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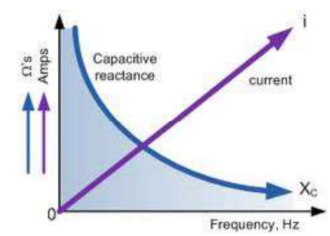
MECH 10
Fundamentals of Electronics

Mechatronics
Real Skills Real Jobs

Class 14
Reactive Components III
Capacitive Reactance



http://www.electronics-tutorials.ws/capacitor/cap_8.html

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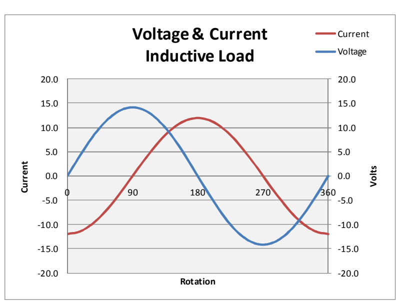
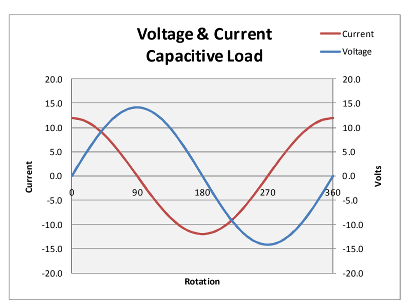
- Reactance
  - The opposition to changes in current or voltage



Opposes Current Change
Voltage Leads Current



Opposes Voltage Change
Current Leads Voltage

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- Capacitive Reactance
  - A capacitor’s opposition to changes in voltage
  - Characteristics
    - Inversely proportional to frequency & capacitance
    - A frequency dependent resistor
  - Applications
    - Motor starting circuits
    - Frequency filters

$$X_C = \frac{1}{2\pi f C}$$

Where;
X_C = capacitive reactance (Ω)
$2\pi f$ = angular velocity (rad/sec)
f = frequency (Hz)
C = capacitance (F)

Name	Unit symbol	Quantity	Symbol
capacitive reactance	X_C	Ohms	Ω

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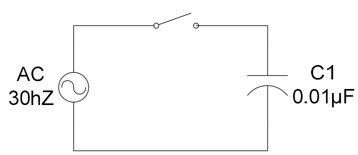
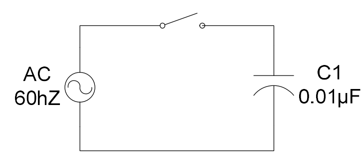
- Capacitive Reactance
  - Circuit Examples
    - Find X_C





$$X_C = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{2\pi \times 30 \times 0.01\mu F}$$

$$X_C = ???\Omega$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{2\pi \times 60 \times 0.01\mu F}$$

$$X_C = ???\Omega$$

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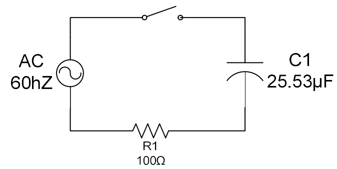
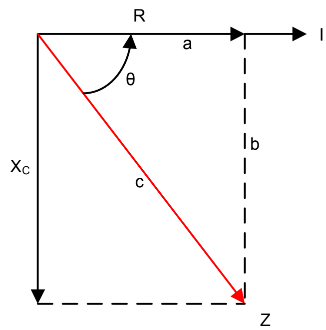
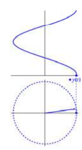
- Capacitive Reactance
  - Impedance
    - $R_T \neq X_C + R1$
    - Vector addition required
    - Pythagorean Theorem







$$X_C = \frac{1}{2\pi fC} = 104\Omega$$

$$R1 = 100\Omega$$

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{100^2 + 104^2}$$

$$Z = ??\Omega$$

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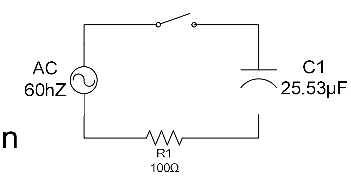
- Capacitive Reactance
  - Impedance – the total opposition to current flow in an AC circuit
    - Resistance & Reactance
      - Vector addition
    - For all reactive circuits!



$$X_C = \frac{1}{2\pi fC} = 104\Omega$$

$$R1 = 100\Omega$$

Name	Unit symbol	Quantity	Symbol
impedance	Z	Ohms	Ω

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{100^2 + 104^2}$$

$$Z = ??\Omega$$

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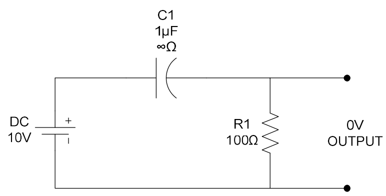
- Capacitive Reactance
  - Frequency Filters
    - High Pass Filters – Series RC

Frequency dependent resistor!



$$X_C = \frac{1}{2\pi fC}$$

$$X_C = \frac{1}{2\times\pi\times 0\times 1\mu F}$$

$$X_C = \infty(undefined)$$

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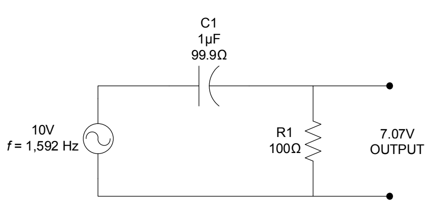
- Capacitive Reactance
  - Frequency Filters
    - High Pass Filters – Series RC

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi\times 1592\times 1\mu F}$$

$$X_C = ??\Omega$$

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{100^2 + 99.97^2} = ??\Omega$$



$$I_T = \frac{V_S}{Z} = \frac{10V}{141.3\Omega} = ??mA$$

Half power point – the frequency where the output is at ½ total circuit power

$$V_{R1} = I_T \times Z$$

$$V_{R1} = 70.77mA \times 100\Omega$$

$$V_{R1} = ??V$$

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- Capacitive Reactance
  - Frequency Filters
    - High Pass Filters – Series RC

$$X_c = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 15{,}920 \times 1\mu F}$$

$$X_c = ??\Omega$$

$$Z = \sqrt{R^2 + X_C^2}$$

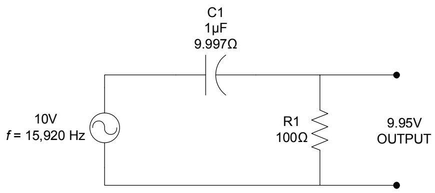
$$Z = \sqrt{100^2 + 9.997^2} = ??\Omega$$

$$I_T = \frac{E}{Z} = \frac{10V}{100.5\Omega}$$

$$I_T = ??\,A$$

$$V_{R1} = 0.995A \times 100\Omega$$

$$V_{R1} = ??V$$



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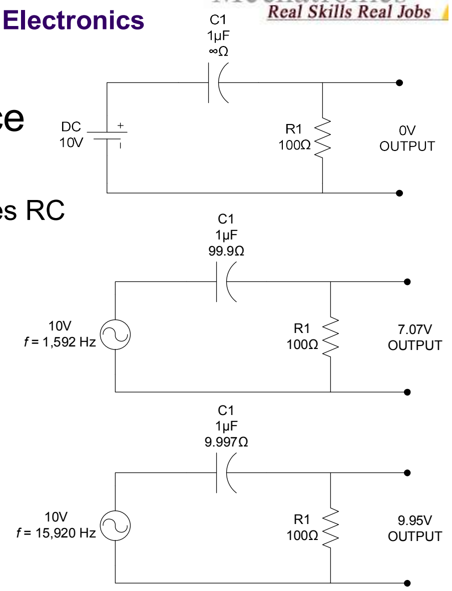
- Capacitive Reactance
  - Frequency Filters
    - High Pass Filters – Series RC

A high-pass filter allows high frequencies to pass through the filter relatively unaffected, while greatly attenuating (preventing) low frequencies from reaching the output.



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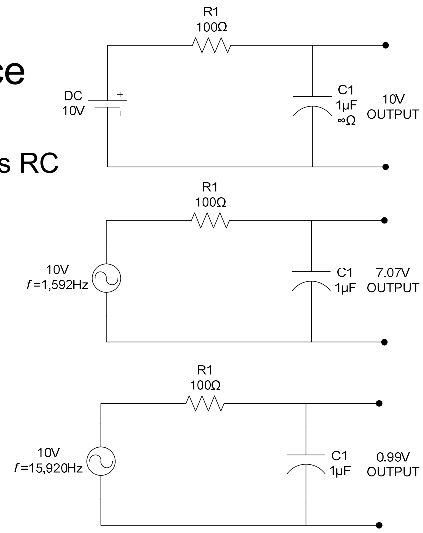
- Capacitive Reactance
  - Frequency Filters
    - Low Pass Filters – Series RC

A low-pass filter allows low frequencies to pass through the filter relatively unaffected, while greatly attenuating (preventing) high frequencies from reaching the output.



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- Lab 14 – High & Low Pass Filters

Learning Objectives

- Build and test the output of a high pass filter (series RC)
- Test the circuit output characteristics with different capacitance values
- Build and test the output of a low pass filter (series LC)
- Test the circuit output characteristics with different inductance values
- Create frequency response curves (Bode Plots) using Electronic Workbench

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar), Expected and measured values recorded on schematic diagram	**10**
X_c and Resistor Calculations	Values calculated and accurate, work is shown	**5**
High Pass Filter	Filter impact on frequencies recorded & accurate	**5**
	Changes to circuit performance noted with new capacitance value added	**5**
Low Pass Filter	Filter impact on frequencies recorded & accurate	**5**
	Changes to circuit performance noted with new inductance value added	**5**
Frequency Response Curves	Response curves (4) included and accurate	**5**
Conclusions	Questions answered completely & accurately.	**10**
	Total	**50**

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