

# ELECTRICAL FUNDAMENTALS

# SCIENCE OF ELECTRICITY AND ELECTRONICS

by  
Nur Hafeizza binti Ramly  
Faculty of Engineering Technology  
hafeizza@ump.edu.my



Science of Electricity and Electronic  
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<http://ocw.ump.edu.my/course/view.php?id=617>

# Chapter Description

- **Aims**
  - Identify the concept of electrical charge, electric current, voltage, and resistance.
  - Apply Ohm's law to solve for unknown voltage and current values.
- **Expected Outcomes**
  - Students should be able to identify the concept of electrical charge, electric current, voltage, and resistance.
  - Students should be able to apply Ohm's law to solve for unknown voltage and current values..
- **References**
  - Thomas L.Floyd "Principles of Electric Circuit" (9th ed.) Prentice Hall, Inc, 2010
  - Charles K. Alexander and Matthew N.O Sadiku "Fundamental of Electric Circuit" (5th ed.) McGraw Hill, 2013
  - John Hiley, Keith Brown and Ian McKenzie Smith "Electrical and Electronics Technology" (11th ed) Prentice Hall, Inc, 2012

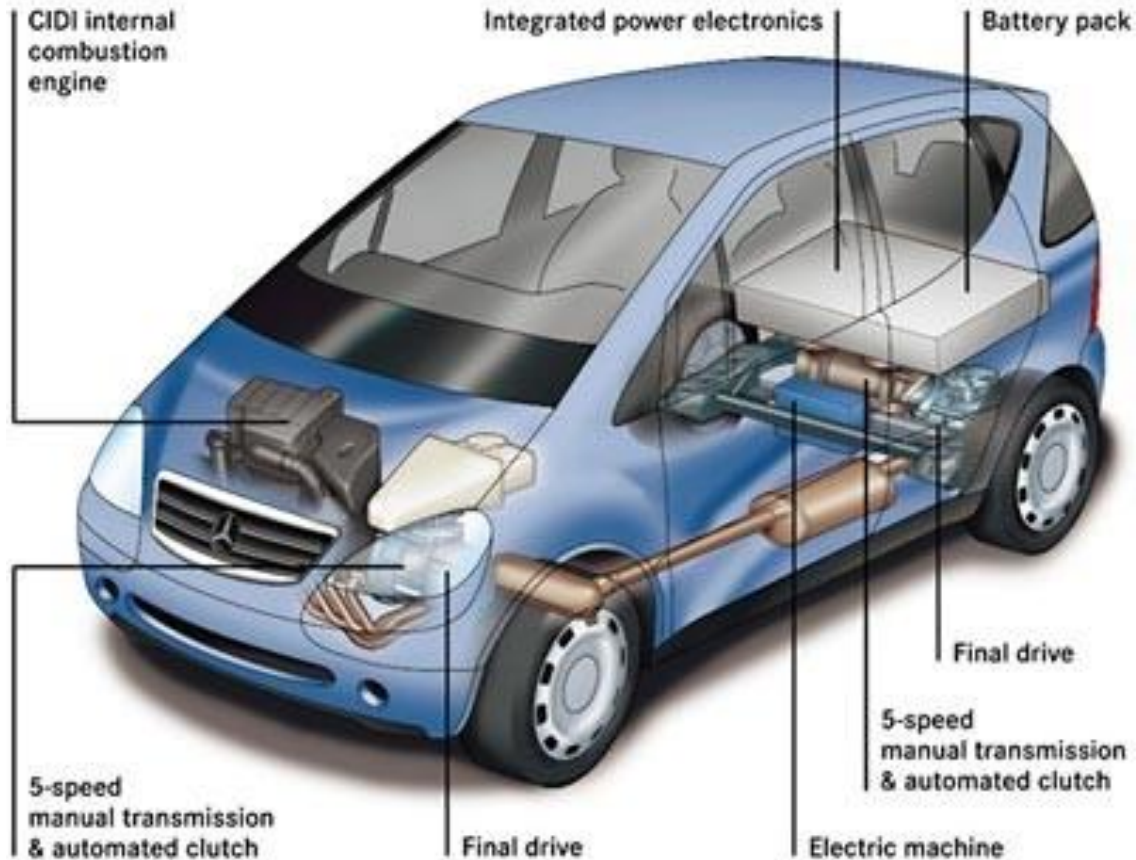


# The application of Electricity & Electronics

- Technology revolves around us and affects our lives in:
  - ❑ Transportation
  - ❑ Power system
- The first Integrated Circuit was developed in 1950s



# Transportation

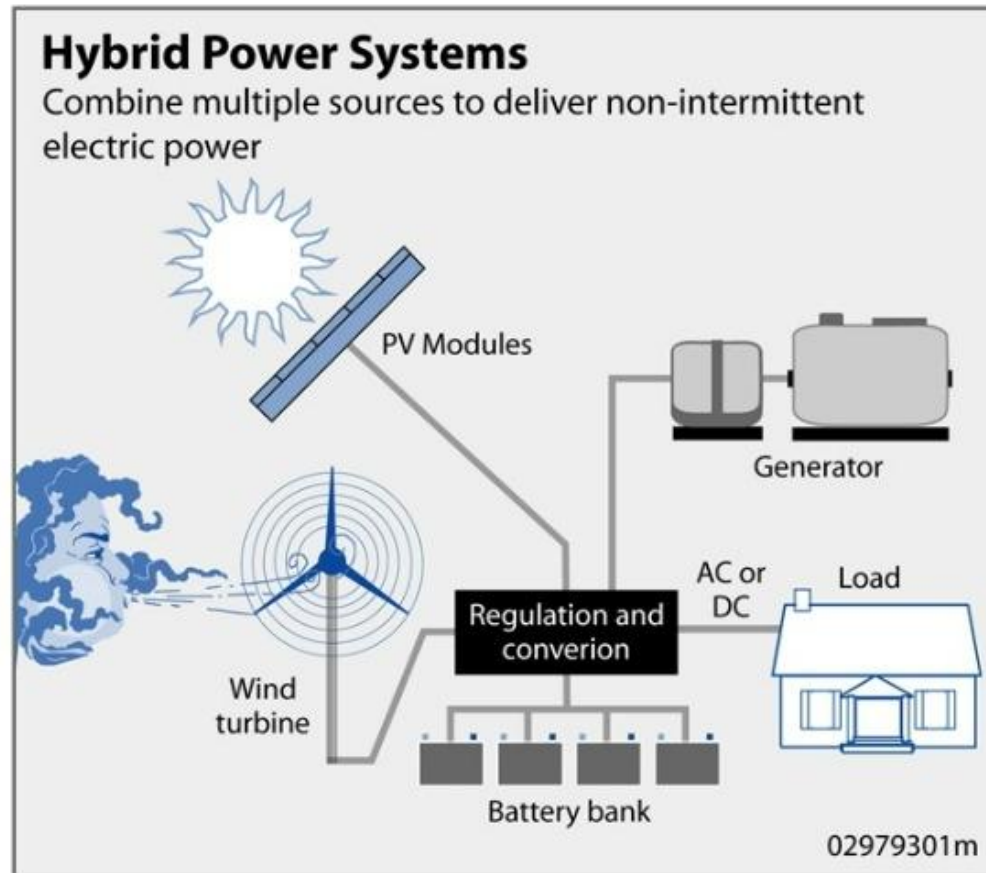


Source : <http://auto.howstuffworks.com/hybrid-car2.htm>



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# Power System



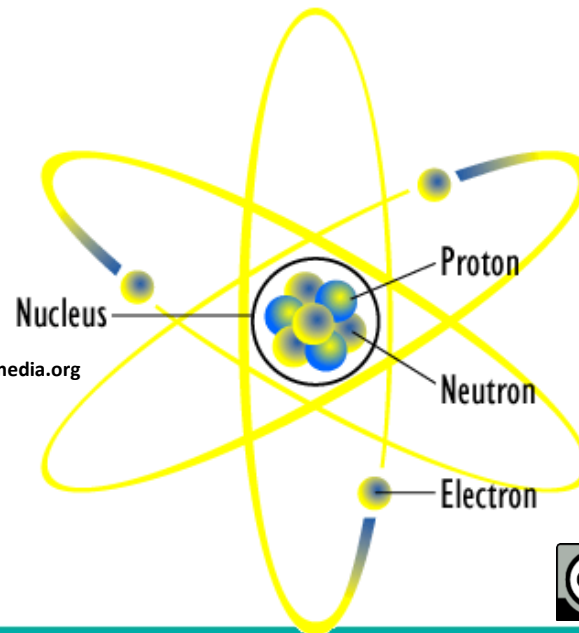
Source : <https://energy.gov/energysaver/hybrid-wind-and-solar-electric-systems>



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# Atoms and Their Structure

- An atom contains of a nucleus of protons and neutrons
- Nucleus is surrounded by a group of orbiting electrons that carries a negative charge which equals to the magnitude of positive charge of proton.
- The atom is electrically neutral when the number of electrons is the equal to the protons.
- The atom with an excess or deficit of electrons is called ion.



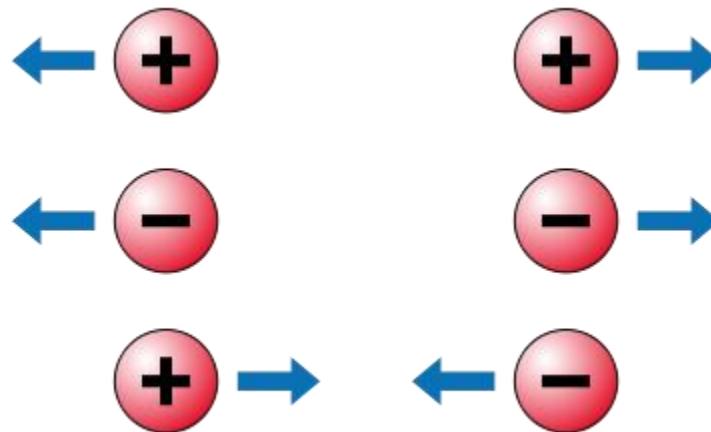
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# Electrical Charge

For unlike charges , they will attract each other while alike charges, they will repel.



Source : [https://commons.wikimedia.org/wiki/File:Charges\\_repulsion\\_attraction.svg](https://commons.wikimedia.org/wiki/File:Charges_repulsion_attraction.svg)



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# Coulomb's Law

$$F = k \frac{Q_1 Q_2}{r^2} \quad [\text{newtons, N}]$$

$F$  – force between two charges in N

$Q_1, Q_2$  – charges in coulombs

$r$  – center-to-center spacing between charges in meters

$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$





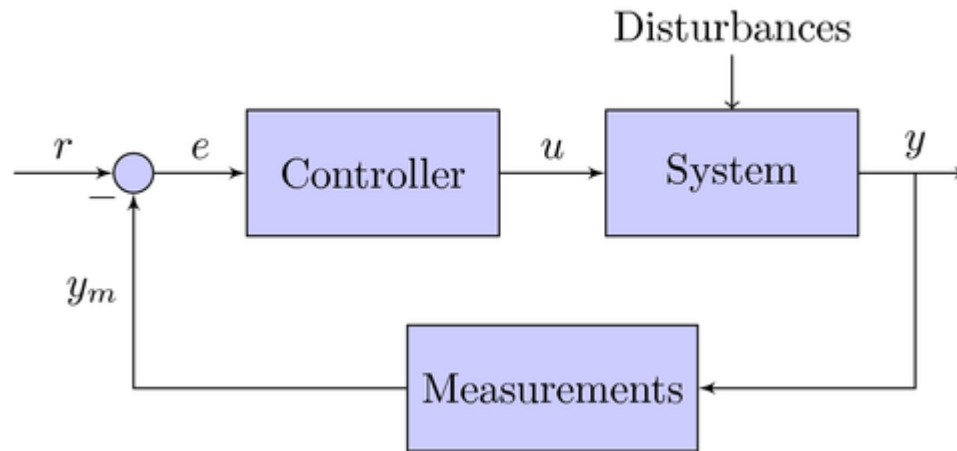
# Circuit Diagram

- Pictorial diagrams
- Block diagrams
- Schematic diagrams



# Block Diagrams

- Blocks represent portions of a system

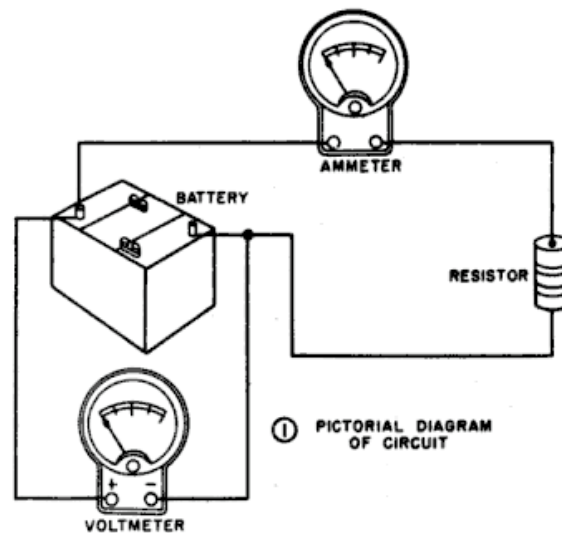


Source : <http://www.texample.net/tikz/examples/control-system-principles/>



# Pictorial Diagrams

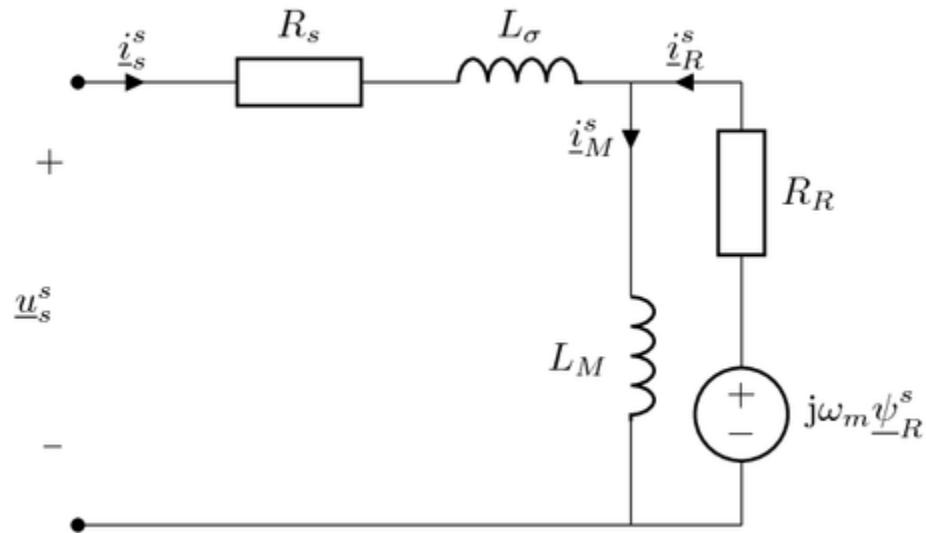
- Help visualize circuits by showing components as they actually appear



Source : <https://commons.wikimedia.org>



# Schematic Diagrams



Source : <http://texample.net/tikz/examples/area/electrical-engineering/>



# What is voltage?

- When two objects have a difference in charges
  - They have a potential difference or voltage between them
- The unit: volt (V)
- Thunderclouds
  - Millions of volts between them



# Voltage

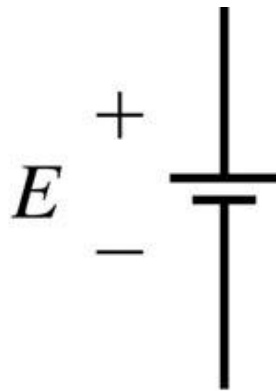
- Voltage between two points
  - One volt if it requires one joule of energy to move one coulomb of charge from one point to another

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$



# DC Voltage Sources

- DC voltage
  - Direct current: current is always in the same direction
- Symbol



# Current

- Current : rate of flow of charges
- Electric current : movement of charges
- More electrons per second passing through a circuit, the greater the current





# Current

- Unit : ampere (A)
- One ampere
  - Current in a circuit when one coulomb of charge passes a given point in one second
- Current ( $I$ ) = Charge ( $Q$ )/time ( $t$ )



# Current

Electron current flow	Conventional current flow
Electrons flow from the negative terminal of a battery to the positive terminal	Currents flow from positive terminal to negative terminal



# Current

- Alternating current changes direction cyclically
- Alternating voltage changes sign cyclically

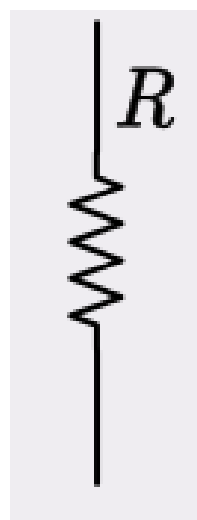


# Voltage sources

- Electronic power supplies
- Batteries
  - Alkaline
  - Lithium
  - Nickel-Cadmium
- Solar cells
- Fuel cells
- DC generators



# Resistance



Symbol: R  
Unit: Ohm ( $\Omega$ )

Source : <https://en.wikipedia.org>



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# Ohm's Law

- Current in a resistive circuit
  - Directly proportional to its applied voltage
  - Inversely proportional to its resistance

$$I = \frac{E}{R}$$

**I = current (amperes, A)**

**E = voltage (volts, V)**

**R = resistance (ohms,  $\Omega$ )**



# Ohm's Law

- For a fixed resistance
  - Doubling voltage doubles the current
- For a fixed voltage
  - Doubling resistance halves the current



# Ohm's Law

$$E = I \times R$$

$$I = E / R$$

$$R = E / I$$





# Electrical Prefixes

Power of 10	Prefix	Symbol
$10^{12}$	Tera	T
$10^9$	Giga	G
$10^6$	Mega	M
$10^3$	Kilo	K
$10^{-3}$	Milli	m
$10^{-6}$	Micro	$\mu$
$10^{-9}$	Nano	n
$10^{-12}$	pico	p



# Conclusion of The Chapter

- When 2 points are having a difference in charges, there will be a potential difference or voltage.
- Electric current is a movement of the electrons
- Ohm's Law is an equation that consists of relationship among voltage, current and resistance



# Reference

Electricity and Electronics by Gerrish, Dugger and Roberts, 10<sup>th</sup> edition, 2009, GW Publisher

Circuit Analysis: Theory and Practice by A. H. Robbins, W. C. Miller, 4<sup>th</sup> edition, 2006, Thomson Delmar Learning

Introductory Circuit Analysis by R. L. Boylestad, 11<sup>th</sup> edition, 2007, Prentice Hall

