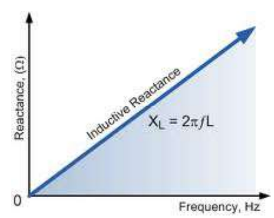
MECH 10
Fundamentals of Electronics

Class 15
Reactive Components IV
Inductive Reactance



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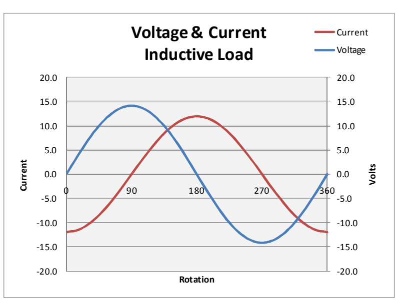
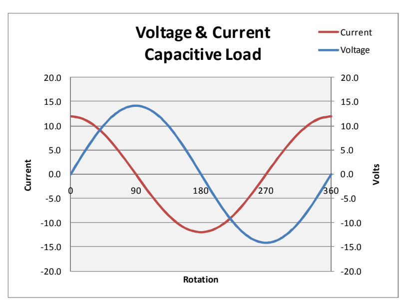
- Reactance
  - The opposition to changes in current or voltage



Opposes Current Change
Voltage Leads Current



Opposes Voltage Change
Current Leads Voltage

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Fundamentals of Electronics

- Inductive Reactance
  - An inductors opposition to changes in current
  - Characteristics
    - Directly proportional to frequency & inductance
    - A frequency dependent resistor
  - Applications
    - Motor starting circuits
    - Frequency filters

$$X_L = 2\pi fL$$

Where;
X_L = inductive reactance (Ω)
$2\pi f$ = angular velocity (rad/sec)
f = frequency (Hz)
L= inductance (H)

Name	Unit symbol	Quantity	Symbol
inductive reactance	X_L	Ohms	Ω

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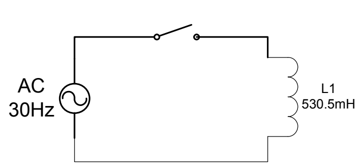
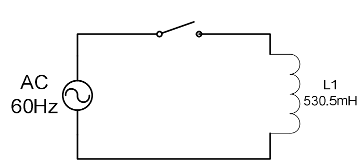
- Inductive Reactance
  - Circuit Examples
    - Find X_L





$$X_L = 2\pi fL$$
$$X_L = 2\pi \times 30Hz \times 530.5mH$$
$$X_L = ??\Omega$$

$$X_L = 2\pi fL$$
$$X_L = 2\pi \times 60Hz \times 530.5mH$$
$$X_L = ??\Omega$$

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Fundamentals of Electronics

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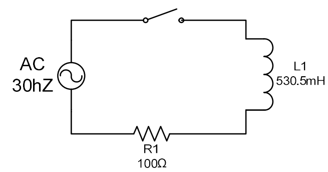
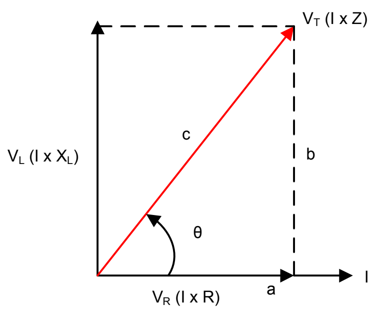
- Inductive Reactance
  - Total Resistance
    - $R_T \neq X_L + R1$
    - Vector addition required
    - Pythagorean Theorem





$$X_L = 2\pi f L = 100\Omega$$
$$R1 = 100\Omega$$

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

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Fundamentals of Electronics

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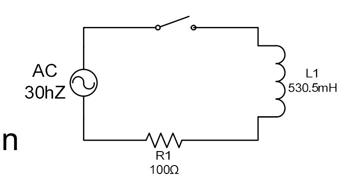
- Inductive Reactance
  - Impedance – the total opposition to current flow in an AC circuit
    - Resistance & Reactance
      - Vector addition
    - For all reactive circuits!



$$X_L = 2\pi f L = 100\Omega$$
$$R1 = 100\Omega$$

Name	Unit symbol	Quantity	Symbol
impedance	Z	Ohms	Ω

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

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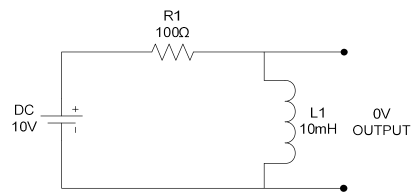
- Inductive Reactance
  - Frequency Filters
    - High Pass Filters – Series LR

Frequency dependent resistor



$$X_L = 2\pi f L = 2 \times \pi \times 0 \times L = 0$$

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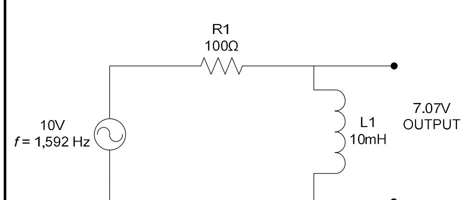
- Inductive Reactance
  - Frequency Filters
    - High Pass Filters – Series LR

$$X_L = 2\pi f L$$
$$X_L = 2 \times \pi \times 1{,}592 \times 10mH = 100\Omega$$

$$Z = \sqrt{R^2 + X_L^2}$$
$$Z = \sqrt{100^2 + 100^2} = 141.4\Omega$$



$$I_T = \frac{V_S}{Z} = \frac{10V}{141\Omega} = 70.71mA$$

$$V_{L1} = I_T \times X_L$$
$$V_{L1} = 70.71mA \times 100\Omega$$
$$V_{L1} = 7.07V$$

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Mechatronics
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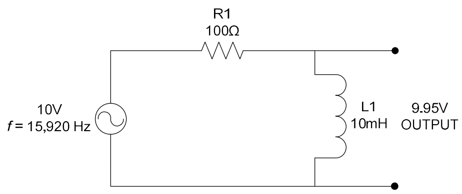
- Inductive Reactance
  - Frequency Filters
    - High Pass Filters – Series LR



$$X_L = 2\pi fL = 2\pi \times 15{,}920 \times 10mH$$
$$X_L = ??\Omega$$

$$Z = \sqrt{R^2 + X_C^2}$$
$$Z = \sqrt{100^2 + 1000^2} = ??\Omega$$

$$I_T = \frac{E}{Z} = \frac{10V}{1005\Omega}$$
$$I_T = ??\,A$$

$$V_{R1} = 9.95mA \times 1000\Omega$$
$$V_{R1} = ??V$$

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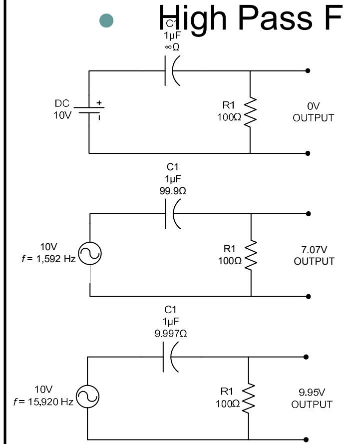
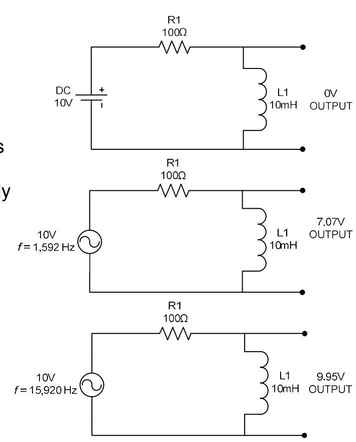
- Inductive & Capacitive Reactance
  - High Pass Filters



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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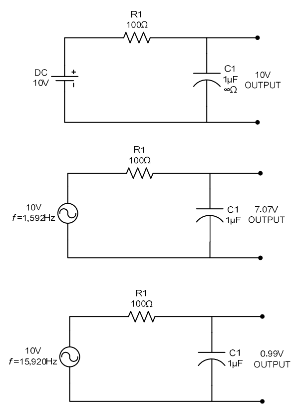
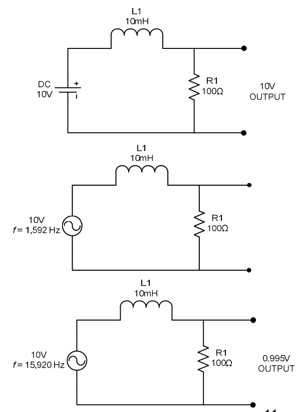
- Inductive & Capacitive Reactance
  - Low Pass Filters



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 15 – Phase Shift

Learning Objectives

- Measure the phase shift of a resistive circuit
- Measure the phase shift of a capacitive circuit
- Measure the phase shift of an inductive circuit

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar), Expected and measured values recorded on schematic diagram	**10**
Circuit 1	Circuit demonstrated with signature	**5**
Circuit 2	X_C & F_C calculated & accurate, phase shift recorded and accurate	**10**
Circuit 3	X_L & F_C calculated & accurate, phase shift recorded and accurate	**10**
Conclusions	Questions answered completely & accurately.	**20**
	Total	**45**