

# BASIC ELECTRICAL THEORY STUDY GUIDE

## BASIC PROPERTIES OF ELECTRICITY

- These properties of electricity are interrelated; A change in voltage and/or current produces a change in power
- They are affected by properties of circuits and components (Resistance, Capacitance and Inductance)

### VOLTAGE

E

VOLTS

V

- Electrical pressure, or electrical force which "pushes" current through a circuit or component

### CURRENT

I

AMPS

A

- The amount of electrical flow (Number of electrons passing a point in a period of time)

### POWER

P

WATTS

W

- Power represents how much electrical work is being done
- Power is a product (multiplication) of Voltage (E) and Current (I)
- Power can be derived from Voltage (E) and Resistance (R), or Current (I) and Resistance (R)

$$P = I \times E$$

$$P = E^2 \div R$$

$$P = I^2 \times R$$

## BASIC PROPERTIES OF CIRCUITS AND COMPONENTS

- These properties of circuits and components are *physical* properties;
- They are not affected by properties of electricity (Voltage, Current and Power)
- Resistors, Capacitors and Inductors have specific values of Resistance, Capacitance and Inductance

### RESISTANCE

R

OHMS

$\Omega$

- Resistance is opposition to current flow

### CAPACITANCE

C

FARADS

F

- Capacitance opposes *change in voltage*, by storing energy in the form of *electric charge*

### INDUCTANCE

L

HENRYS

H

- Inductance opposes *change in current*, by storing energy in the form of a *magnetic field*

## PROPERTIES SPECIFIC TO ALTERNATING CURRENT (AC)

|       |                |                                                 |                         |                    |                |
|-------|----------------|-------------------------------------------------|-------------------------|--------------------|----------------|
| POWER | TRUE POWER     | Power consumed by the load                      | $P_t$ or $P_{true}$     | WATTS              | W              |
|       | APPARENT POWER | Power provided by the source                    | $P_a$ or $P_{apparent}$ | Volt-Amps          | VA (kVA)       |
|       | POWER FACTOR   | Ratio of $P_t$ to $P_a$ ( $pf = P_t \div P_a$ ) | pf                      | n/a                | % or Decimal # |
|       | REACTIVE POWER | Power caused by capacitance and inductance      | $P_r$ or $P_{reactive}$ | Volt-Amps Reactive | VAR (kVAR)     |

### FREQUENCY

f

HERTZ

Hz

- Number of Cycles Per Second (CPS) of the AC sine wave; 60 Hz in North America; 50 Hz is most of the world

### REACTANCE

X

OHMS

$\Omega$

#### CAPACITIVE REACTANCE

$X_c$

OHMS

$\Omega$

- Opposition to current flow in an AC circuit due to capacitance;  $X_c \downarrow$  as frequency  $\uparrow$

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

#### INDUCTIVE REACTANCE

$X_L$

OHMS

$\Omega$

- Opposition to current flow in an AC circuit due to inductance;  $X_L \uparrow$  as frequency  $\uparrow$

$$X_L = 2\pi f L$$

### IMPEDANCE

Z

OHMS

$\Omega$

- Total opposition to current flow in an AC circuit; Varies with frequency (f)
- Includes Resistance (R), Capacitive Reactance ( $X_c$ ), and Inductive Reactance ( $X_L$ )

$$Z = \sqrt{R^2 + (X_L - X_c)^2}$$

## BASIC CIRCUIT ARRANGEMENTS

### SERIES

### PARALLEL

- Current flows through components *sequentially*
- Current is *constant* through components in series
- Voltage varies across components

- Current flows through branches *simultaneously*
- Voltage is *constant* across parallel branches
- Current varies through individual branches

## OHM'S LAW

- Relationship between Voltage (E), Current (I) and Resistance (R)
- It can be expressed using the three formulas below
- Impedance (Z) must be substituted for Resistance (R) in AC circuits that have capacitive and inductive properties

$$E = I \times R$$

$$I = E \div R$$

$$R = E \div I$$

# Basic Electronics Theory Study Guide

**Daniel F McAuley**



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