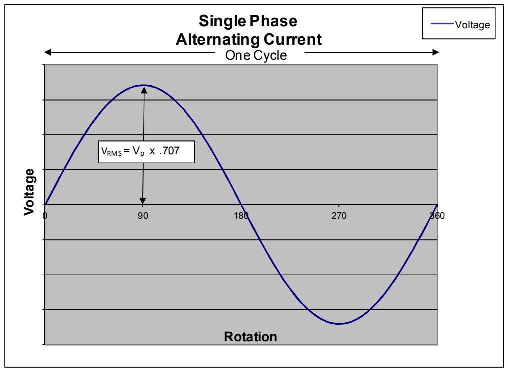
MECH 10
Fundamentals of Electronics

Class 11
Alternating Current



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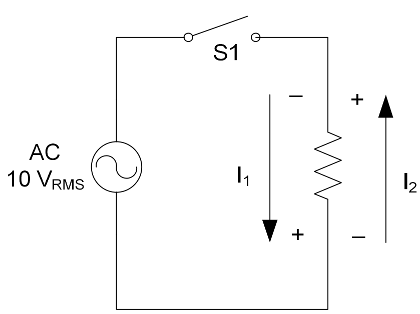
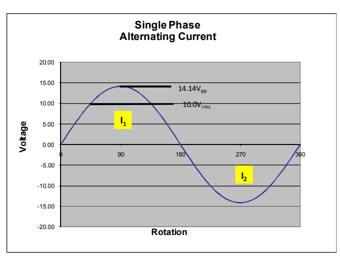
Fundamentals of Electronics

- Alternating Current
  - Electric charge that periodically reverses direction
    - North America – 60 cycles per second
    - Europe – 50 cycles per second





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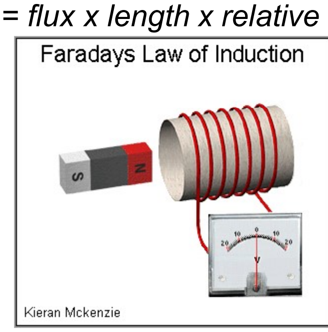
- Alternating Current
  - Generation

3

- Electro Magnetism (induction)
  - Michael Faraday - 1831
    - *The induced electromotive force or EMF in any closed circuit is equal to the time rate of change of the magnetic flux through the circuit.*
    - *Voltage = flux x length x relative velocity*



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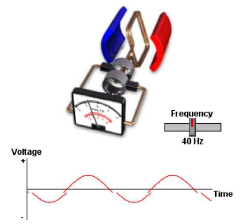
- Electro Magnetism (induction)
  - Generator action
    - The conversion of mechanical energy (torque) into electrical energy
    - Induced voltage is directly proportional to the number of coil turns and the rate the conductor cuts through magnetic lines of force



$$V_{ind} = N \times \frac{Wb}{s}$$

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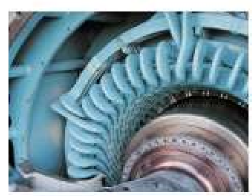
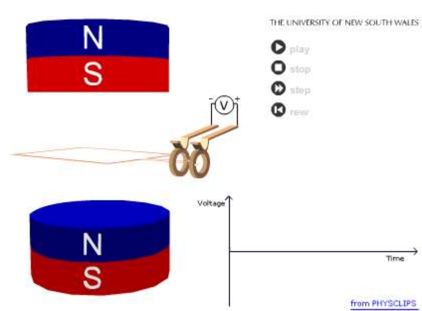
Mechatronics Real Skills Real Jobs

- Alternating Current
  - Generation
    - Electromagnetic Induction
    - Relative motion between conductor & magnetic field





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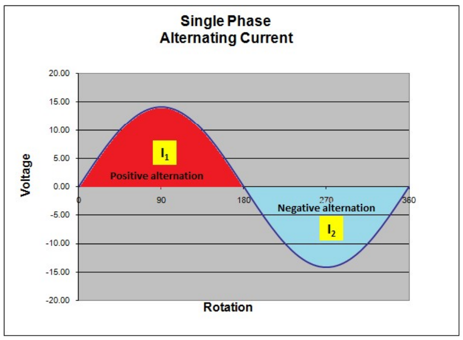
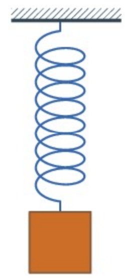
- Alternating Current
  - Sine wave – a mathematical function that describes a smooth repetitive oscillation
    - Alternations





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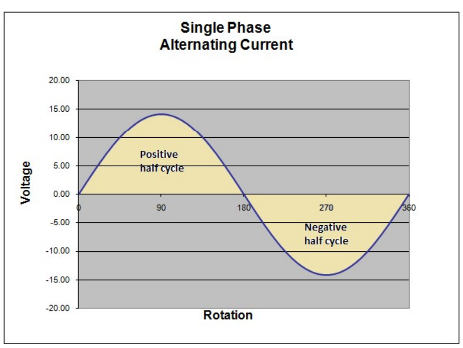
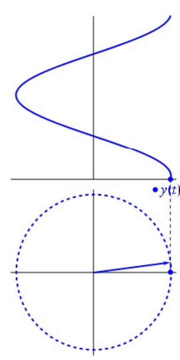
- Alternating Current
  - Sine wave – a mathematical function that describes a smooth repetitive [oscillation]
    - Cycles





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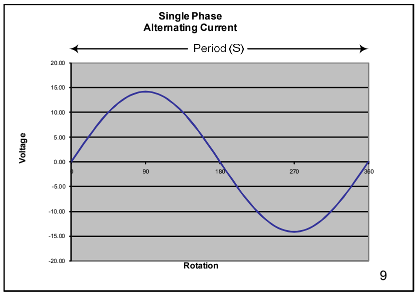
- Alternating Current
  - Sine wave
    - Period (seconds) – the time required to complete one alternation cycle
    - Frequency (hertz) – one divided by the period

$$f = \frac{1}{P}$$

$$P = \frac{1}{f}$$



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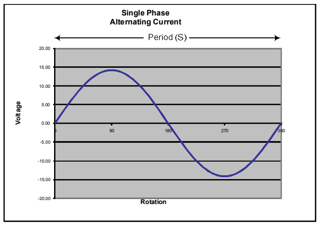
- Alternating Current
  - Sine wave
    - Example – a sine wave signal takes 20 milli-seconds to complete one alternation. Find the frequency in Hertz.

$$f = \frac{1}{P}$$

$$f = \frac{1}{20 \ mS} = ?? \ Hz$$



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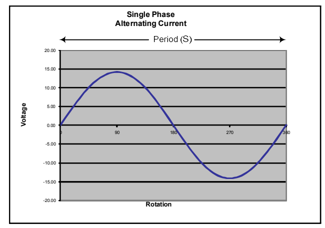
- Alternating Current
  - Sine wave
    - Example – a sine wave signal has a frequency of 1200Hz. Find the period in microseconds.

$$P = \frac{1}{f}$$

$$p = \frac{1}{1200 \quad Hz} = ??? \quad \mu S$$



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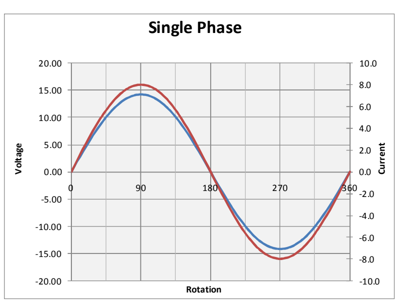
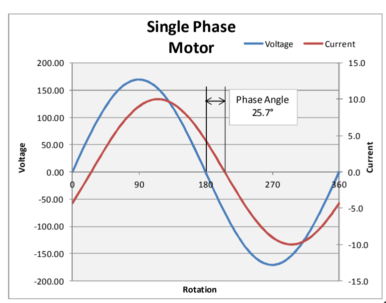
- Alternating Current
  - Phase angle (θ) – the degrees of separation between alternating signals (of equal frequency)
    - Measured at peaks, valleys or zero crossings



0° Phase Angle



25.7° Phase Angle

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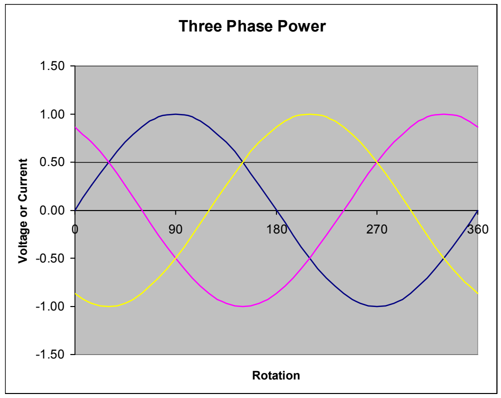
- Alternating Current
  - Three Phase Power

•3-phase advantages
- Less conductor material
- Constant power transfer
- Rotating magnetic field

$$I = \frac{E \times \sqrt{3}}{R}$$

$$P = I \times V \times \sqrt{3}$$



MECH 10
Fundamentals of Electronics

- Alternating Current
  - Phase angle (θ) – the degrees of separation between alternating signals
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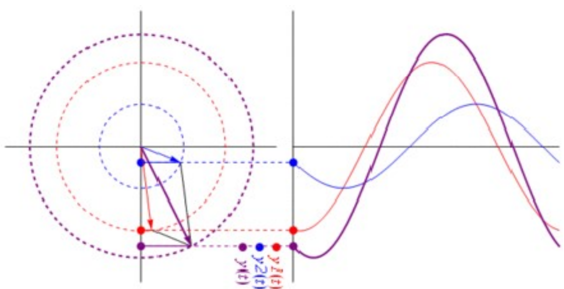

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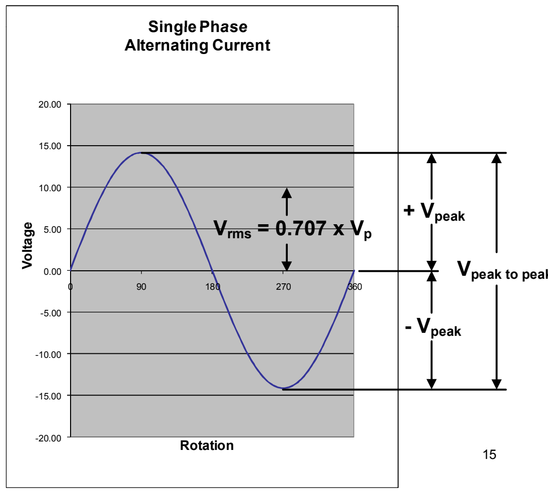
- Alternating Current

Effective Voltage - The DC equivalent of an AC voltage.

Effective Current- The DC equivalent of an AC current.

Produces the same power as this DC equivalent

RMS – root mean square



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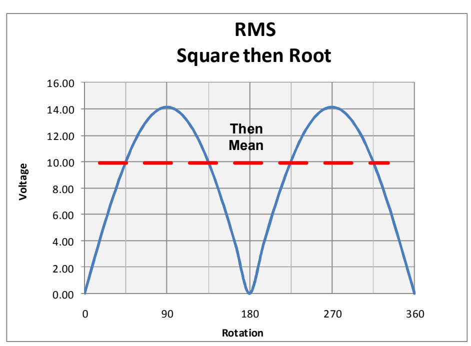
- Alternating Current
  - Effective voltage
    - RMS – Root mean square
      - Should be square, root, mean

$$V_{RMS} = \frac{V_p}{\sqrt{2}}$$

$$V_{RMS} = V_p \times 0.707$$



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Fundamentals of Electronics

Mechatronics
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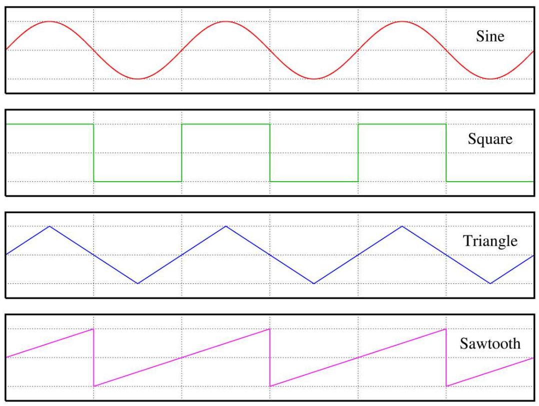
- Alternating Current
  - Periodic Waveforms



$$V_{RMS} = \frac{V_P}{\sqrt{2}} = V_P \times 0.707$$

$$V_{RMS} = V_P \times D$$ **For V_{min} = 0**

$$V_{RMS} = \frac{V_P}{\sqrt{3}} = V_P \times 0.577$$

$$V_{RMS} = \frac{V_P}{\sqrt{3}} = V_P \times 0.577$$

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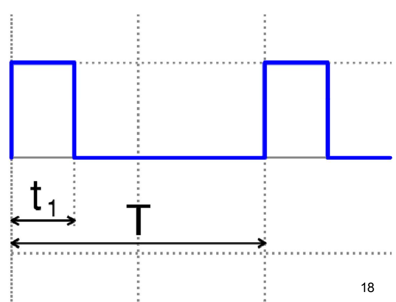
- Alternating Current
  - Periodic Waveforms
    - Square Wave Duty Cycle
      - Pulse duration / Cycle duration x 100%
      - Power delivery is directly proportional to duty cycle

$$Duty\_Cycle = \frac{t_w}{T} \times 100\%$$

$$V_{AVG} = V_P \times D$$ **For V_{min} = 0**



Where;
t_w = pulse duration (seconds)
T = cycle duration (seconds)
D = duty cycle

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- Oscilloscope
  - A device for analyzing voltage oscillations

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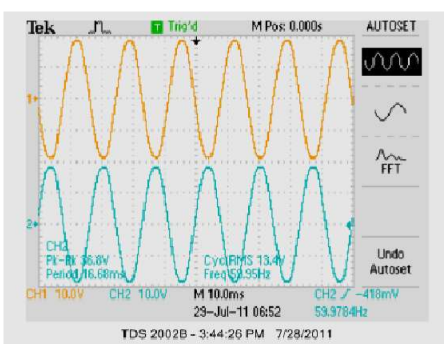
Fundamentals of Electronics

Mechatronics
Real Skills Real Jobs

- Oscilloscope
  - A device for analyzing voltage oscillations



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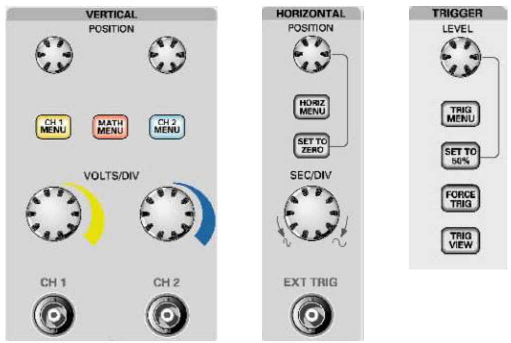
- Oscilloscope
  - Vertical System & Controls
  - Horizontal System Controls
  - Trigger System & Controls



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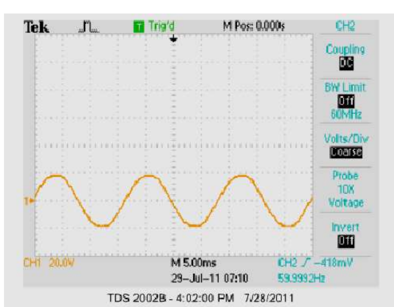
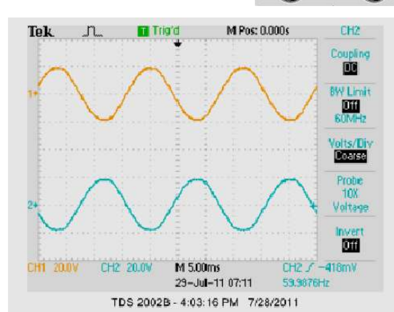
Real Skills Real Jobs

- Oscilloscope
  - Vertical System & Controls
    - Vertical Position



Single Channel



Two Channel

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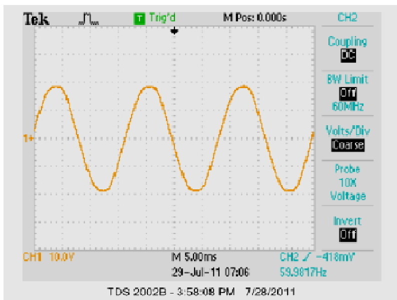
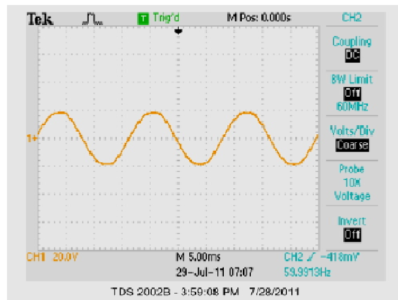
Mechatronics Real Skills Real Jobs

- Oscilloscope
  - Vertical System & Controls
    - Amplitude control – VOLTS/DIV



10.0V/DIV



20.0V/DIV

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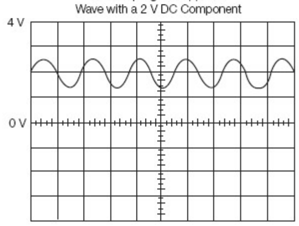
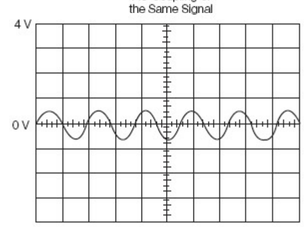
Mechatronics Real Skills Real Jobs

- Oscilloscope
  - Input Coupling
    - DC – displays entire signal, AC & DC
    - AC – displays only alternations
    - GND – disconnects input from vertical system (displays true ground point)

DC Coupling of a V_{P-P} Sine Wave with a 2 V DC Component



AC Coupling of the Same Signal



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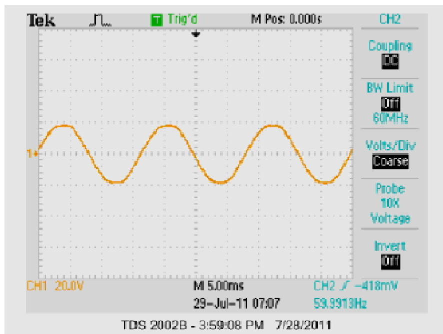
Real Skills Real Jobs

- Oscilloscope
  - Input Coupling
    - CH 1 MENU
      - Coupling – Choose DC / AC / GND



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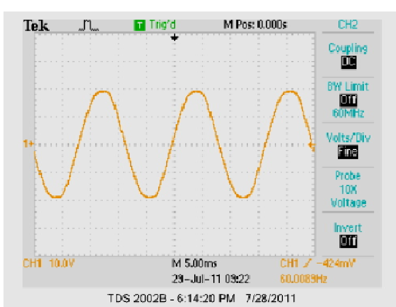
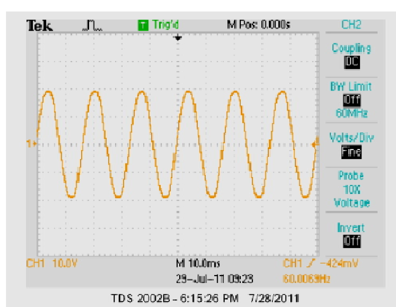
- Oscilloscope
  - Horizontal Controls
    - Time Division
      - Seconds / division



5.00 mS / division



10.00 mS / division

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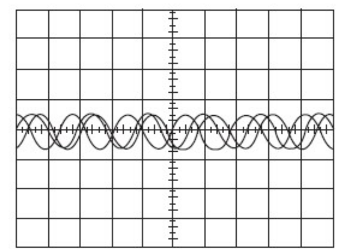
- Oscilloscope
  - Trigger Controls
    - Synchronizes horizontal refresh rate with the measured signal
      - Edge trigger – sync to rising or falling edge
      - Threshold trigger – sync to signal reaching set value
      - Advanced – serial pattern, slew rate…



Untriggered display.

- Lab 11 – Oscilloscope

Learning Objectives

- Understand the basic setup for oscilloscope measurements
- Measure AC & DC voltage signals with oscilloscope and DMM
- Calculate RMS voltage from peak voltage
- Calculate frequency from waveform period

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar), Expected and measured values recorded on schematic diagram	**10**
DC Voltage	DMM & Scope readings recorded, values compared	**5**
AC Voltage & Frequency	DMM & Scope readings recorded, values compared	**5**
	Waveform scatter plot drawn & accurate	**5**
Dual Trace	Waveform scatter plot drawn & accurate with phase shift labeled	**5**
Alternate Waveforms	DMM & Scope readings recorded, values compared	**5**
Conclusions	Questions answered completely & accurately.	**5**
	Total	**40**