" signal strength:

$$x_{rms} = \sqrt{\frac{1}{T}\int_{t=0}^{T} x^2(t)\,dt}$$

  - rms = "root-mean-square"
  - *x* here could be either *i* or *v*
- Can easily calculate average signal power given RMS signal value:
  - *E.g.*, $P_{av} = I_{rms}^2 \cdot R$

RMS Value of a Sinusoidal Signal

- **Exercise:** Use your knowledge of calculus to prove that for any sinusoidal signal $x(t)$, over any integer number of cycles,

$$x_{rms} = \frac{1}{\sqrt{2}} X,$$

  - where X is the signal amplitude.

§4.3 – Solution of Circuits Containing Energy Storage Elements (Dynamic Circuits)

- This part of lecture was done on whiteboard
  - See notes posted after the lecture