

TOPIC 2 – INTRO TO ELECTROMAGNETICS

2.1 Basic Electronics

2.1.1 V, I, R and Ohm's Law

Basic electrical parameters

- ◆ Voltage – the electrical “push” – in units of Volts (V)
- ◆ Current – the electrical “flow” – in units of Amperes (A)
- ◆ Resistance - the electrical “obstruction” – in units of Ohms

Ohm's Law – applies to all circuits both AC and DC

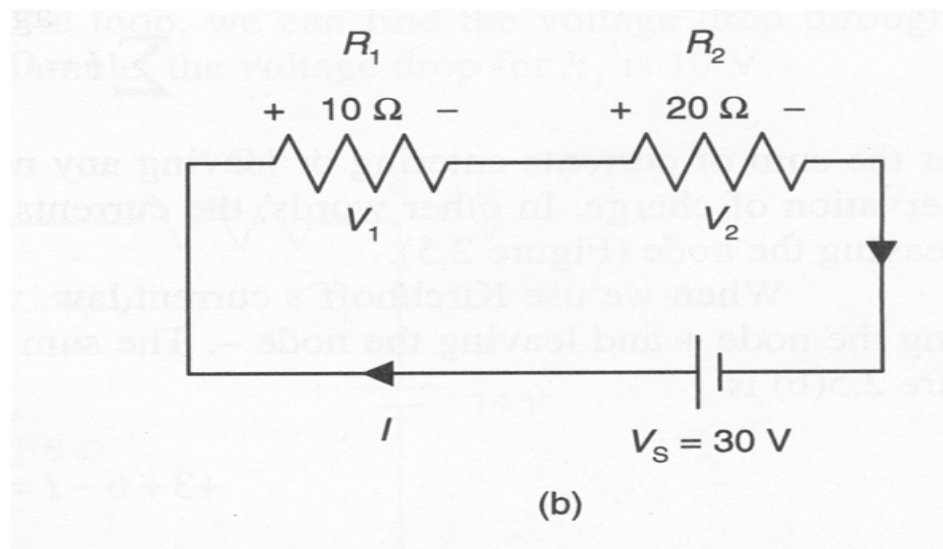
$$\blacksquare V = I * R$$

Note: Class slides are based on materials developed by Al Messano in previous sessions of class

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2.1 Basic Electronics

2.1.1. V, I, R and Ohm's Law



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2.1.2. Capacitance (C)

- ◆ Electric component which generates a Current which is proportional to the change in voltage across it:

$$I(t) = C(dV/dt)$$

- ◆ Basic unit: Farad (F).
- ◆ Acts like a battery that wants to charge up.
- ◆ Consists of two parallel plates of surface area A separated by a distance d.
- ◆ The Capacitance is given by:

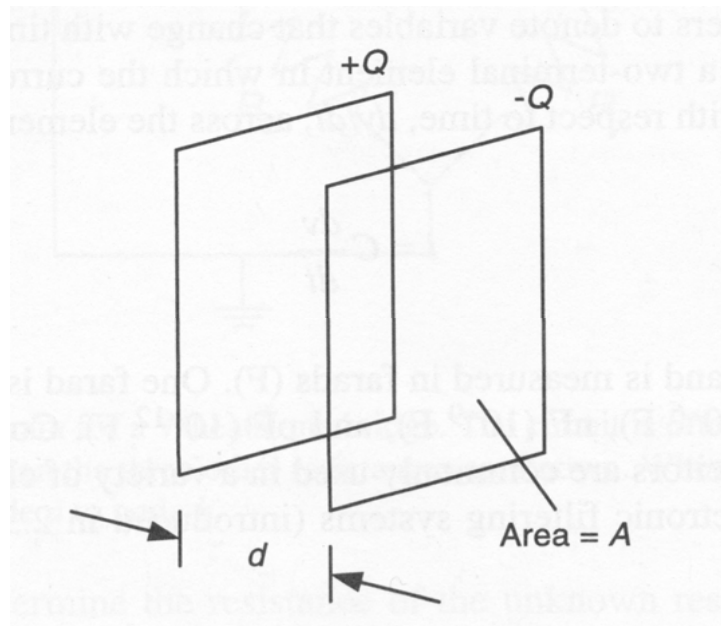
$$C = (\varepsilon * A)/d$$

Where ε is the electric Permittivity of the dielectric

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2.1.2. Capacitance (C)



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2.1.3. Inductance (L)

- ◆ Electric component which generates a Voltage which is proportional to the change in Current across it:

$$v(t) = L(di/dt)$$

- ◆ Basic unit: Henry (H).
- ◆ Consists of a coil of conductive material.
- ◆ Calculation of Inductance is complex being based on the geometry of the coil and the magnetic permeability (μ) of the material used.



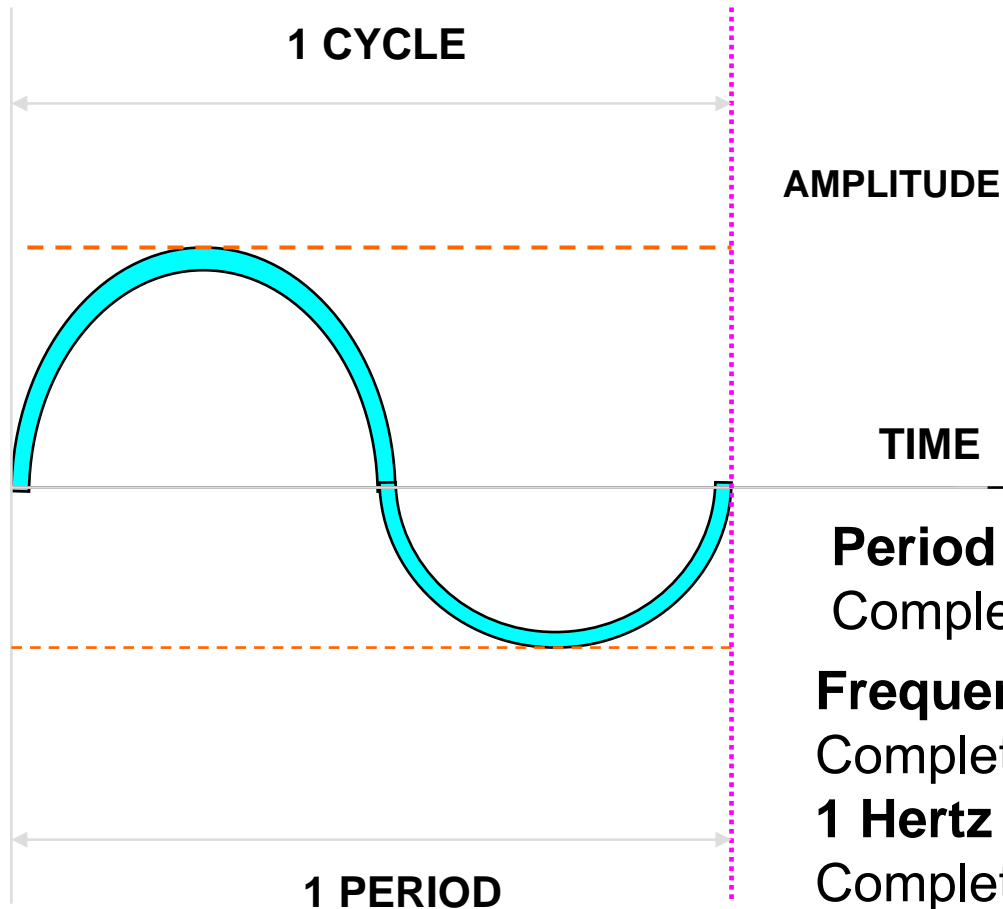
2.1. Basic Electronics

2.1.4. Frequency

Essential Characteristics For All Types of Waves

- ◆ Amplitude
- ◆ Frequency
- ◆ Wavelength

2.1. Basic Electronics

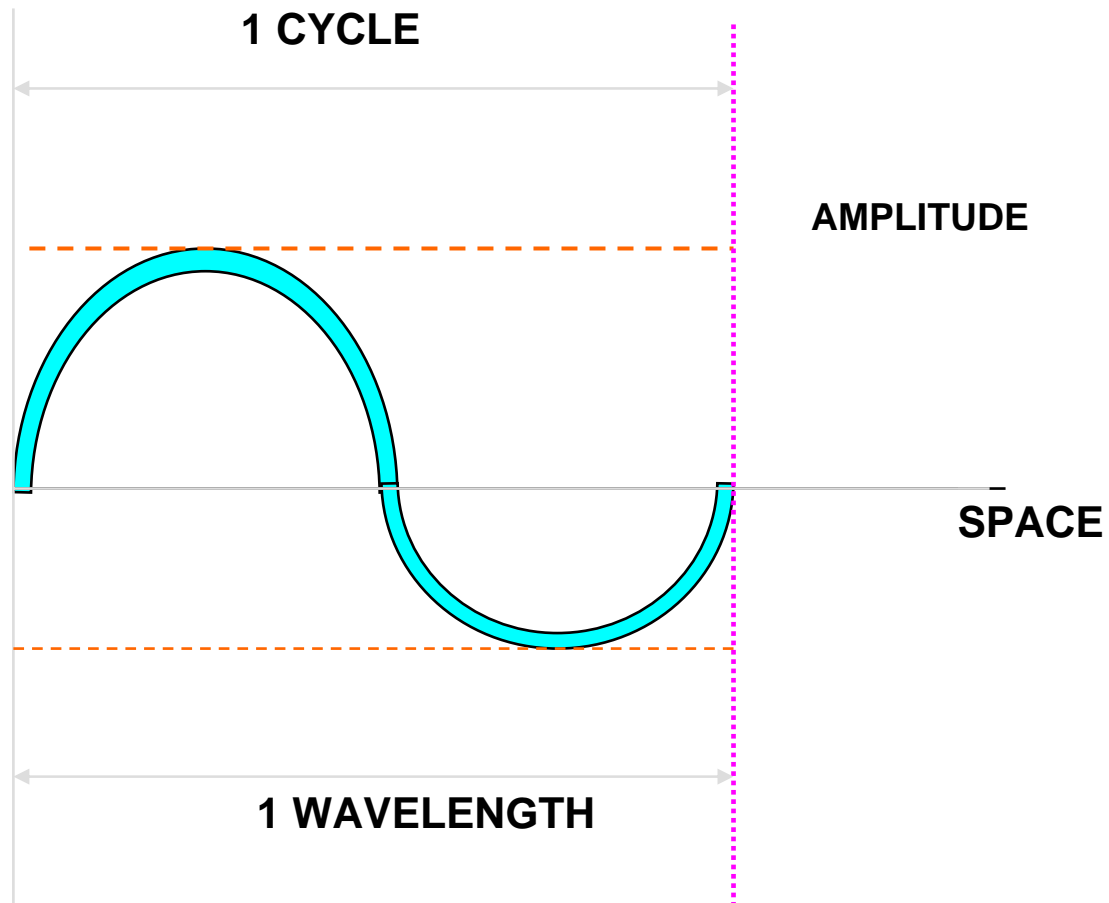


Period = time to
Complete 1 **Cycle**

Frequency = # of **Cycles**
Completed per second

1 Hertz = 1 **Cycle**
Completed per second

2.1. Basic Electronics





2.1. Basic Electronics

Frequency and Wavelength



- Frequency is measured in Hertz or Cycles per Second.
- Wavelength is measured in units of length.
- The higher the frequency, the shorter the wavelength.
- The higher the frequency, the higher the energy content.

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2.1. Basic Electronics

- ◆ 2.1.5 Impedance
- ◆ Electrical components have responses that vary with frequency.
- ◆ This frequency response is known as impedance, Z .
- ◆ Impedance has both a real and a complex part and is of the form: $Z = R + jX$ where X is called Reactance.
- ◆ So the following relationships hold:
 - Resistor: $Z = R + 0*j = R$
 - Capacitor: $Z = 0 - j/\omega C = -j/\omega C$
 - Inductor: $Z = 0 + j\omega L = j\omega L$
 - ◆ Where $\omega = \text{radial frequency} = 2 * \pi * \text{frequency [Hz]}$

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2.1. Basic Electronics

Impedance and Capacitance Effects

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2.1. Basic Electronics

2.1.6. Typical Electrical Responses

