Technician Class Course

Session 3

ARRL The national association for AMATEUR RADIO

BASIC ELECTRICAL PROPERTIES

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Resistors and Resistance

- Resistor: the electronic component
- Resistance: the opposition to the flow of an electric current
- Unit of resistance: Ohm
- Energy is dissipated as heat

Schematic Symbol

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Inductors and Inductance

- Inductor: the electronic component
- Inductance: opposition to “time-varying” (i.e., AC) current changes
- Unit of inductance: Henry
- Energy is stored in a magnetic field

Schematic Symbol

Capacitors and Capacitance

- Capacitor: the electronic component
- Capacitance: opposition to “time-varying” (i.e., AC) voltage changes
- Unit of capacitance: Farad
- Energy is stored in an electric field

Schematic Symbol

REACTANCE, IMPEDANCE AND RESONANCE

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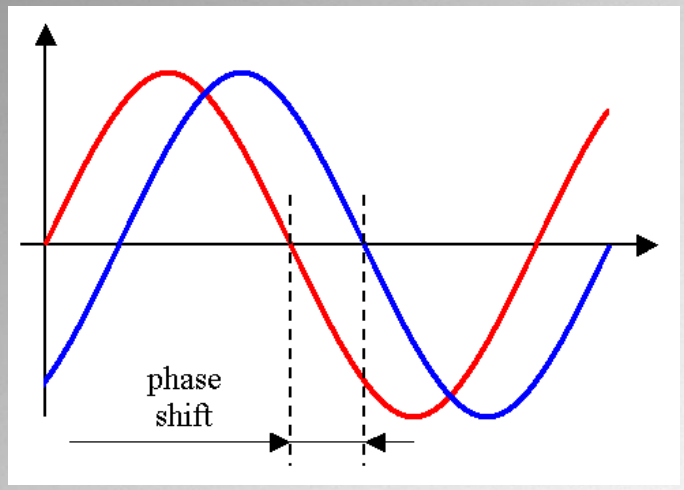
Frequency and Phase Terminology



- The red and blue traces shown are out of phase
- Phase shift a is time separation

- The red trace "lags" the blue trace
- The blue trace "leads" the red trace

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Analogy between DC and AC

- Resistance (R)
  - same as what was discussed with DC

Analogy between DC and AC

- Reactance (X) is unique to AC circuits
  - Capacitive reactance (X_C)
    - Unit of measure: Ohm
    - Frequency dependent
  - Inductive reactance (X_L)
    - Unit of measure: Ohm
    - Frequency dependent

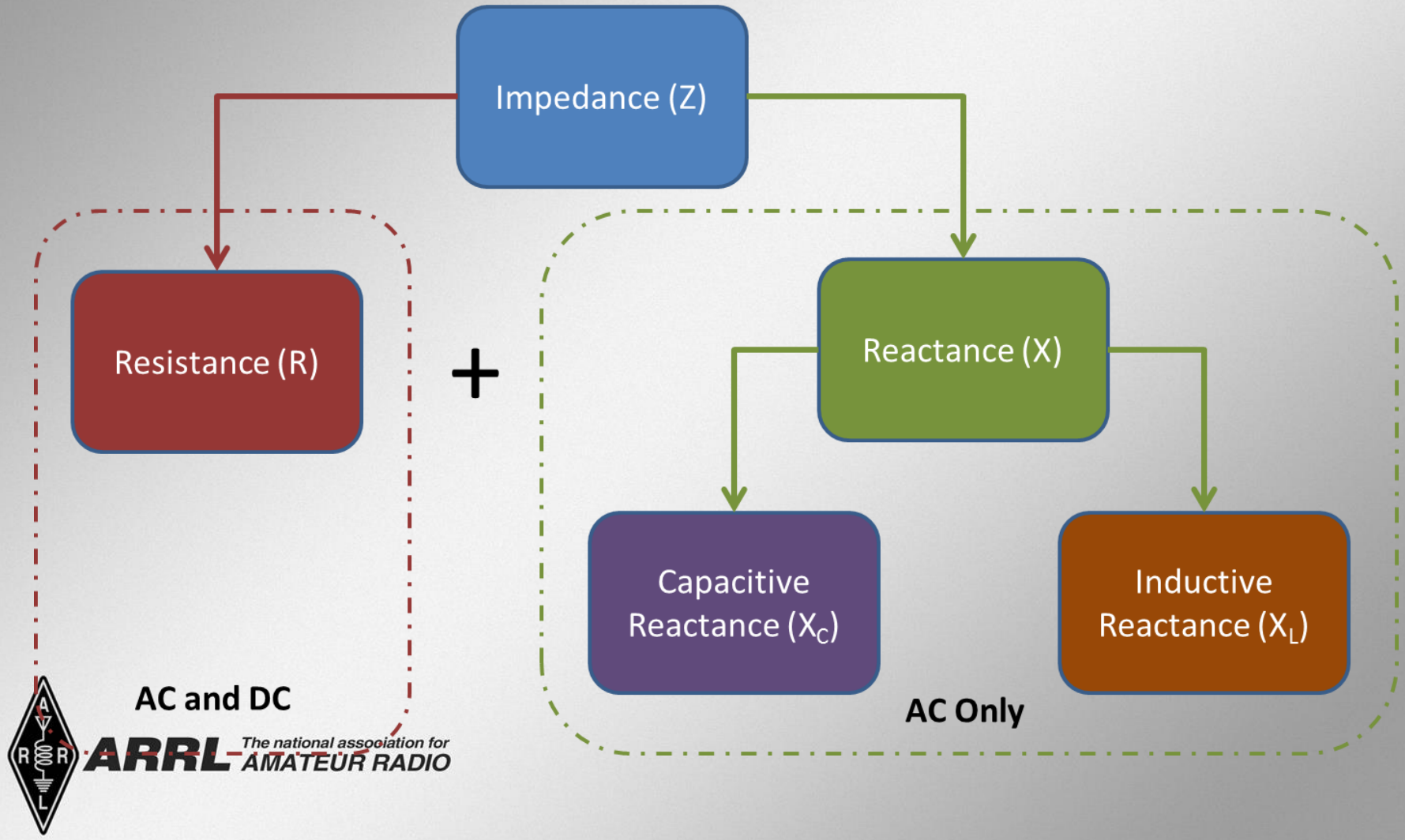
Analogy between DC and AC

- In DC circuits, the current and voltage are always in phase
- In AC circuits, the current and voltage are (generally) not in phase
  - Resistive circuits – current in phase with voltage
  - Capacitive circuits – current leads voltage
  - Inductive circuits – current lags voltage

Impedance

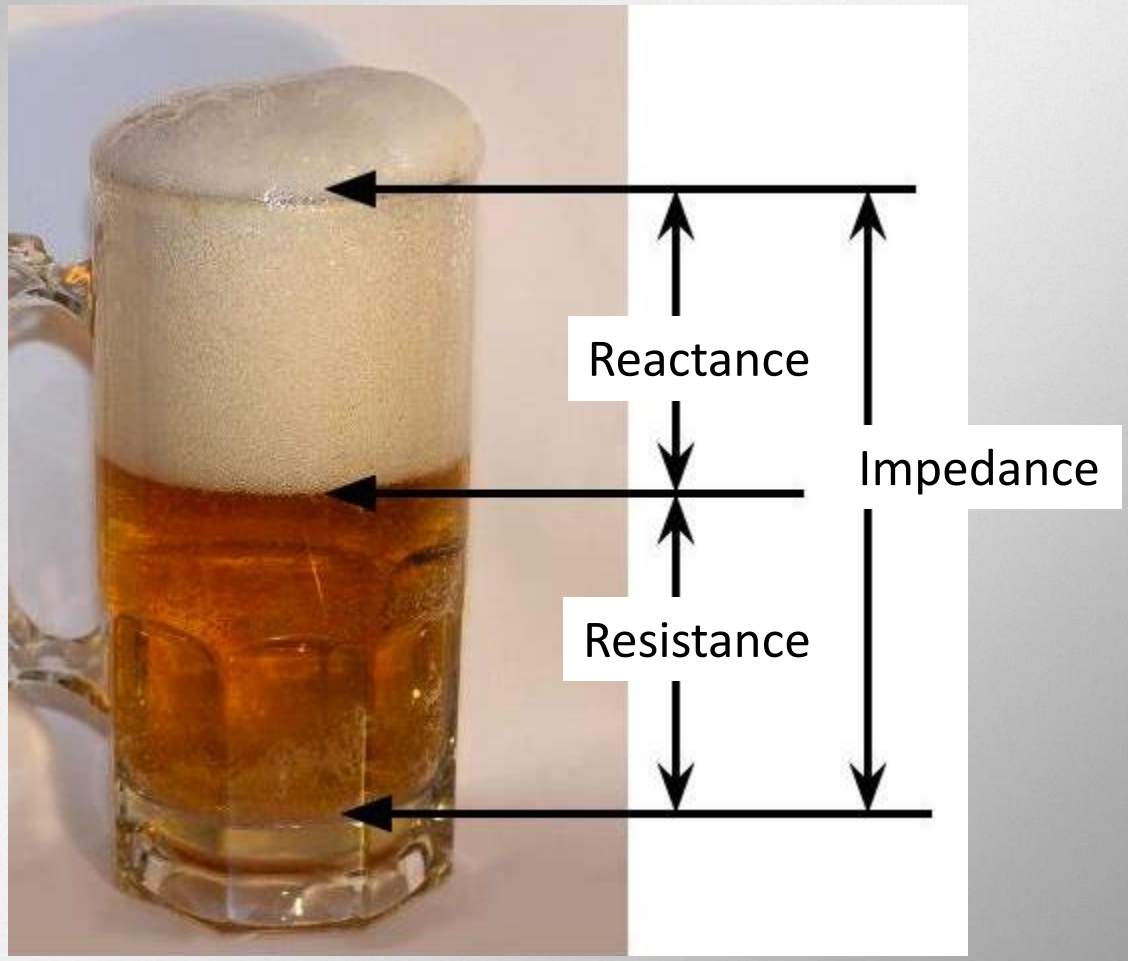
- Real circuits contain combinations of R, L and C
- Impedance (Z) is the combination of the total resistance and the total reactance
  - Both capacitive and inductive reactance
- Unit of measure: Ohm

Resistance, Reactance and Impedance



Impedance

The power that does the work is in the resistance…



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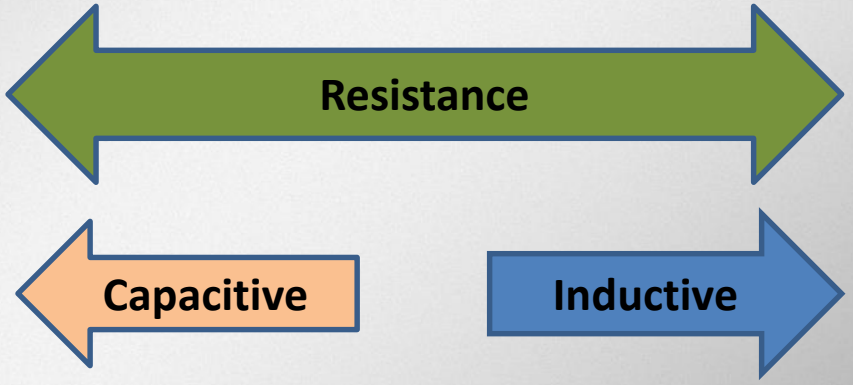
Impedance

- Contributions from capacitive and inductive reactances work to oppose each other
- The circuit sees the net effect of the reactances but the resistances remain the same

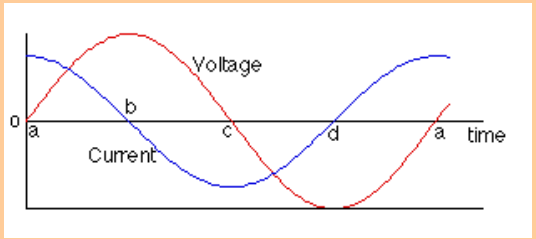


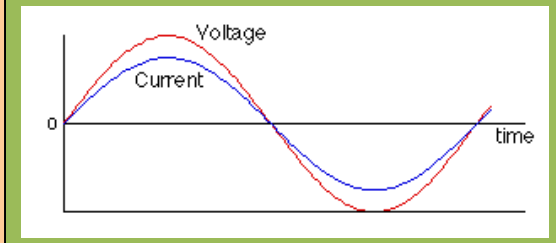
Resonance

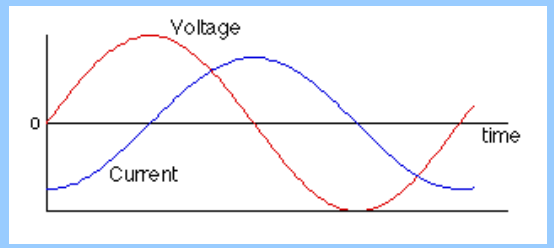
- Resonance is a special condition
- Reactances are equal in amplitude but opposite in phase/sign
- Reactances cancel each other out at one specific frequency
  - This is the resonant frequency
  - Resistance remains unchanged

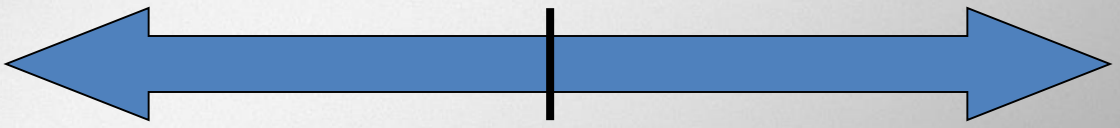
Resonant Circuit Behavior

$X_L < X_C$	$X_L = X_C$	$X_L > X_C$
"Capacitive"	"Resonance"	"Inductive"









Below Resonance | Resonance | Above Resonance

Maximum power transfer occurs at resonance

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Resonance

- Resonance is an important phenomena for radio circuits and antennas
- We “tune” circuits and antennas for resonance for the maximum transfer of power between stages and between radios and antennas

Antennas

- Antennas also exhibit a combination of resistance and reactance
- Reactance changes with frequency
- Antennas are adjusted to be resonant at the desired frequency