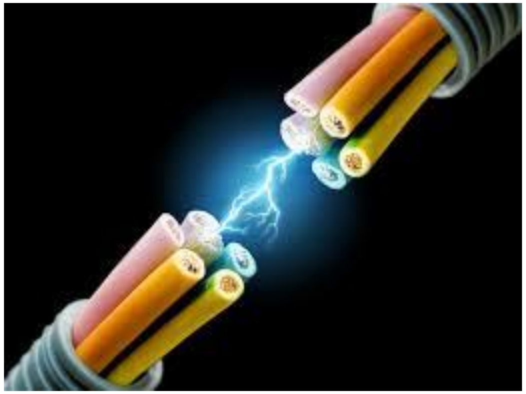
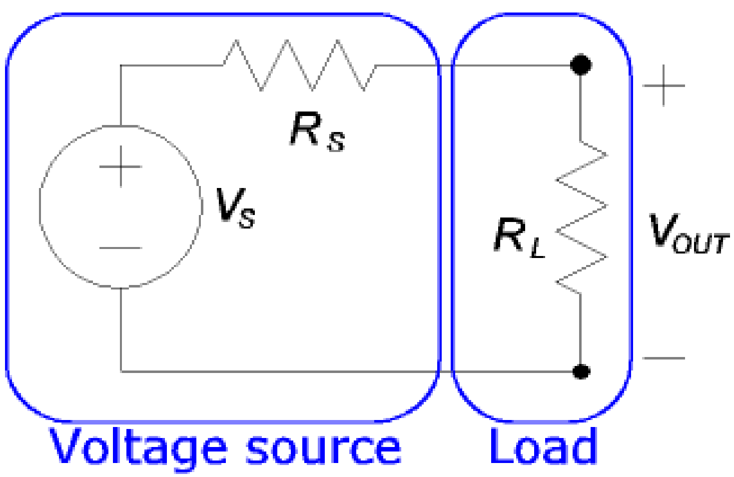
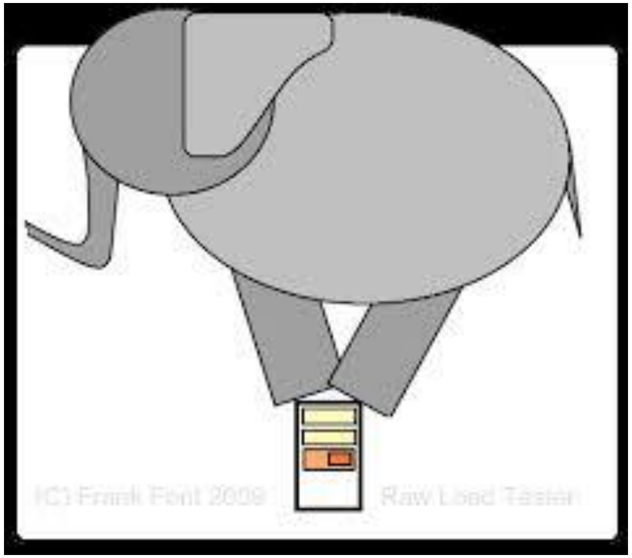
FUNDAMENTALS OF ELECTRICAL ENGINEERING


LOAD (POWER CONSUMED)

- It is a any electric load on a circuit that does work.
- A device connected to the output of a circuit
  - Example: Power windows, light bulbs, motors.





CIRCUIT

- Source:

A Voltage or a Current source which delivers Electrical energy

- Sink:

A Element which consumes Electrical energy

- Circuit:

Consist of a source and a sink connected with some wires forming a closed loop

CIRCUIT DEFINITIONS

- Node:

  Any point where 2 or more circuit elements are connected together

- Branch:

  A circuit element between two nodes

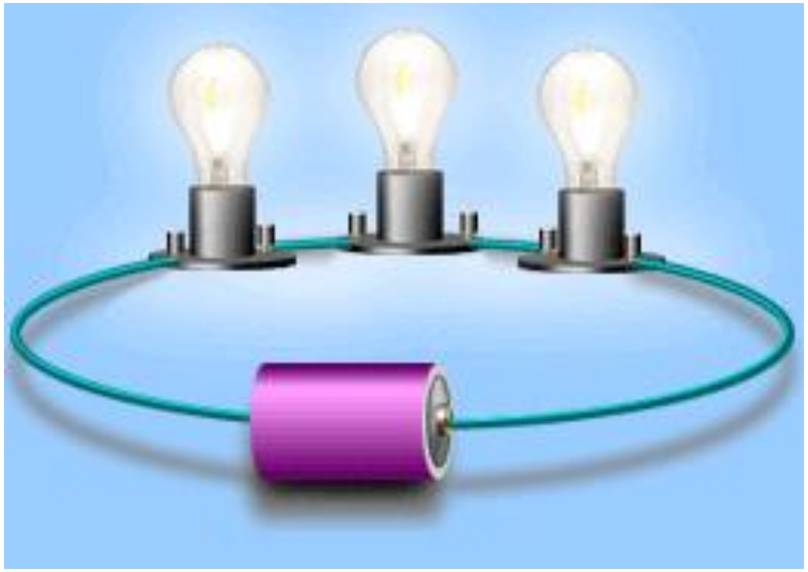
- Loop:

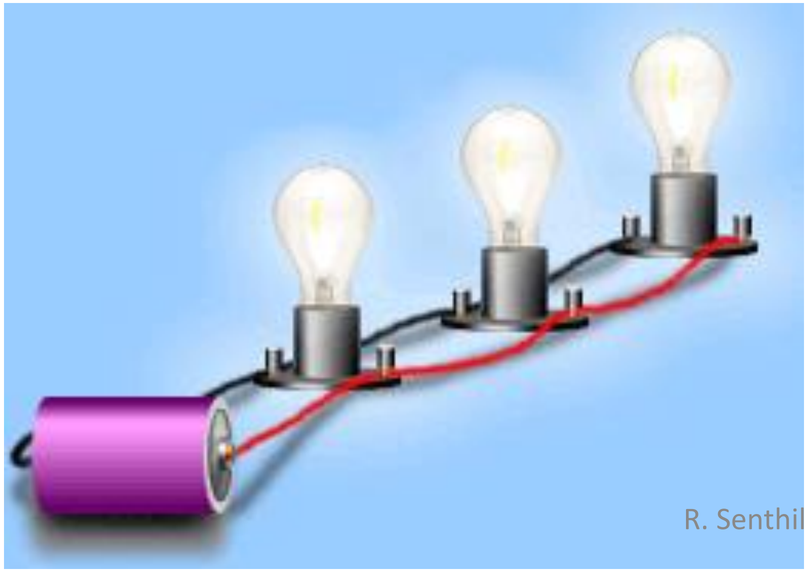
  Collection of branches that form a closed path returning to the same node without intersecting

Would This Work?

Would This Work?

Simple Circuits



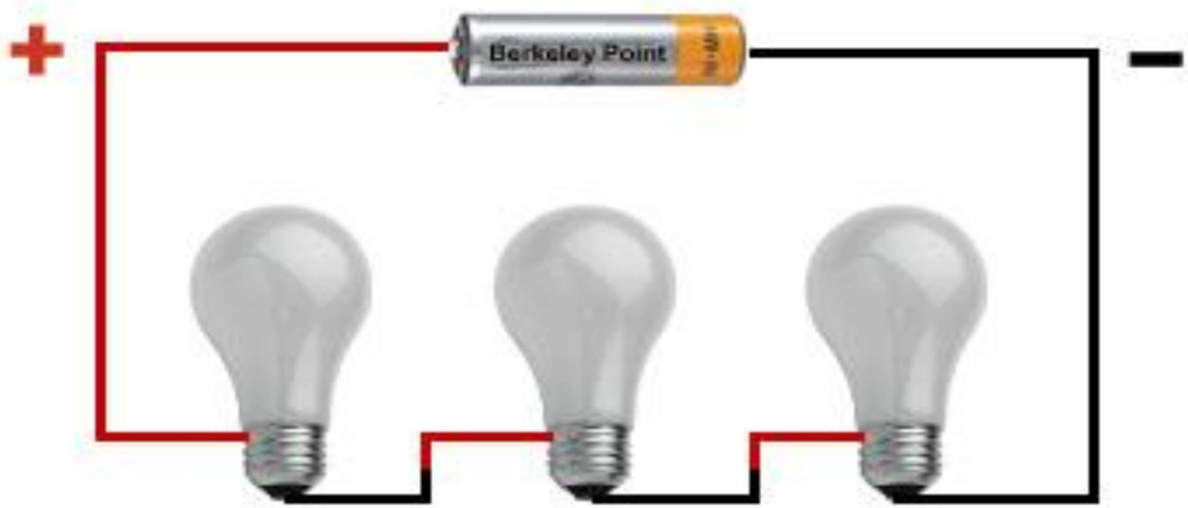


- Series circuit
  - All in a row
  - 1 path for electricity
  - 1 light goes out and the circuit is broken
- Parallel circuit
  - Many paths for electricity
  - 1 light goes out and the others stay on

DIFFERENT TYPES OF CIRCUIT

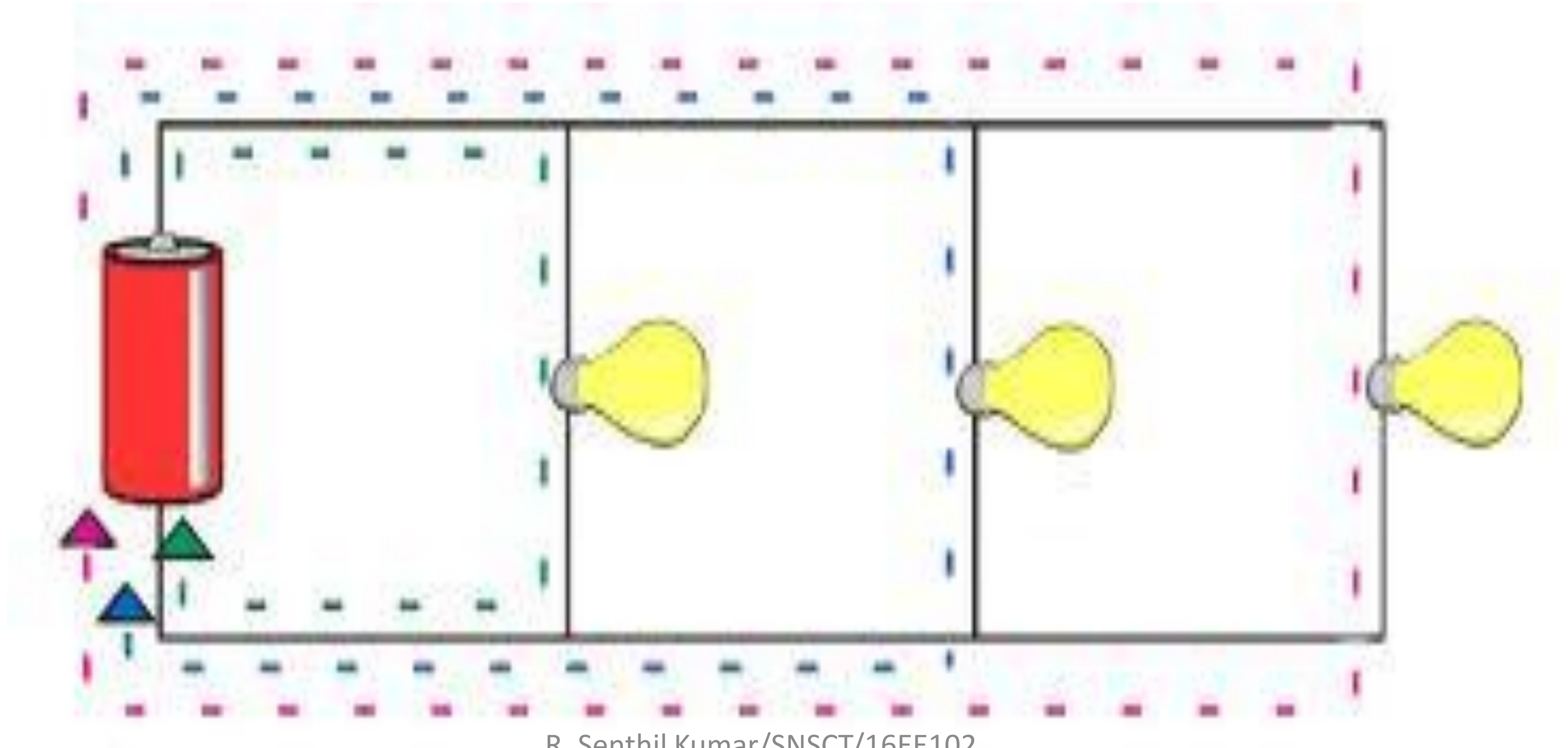
SERIES CIRCUIT

- One pathway for current to flow.
- Example: Old Christmas lights

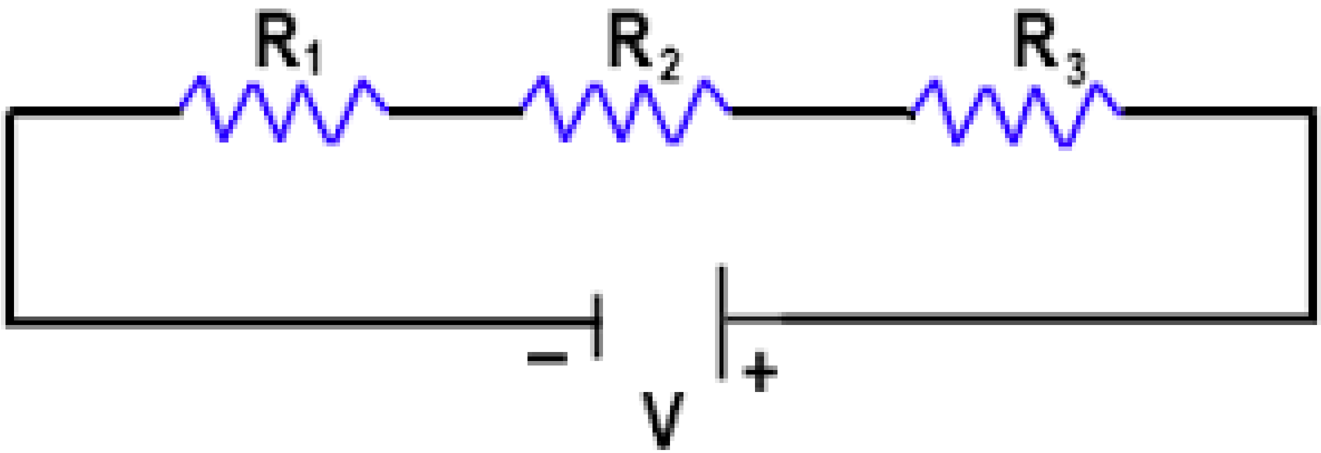


PARALLEL CIRCUIT

- More then one path way for current to flow.
- Used in most electrical vehicle circuits.

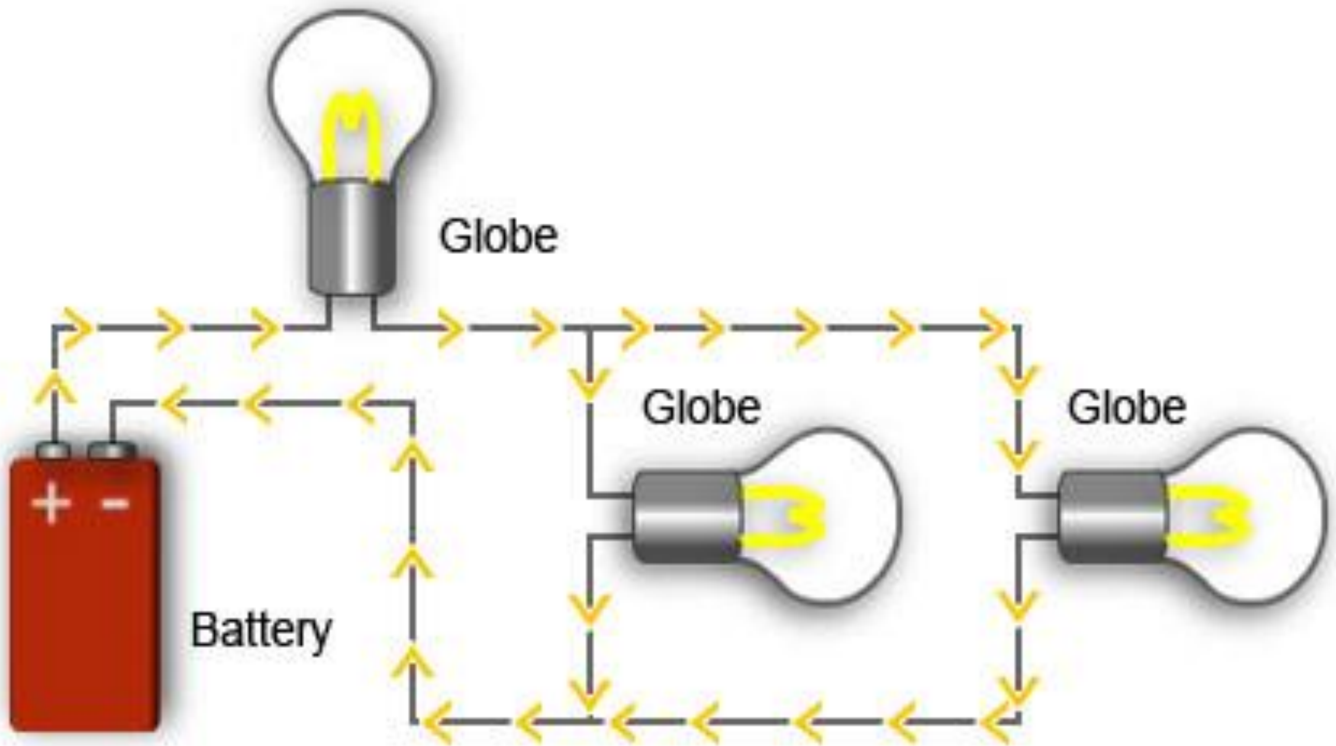


SERIES RESISTANCE CIRCUIT



$$R_{total} = R_1 + R_2 + R_3 \; . \; . \; . \; . \; .$$

PARALLEL RESISTANCE CIRCUIT

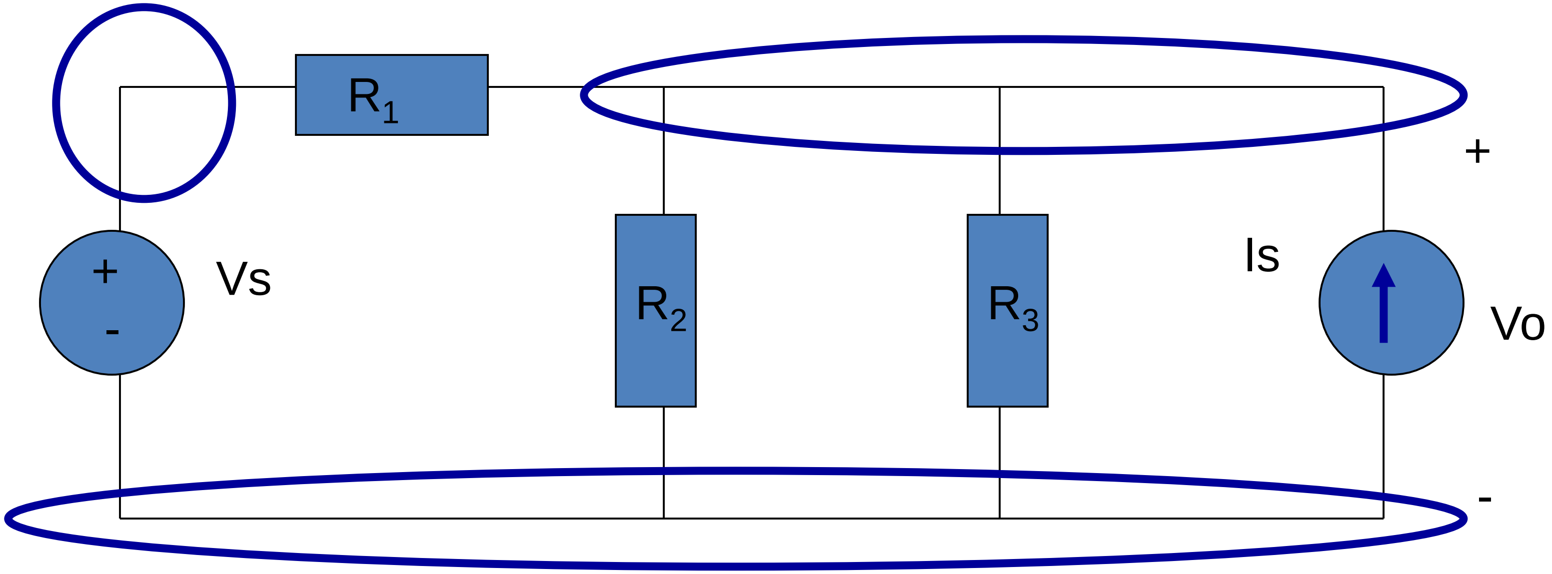


$$\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots\text{etc.}$$

$$R_{TOT} = \frac{R_1 \times R_2}{(R_1 + R_2)}$$

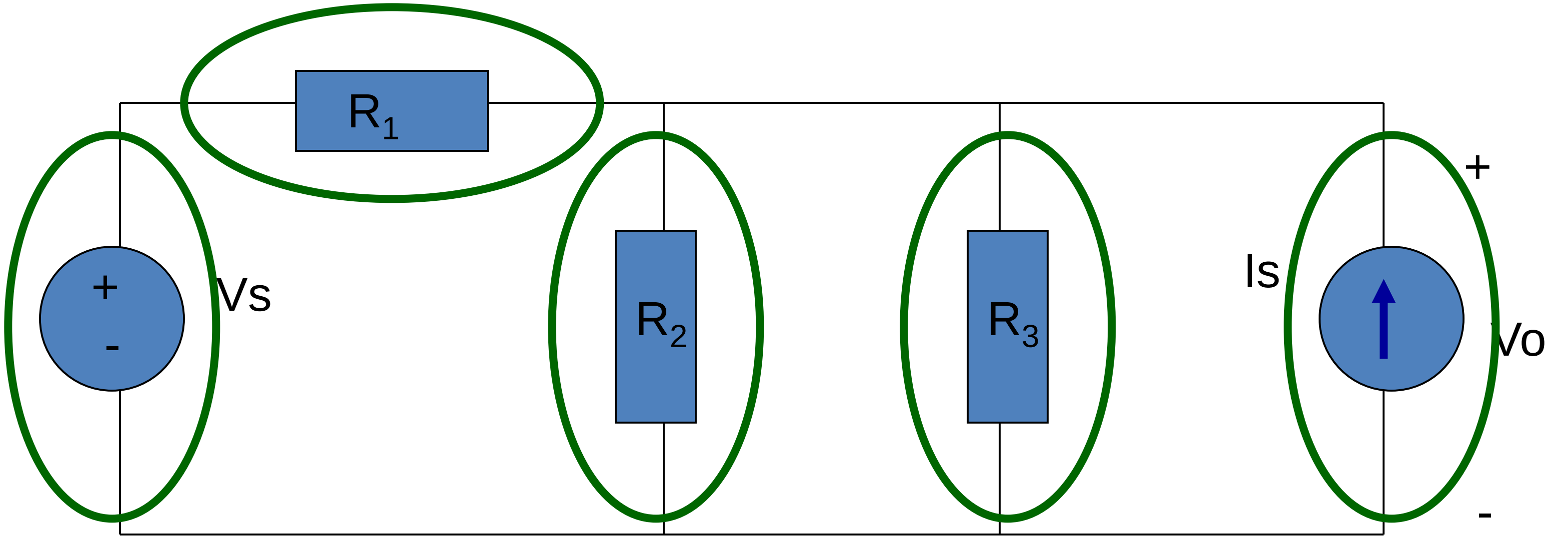
EXAMPLE

- Three nodes



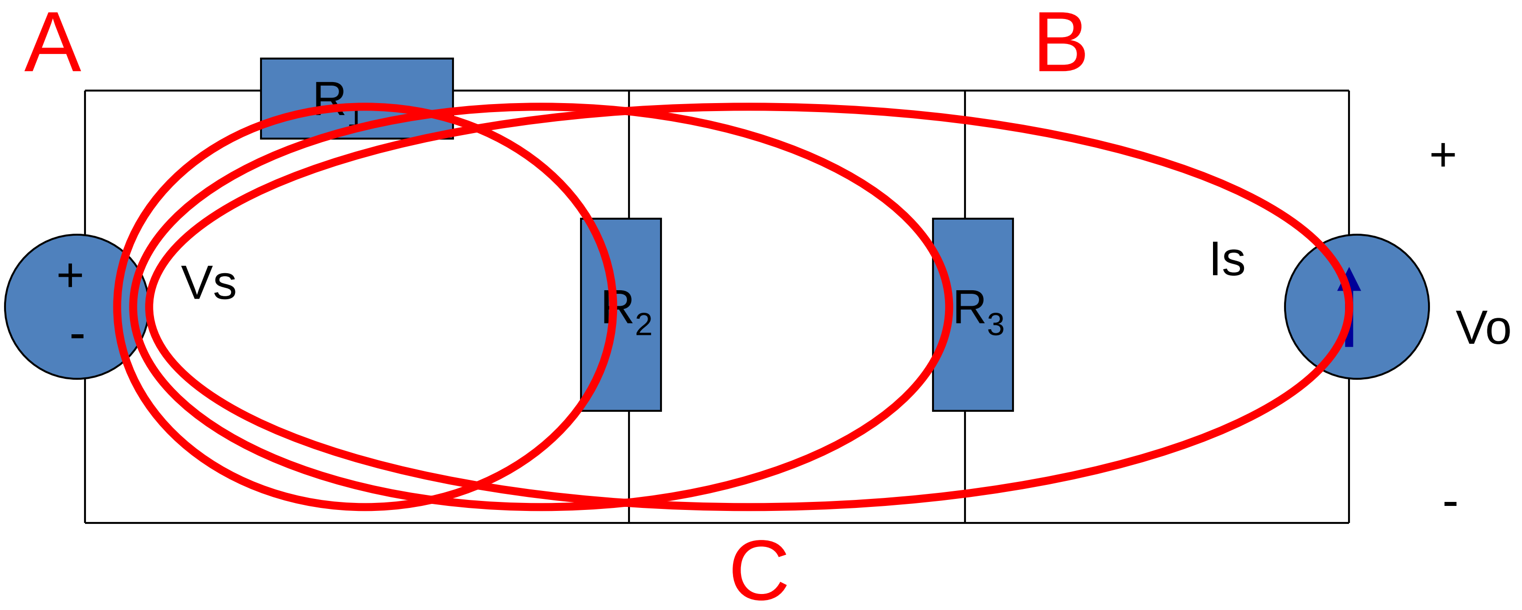
EXAMPLE

- 5 Branches



Example

- Three Loops, if starting at node A



AC FUNDAMENTALS

PARAMETER VALUES:

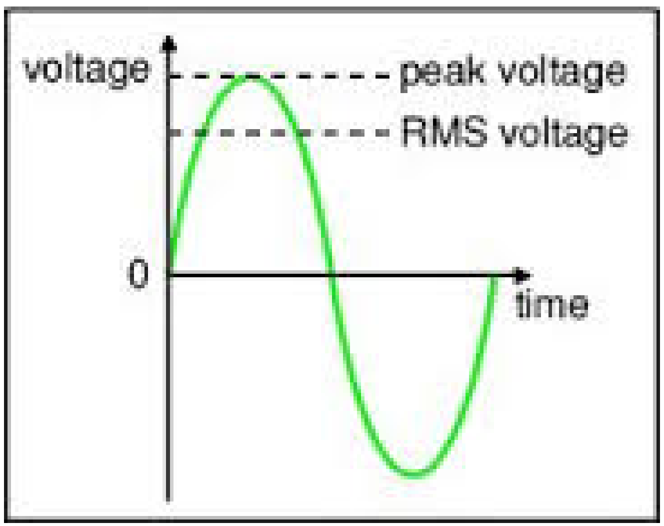
- Instantaneous (e, i)
- Peak (V_m, I_m)
- Average (V_{ave}, I_{ave})
- RMS (V, I or V_{rms}, I_{rms})

Parameters V and I are in sine wave.

ROOT MEAN SQUARE (RMS)

Definition:

The RMS value of a set of values (or a continuous-time waveform) is the square root of the arithmetic mean of the squares of the original values.



$$rms = \frac{Vpeak}{\sqrt{2}} \text{ (for an undistorted sine wave)}$$

$$rms = \frac{Vpeak}{\sqrt{3}} \text{ (for an undistorted triangle wave)}$$

$$rms = \frac{Vpeak}{1} \text{ (for a symmetrical square wave)}$$

POWER

- The instantaneous power dissipated in a component is a product of the instantaneous voltage and the instantaneous current

$$p = vi$$

- In a resistive circuit the voltage and current are in phase – calculation of *p* is straightforward
- In reactive circuits, there will normally be some phase shift between *v* and *i*, and calculating the power becomes more complicated

1.POWER IN RESISTOR

- Suppose a voltage $v = V_p \sin \omega t$ is applied across a resistance R. The resultant current i will be

$$i = \frac{v}{R} = \frac{V_P \sin \omega t}{R} = I_P \sin \omega t$$

- The result power p will be

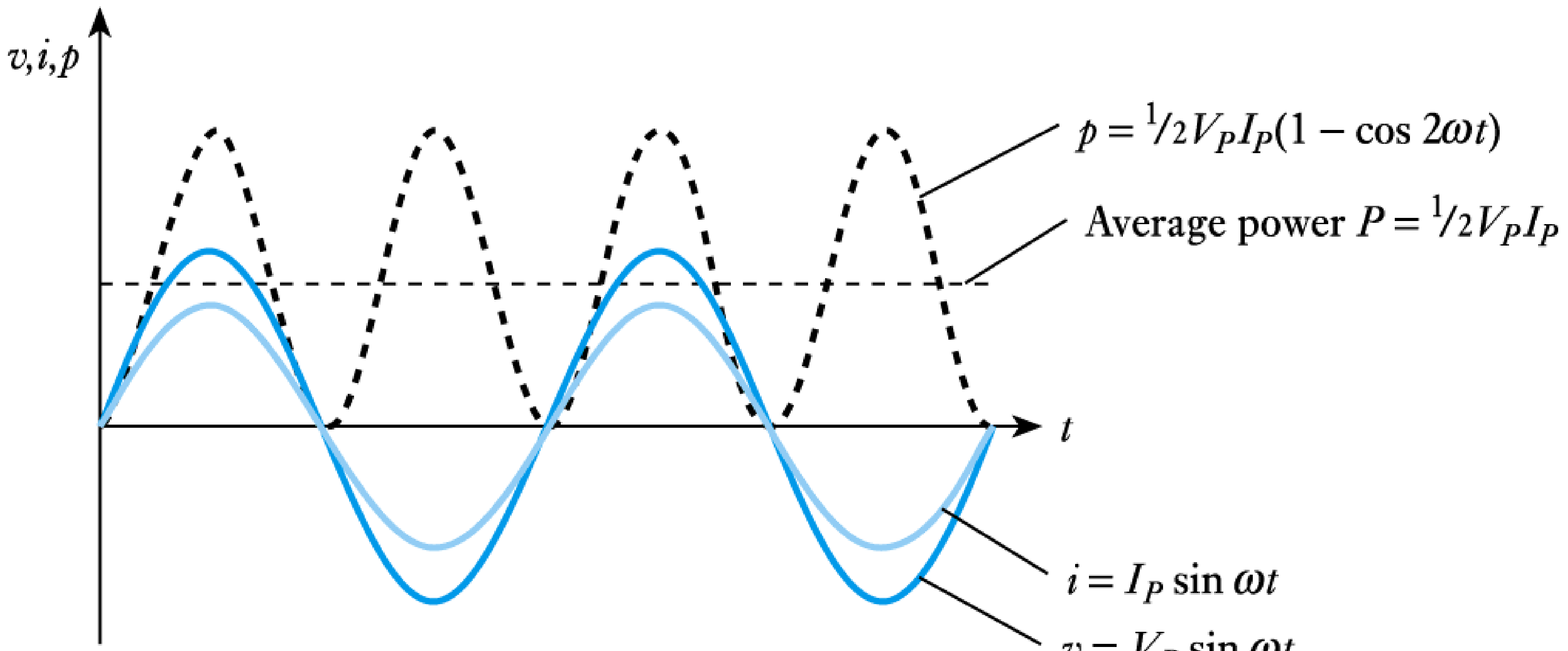
$$p = vi = V_P \sin \omega t \times I_P \sin \omega t = V_P I_P (\sin^2 \omega t) = V_P I_P (\frac{1 - \cos 2\omega t}{2})$$

- The average value of (1 - cos $2\omega t$) is 1, so

$$\text{Average Power } P = \frac{1}{2} V_P I_P = \frac{V_P}{\sqrt{2}} \times \frac{I_P}{\sqrt{2}} = VI$$

where V and I are the **RMS voltage and current**

RELATIONSHIP BETWEEN *V, I* AND *P* IN A RESISTOR

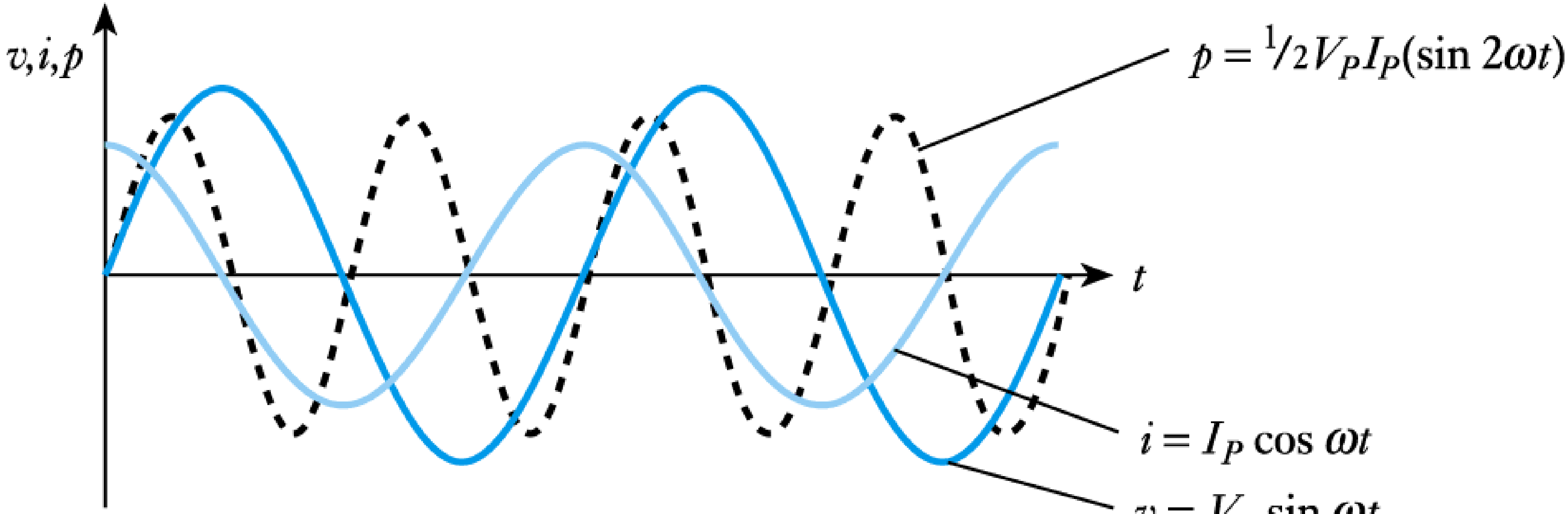


2.POWER IN CAPACITORS

- For capacitors we know that the current leads the voltage by 90°.
- Therefore, if a voltage $v = V_p \sin \omega t$ is applied across a capacitance *C*, the current will be given by $i = I_p \cos \omega t$
- *Then*

$$
\begin{aligned}
p &= vi \\
&= V_P \sin \omega t \times I_P \cos \omega t \\
&= V_P I_P (\sin \omega t \times \cos \omega t) \\
&= V_P I_P \left(\frac{\sin 2\omega t}{2}\right)
\end{aligned}
$$

RELATIONSHIP BETWEEN *V*, *I* AND *P* IN A CAPACITOR



3.POWER IN INDUCTORS

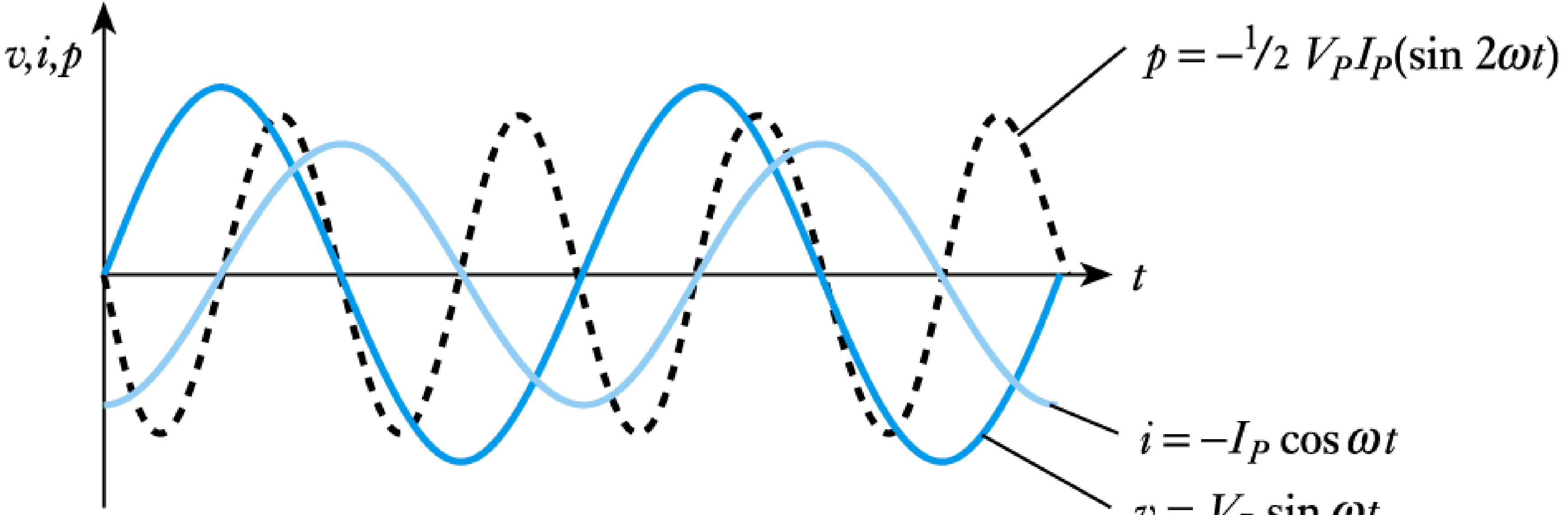
- For inductors we know that the current lags the voltage by 90°.

- Therefore, if a voltage $v = V_p \sin \omega t$ is applied across an inductance L, the current will be given by $i = -I_p \cos \omega t$

- Then

$$
\begin{aligned}
p &= vi \\
&= V_P \sin \omega t \times -I_P \cos \omega t \\
&= -V_P I_P (\sin \omega t \times \cos \omega t) \\
&= -V_P I_P (\frac{\sin 2\omega t}{2})
\end{aligned}
$$

RELATIONSHIP BETWEEN *V*, *I* AND *P* IN AN INDUCTOR



ACTIVE AND REACTIVE POWER

- When a circuit has resistive and reactive parts, the resultant power has 2 parts:
  - The first is *dissipated* in the resistive element. This is the **active power, *P***
  - The second is *stored* and *returned* by the reactive element. This is the **reactive power, *Q*** , which has units of **volt amperes reactive** or **var**

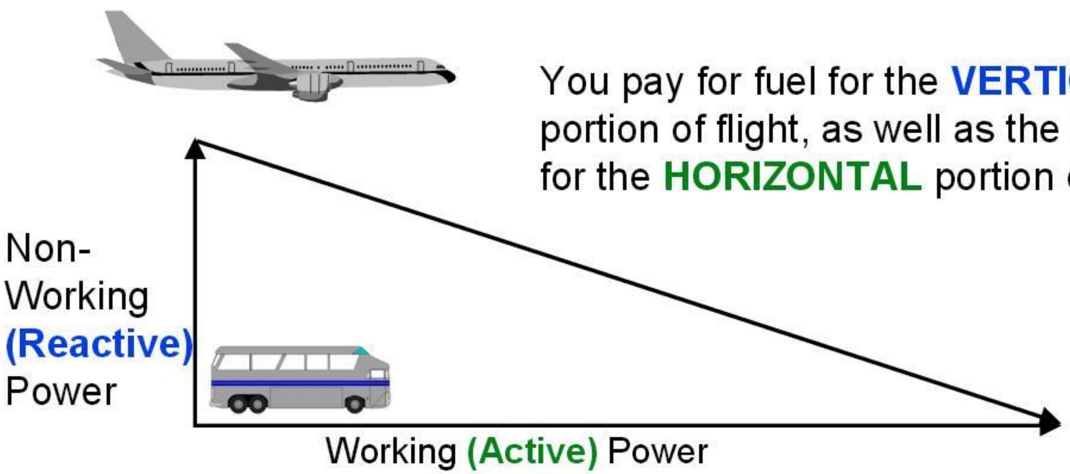
POWERS AND UNITS

Active Power	$P = VI \cos \phi$	watts
Reactive Power	$Q = VI \sin \phi$	var
Apparent Power	$S = VI$	VA

$$S^2 = P^2 + Q^2$$

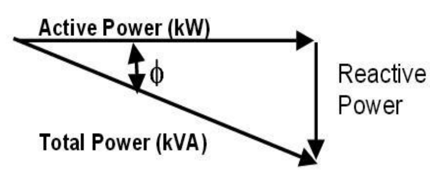
POWER TRIANGLE

The Power Triangle:



You pay for fuel for the **VERTICAL** portion of flight, as well as the fuel for the **HORIZONTAL** portion of flight.

- **Power Factor is the ratio of Active Power to Total Power:**



$$\text{Power Factor} = \frac{\text{Active (Real) Power}}{\text{Total Power}} = \frac{kW}{kVA} = \text{Cosine}(\theta)$$

- **Power Factor is a measure of efficiency (Output/Input)**

POWER FACTOR

Definition:

It is the ratio of the real power flowing to the load, to the apparent power in the circuit (or) the cosine angle of voltage and current

- Real power is the capacity of the circuit for performing work in a particular time.

- Apparent power is the product of the current and voltage of the circuit

THANK YOU…