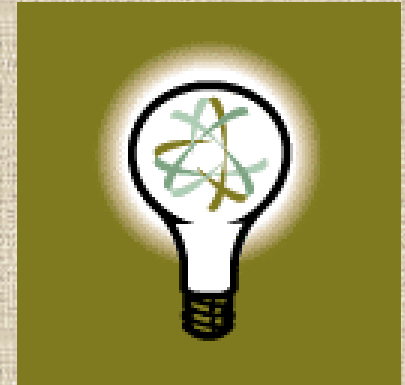


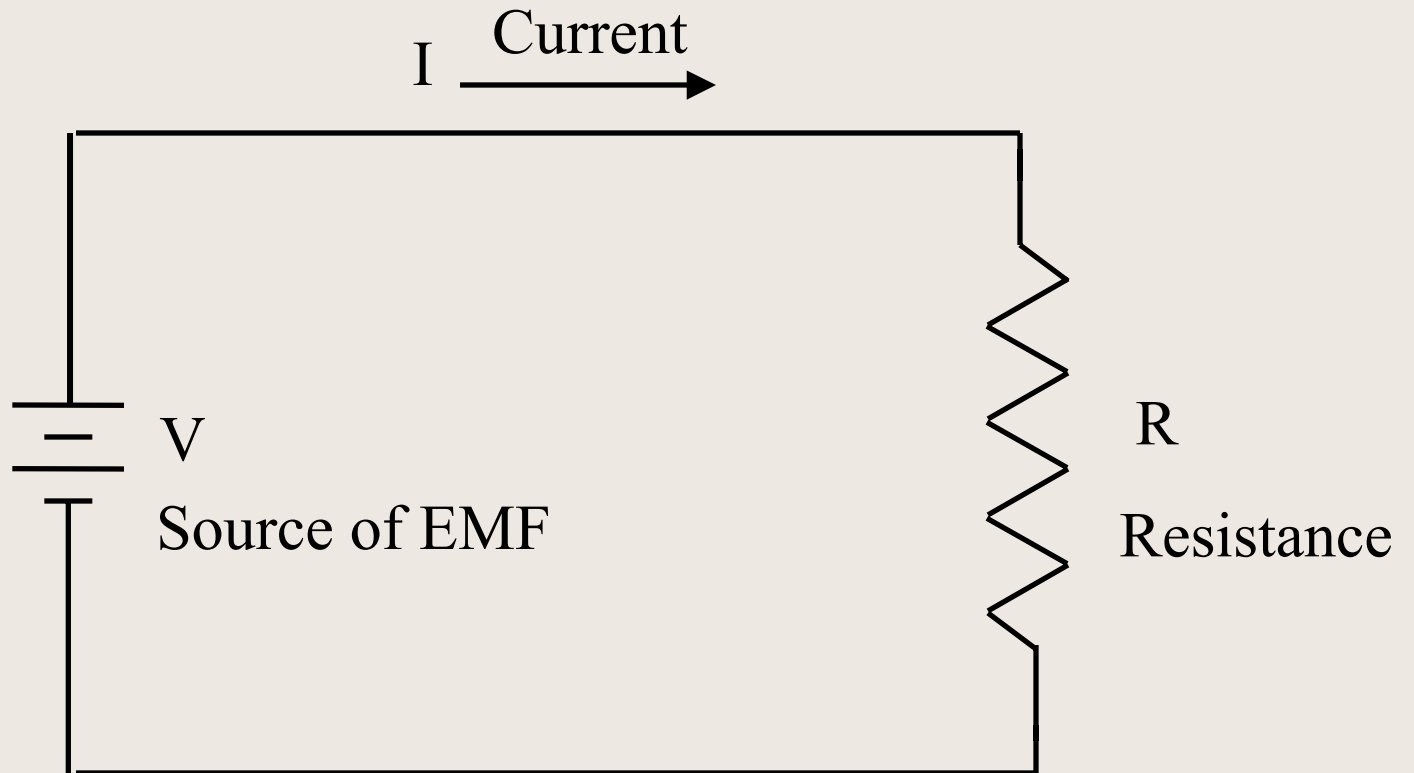
# Electrical



## Module 1



# Basic Electrical Circuit



# Basic Terms

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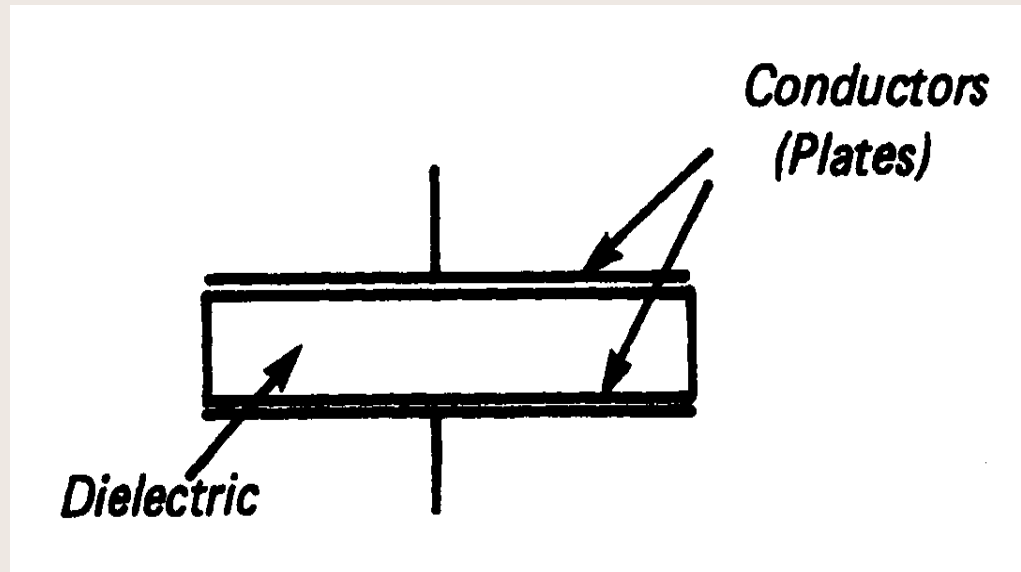
- Current
- Voltage
- Resistance

# Ohm's Law

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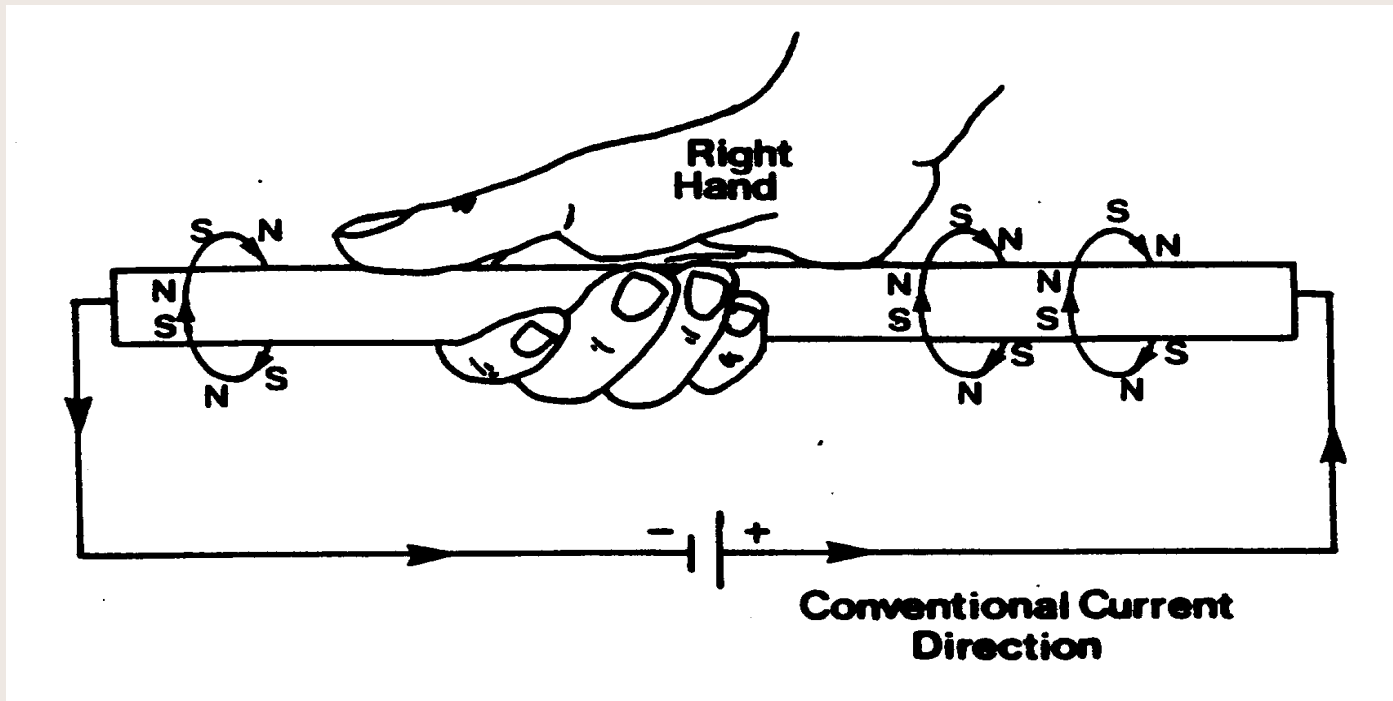
$$I = \frac{V}{R}$$

# Capacitors

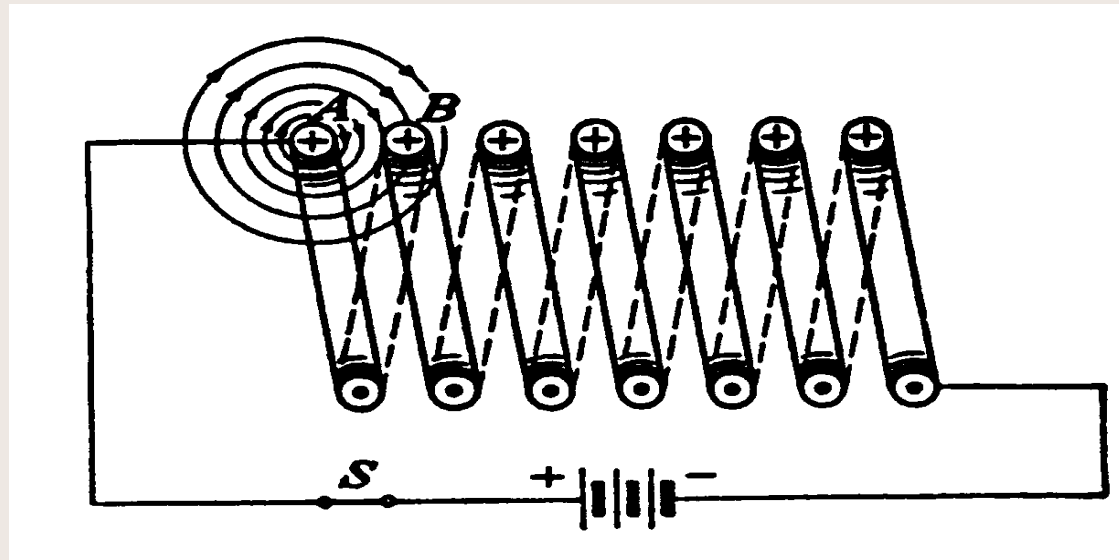


$$C = \epsilon \frac{A}{d}$$

# Magnetic Field



# Coil



# Inductors, Capacitors & ac

- Ac circuits have continuously changing values of voltage and current
- Inductors and capacitors continuously oppose these changes
- Opposition to current is called **reactance**
- Measured in ohms

$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$



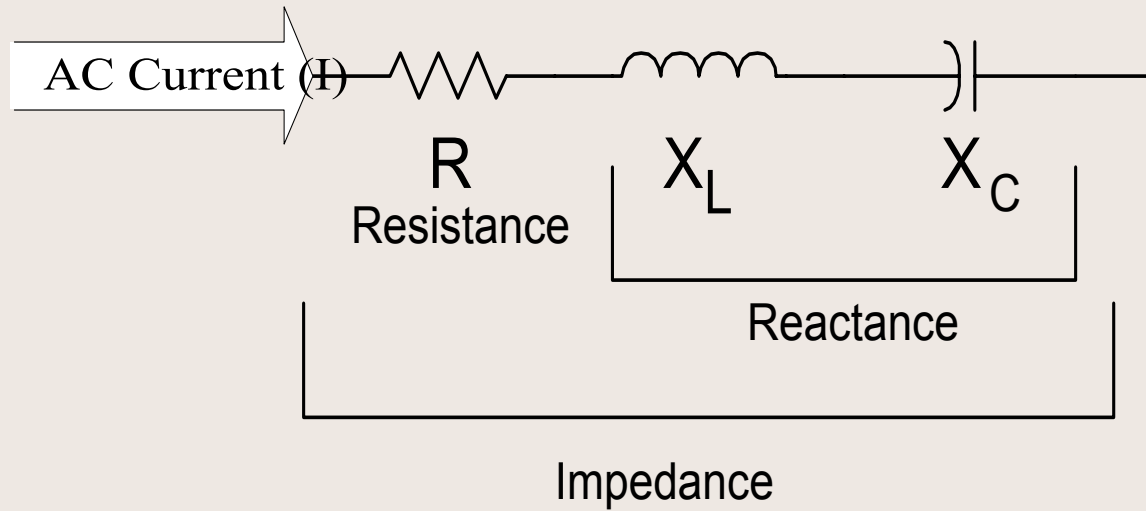
# Reactance Voltages & Currents

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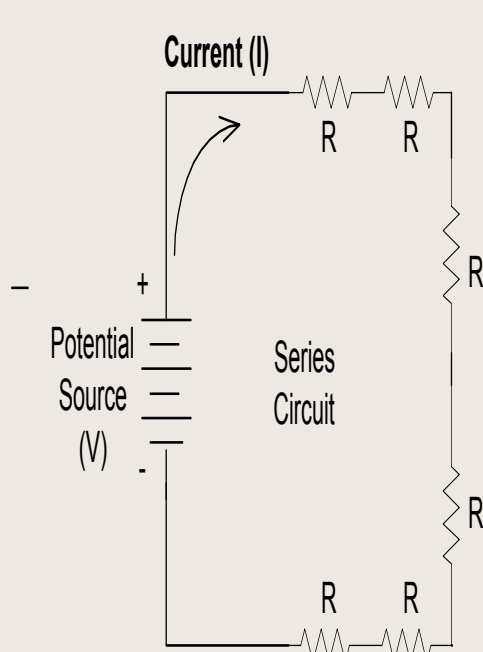
$$V_{X_L} = I_{X_L} \times X_L$$

$$V_{X_C} = I_{X_C} \times X_C$$

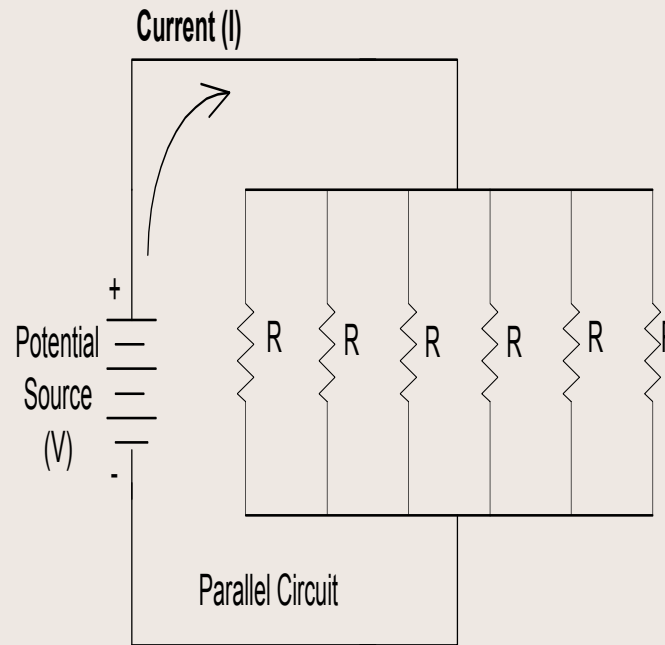
# Terminology



# Resistors

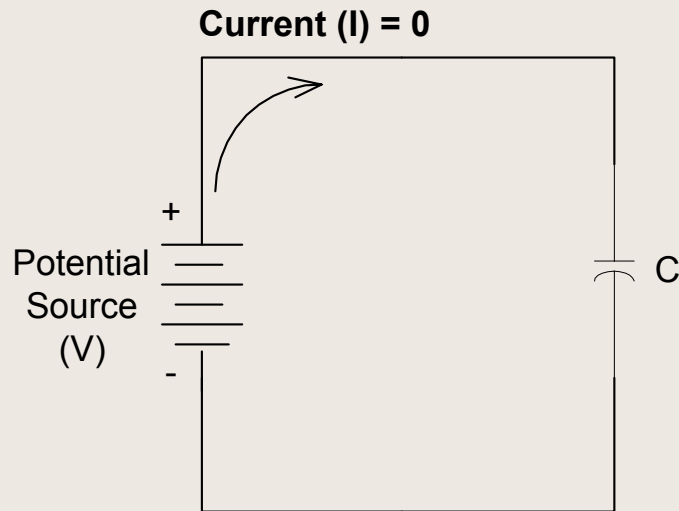


With all 6 Resistances the same value (R)  
Current would be 6 times less  
that of 1 resistance (R)



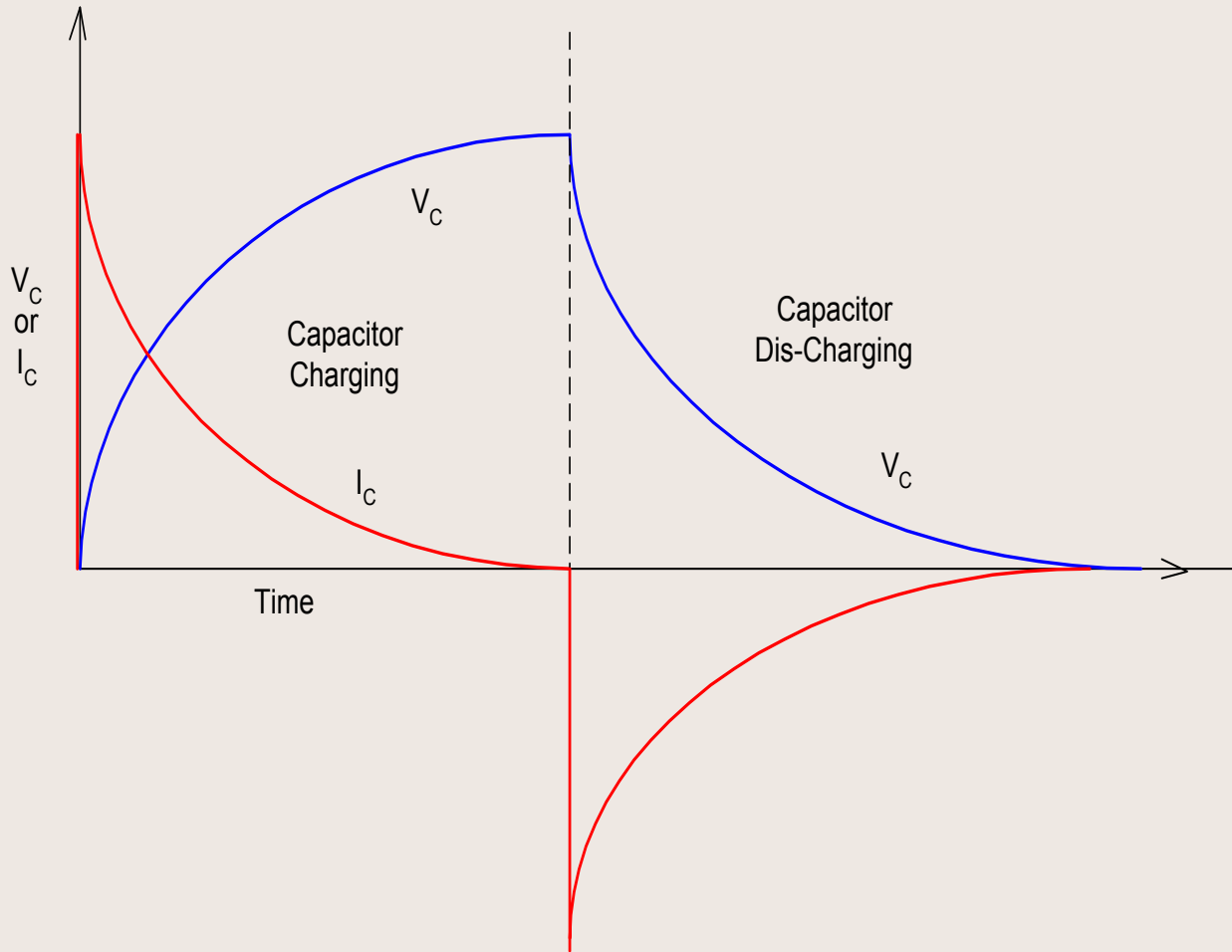
With all 6 Resistances the same value (R)  
Current would be 6 times more  
that of 1 resistance (R)

# Capacitor in a DC circuit

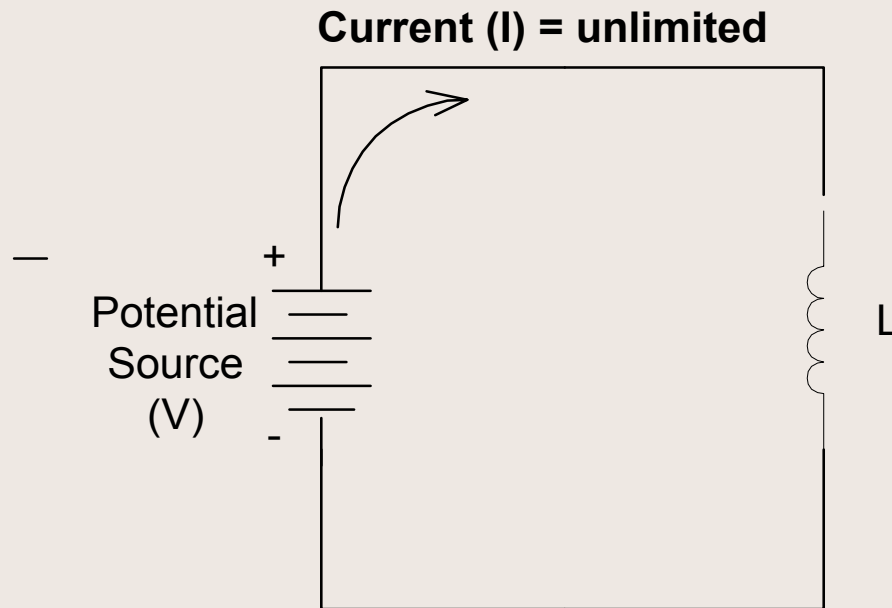


Capacitors will not pass DC Current

# Capacitive Transients

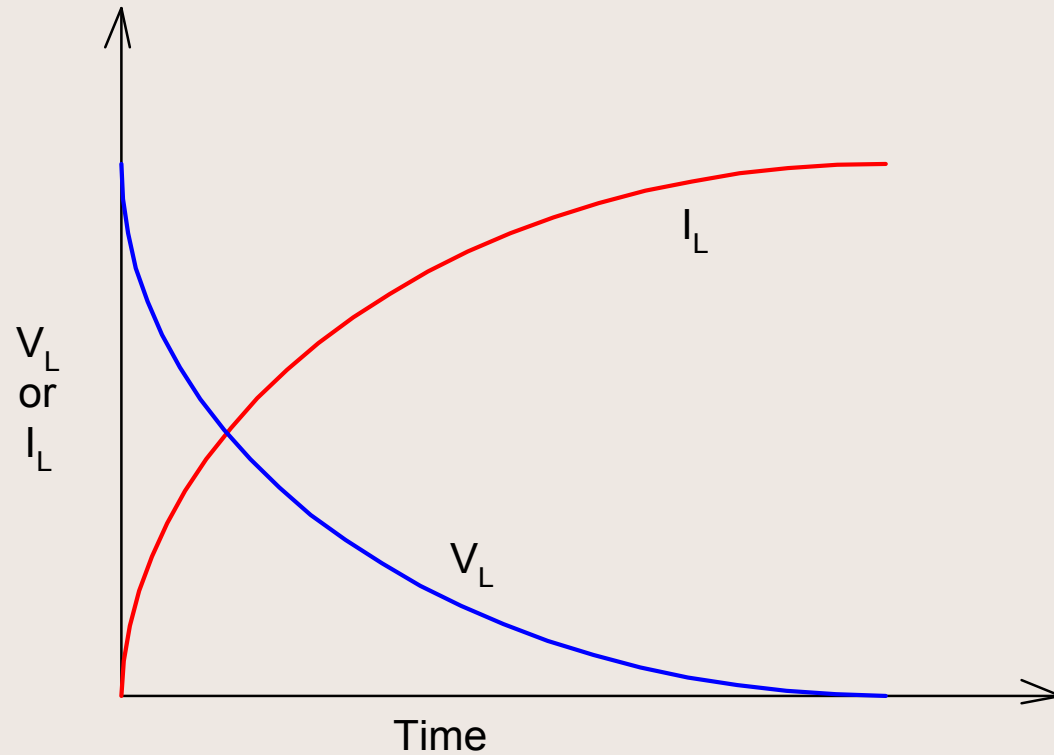


# Inductor in a DC circuit

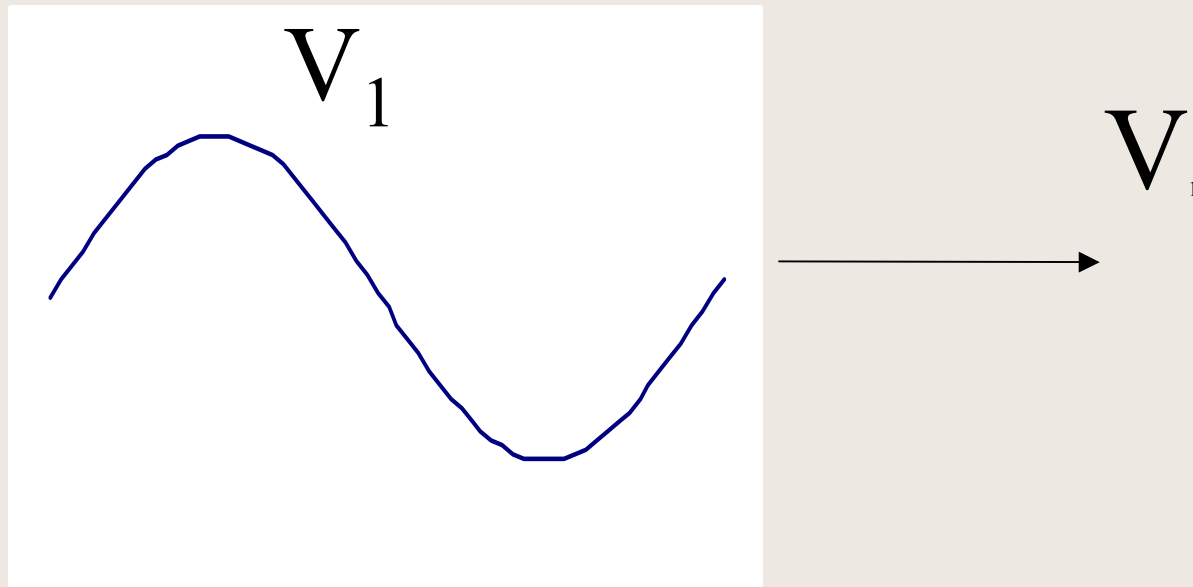


Inductors are a Short circuit to DC Current

# Inductor Transients

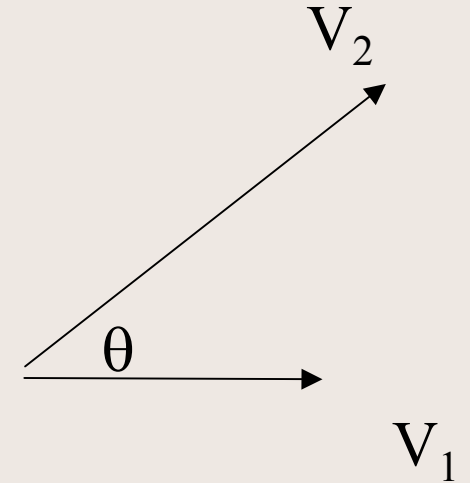
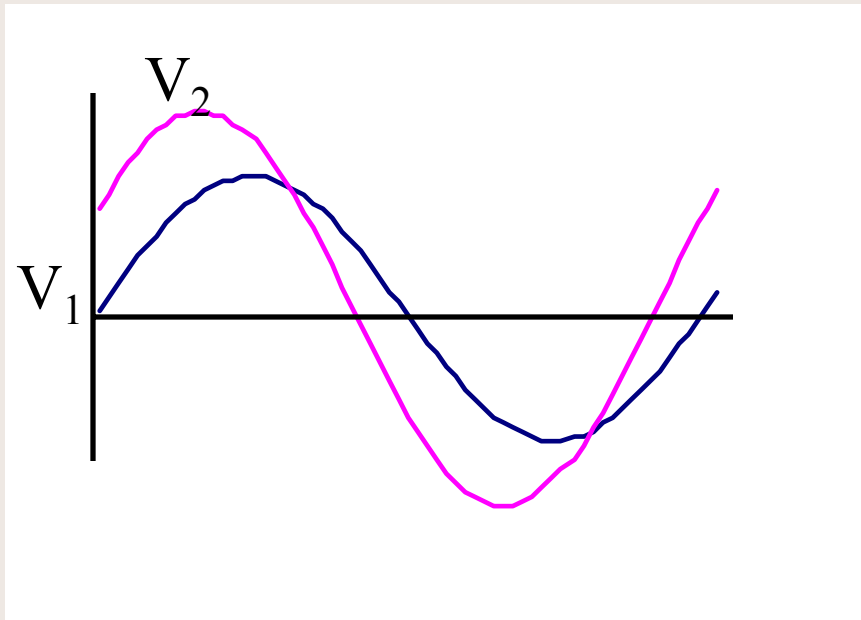


# Sine curves and phasors



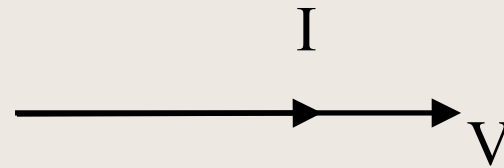
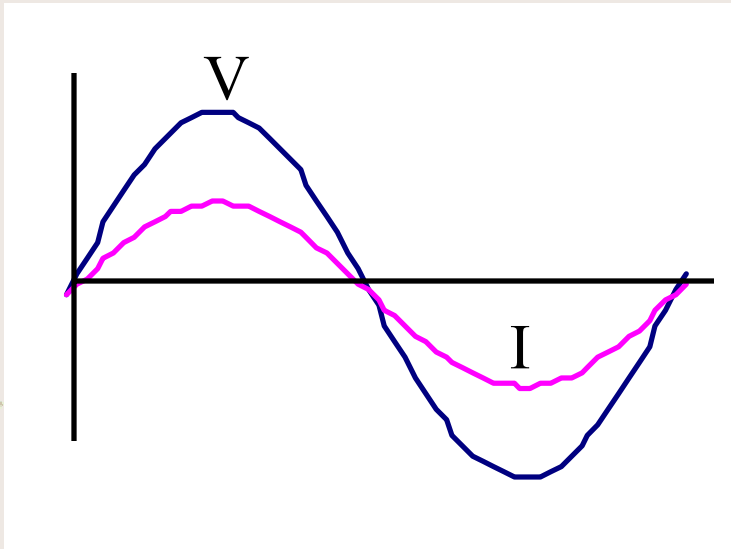


# Phasor Diagram

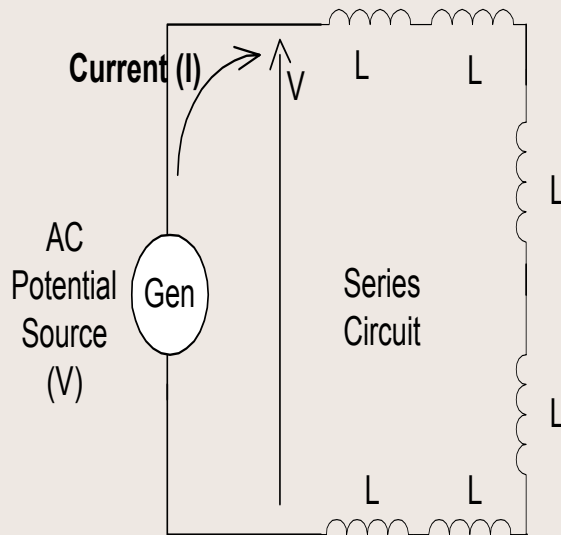


$V_2$  Leads  $V_1$  by  $\theta$

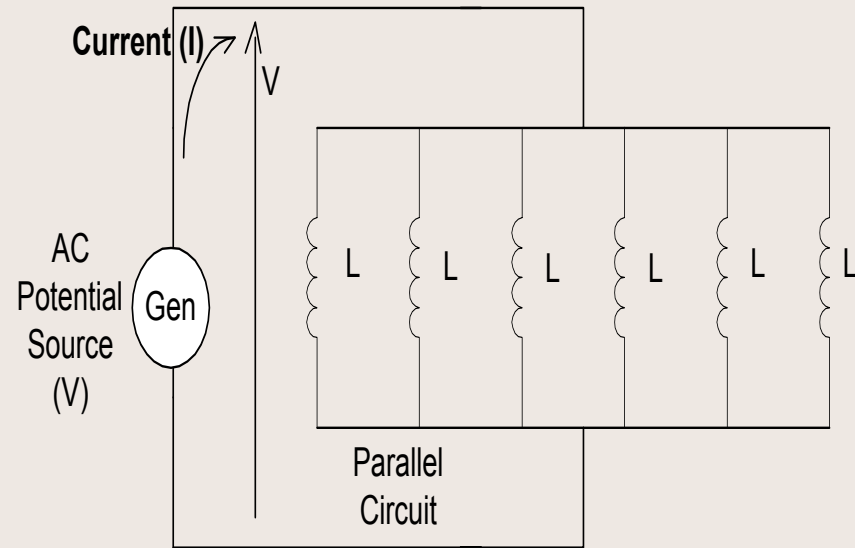
# Resistive Circuit



# Series & Parallel Inductors



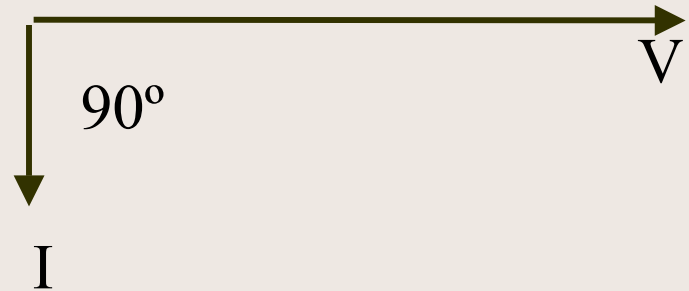
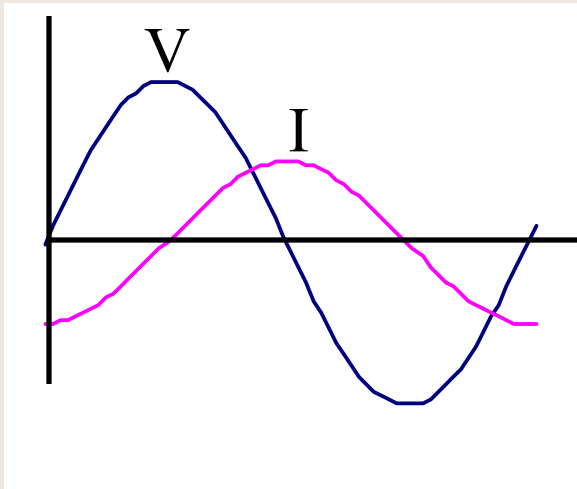
With all 6 Inductances the same value (L)  
Current would be 6 times less  
that of 1 Inductance (L)



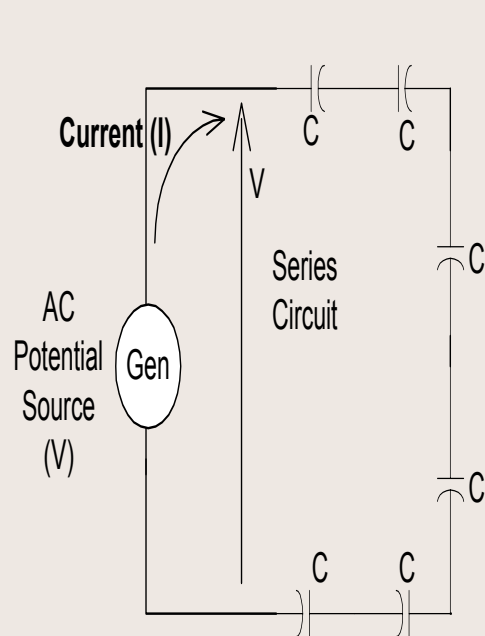
With all 6 Inductances the same value (L)  
Current would be 6 times more  
that of 1 Inductance (L)

In both circuits the Current will lag the Voltage by 1/4 cycle

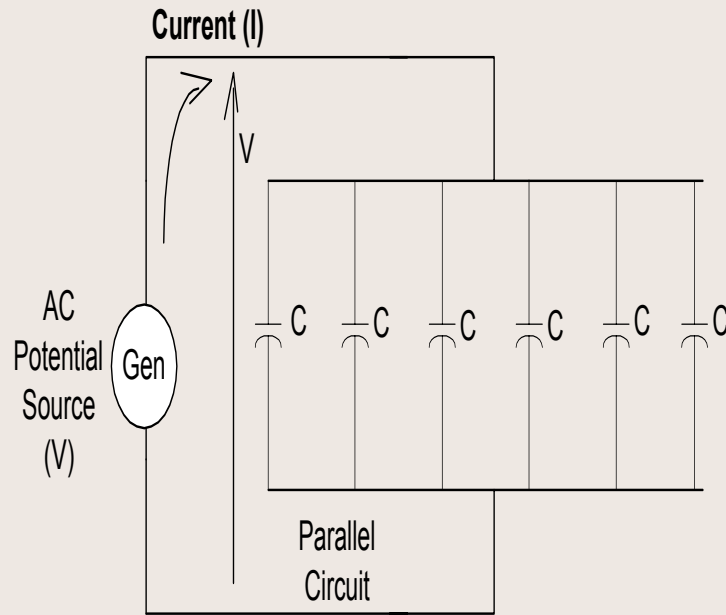
# Inductive Phasors



# Series & Parallel Capacitors



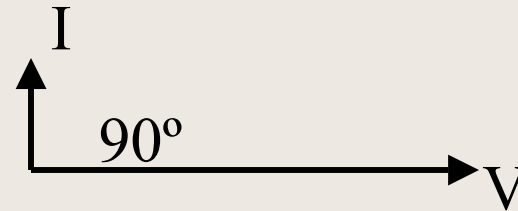
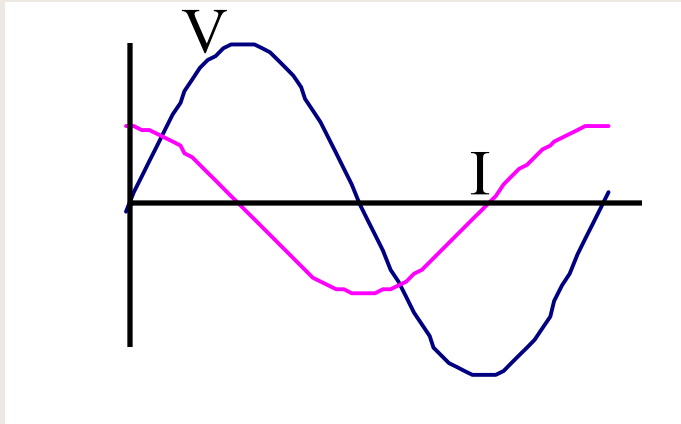
With all 6 Capacitances (C) the same value  
Current would be 6 times less  
that of 1 Capacitance



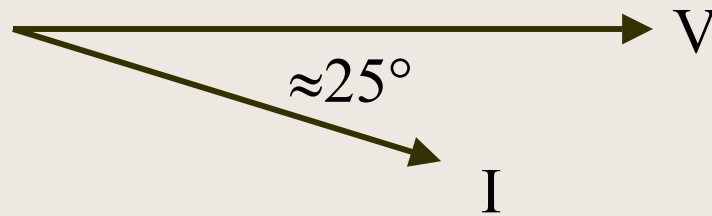
With all 6 Capacitances (C) the same value  
Current would be 6 times more  
that of 1 Capacitance

In both circuits the Current will lead the Voltage by 1/4 cycle

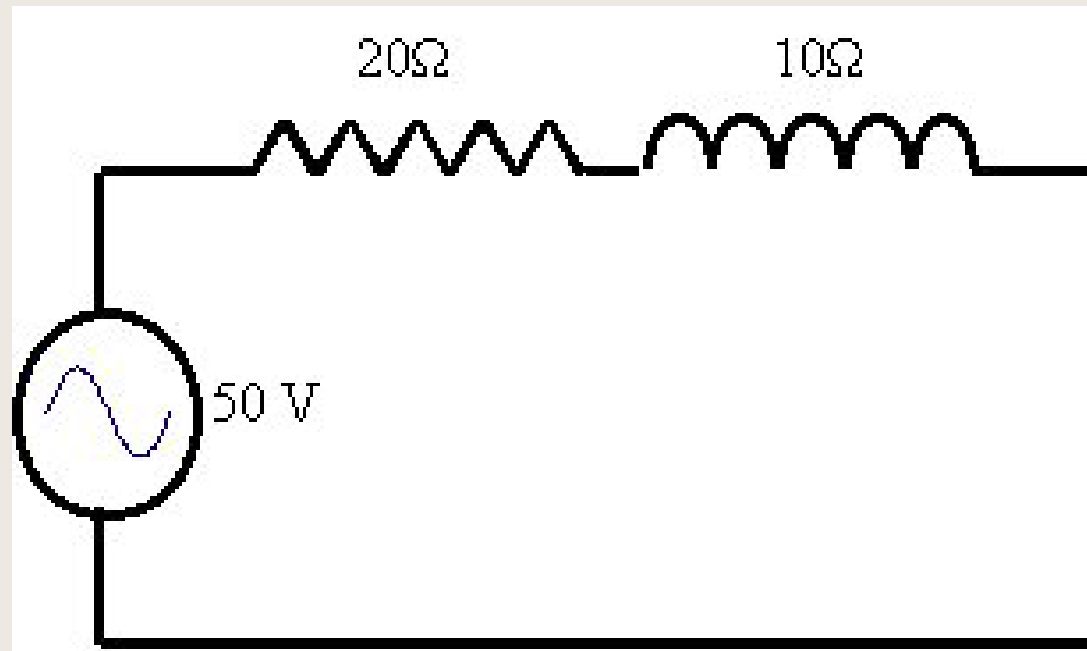
# Capacitive Phasors



# Phasors for a typical circuit

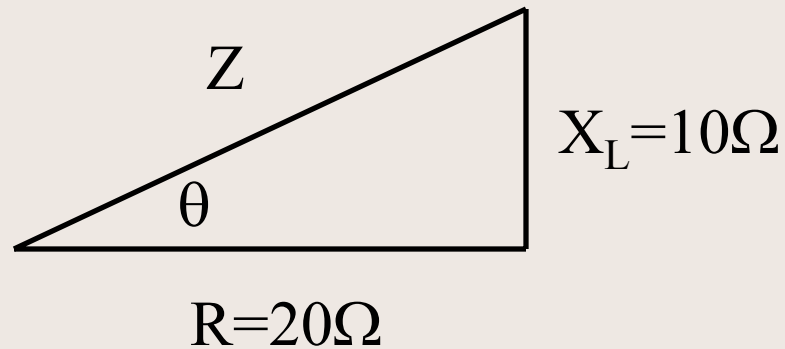


# Resistor and Inductor in Series





# Impedance Triangle

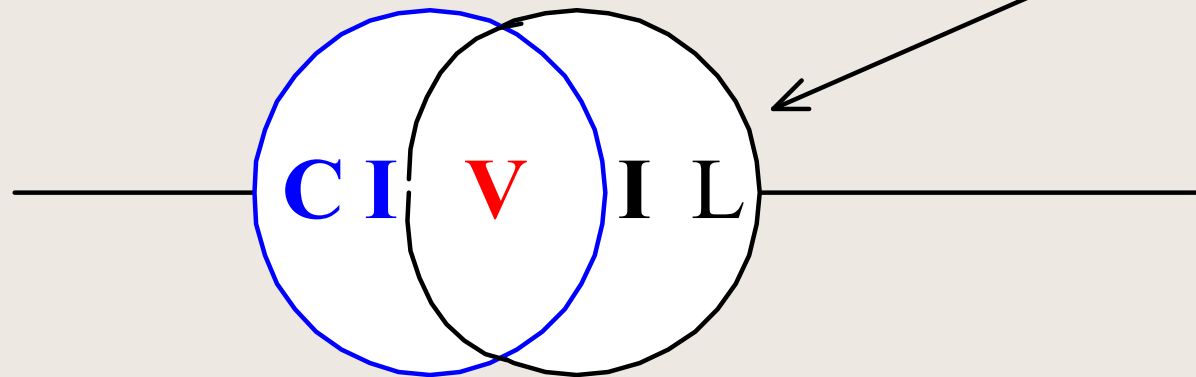


What is the impedance of the circuit?

What is the phase angle?

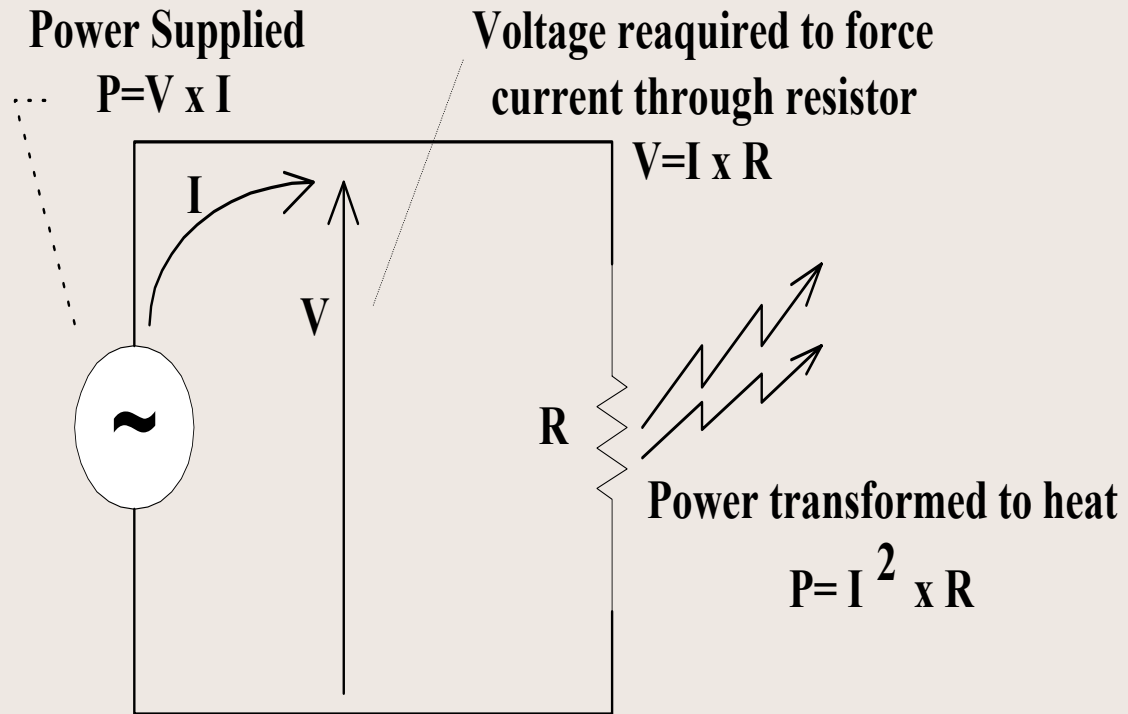
# Acrostic

V comes before (leads) I in an Inductor

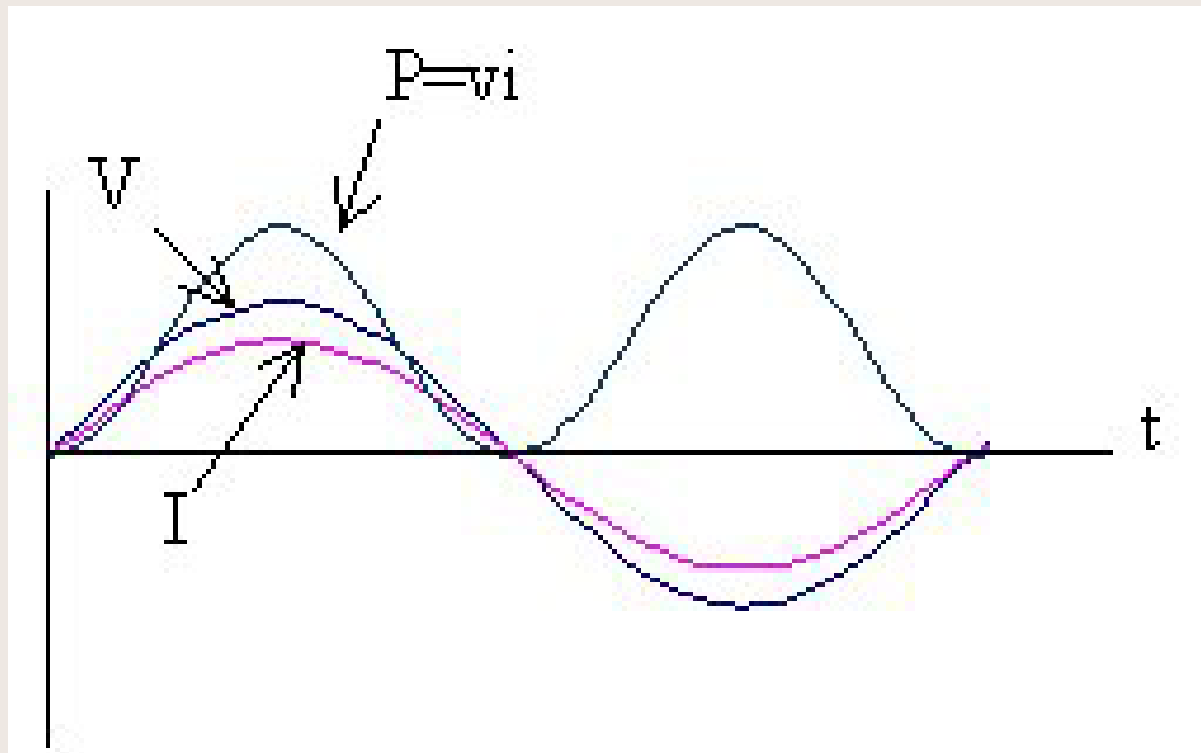


I comes before (leads) V in a Capacitor

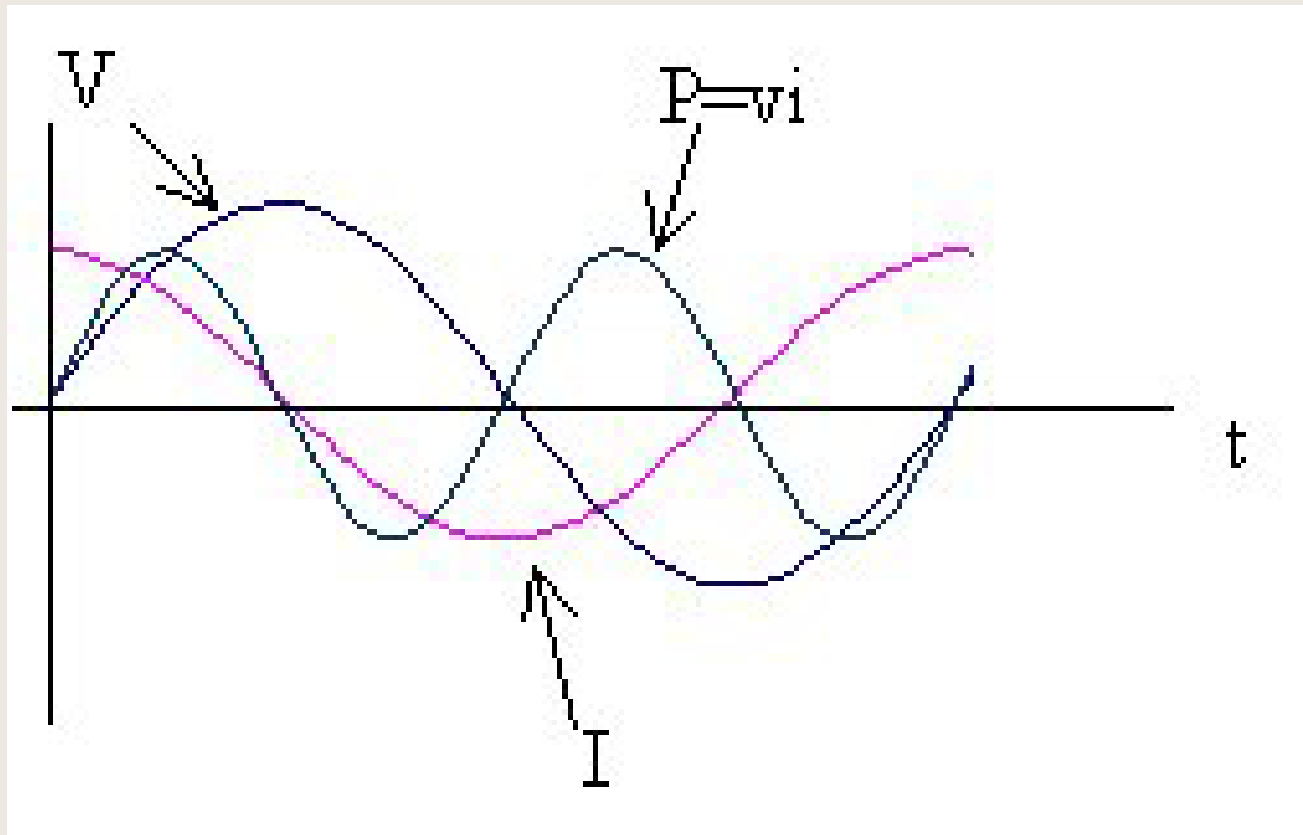
# Power



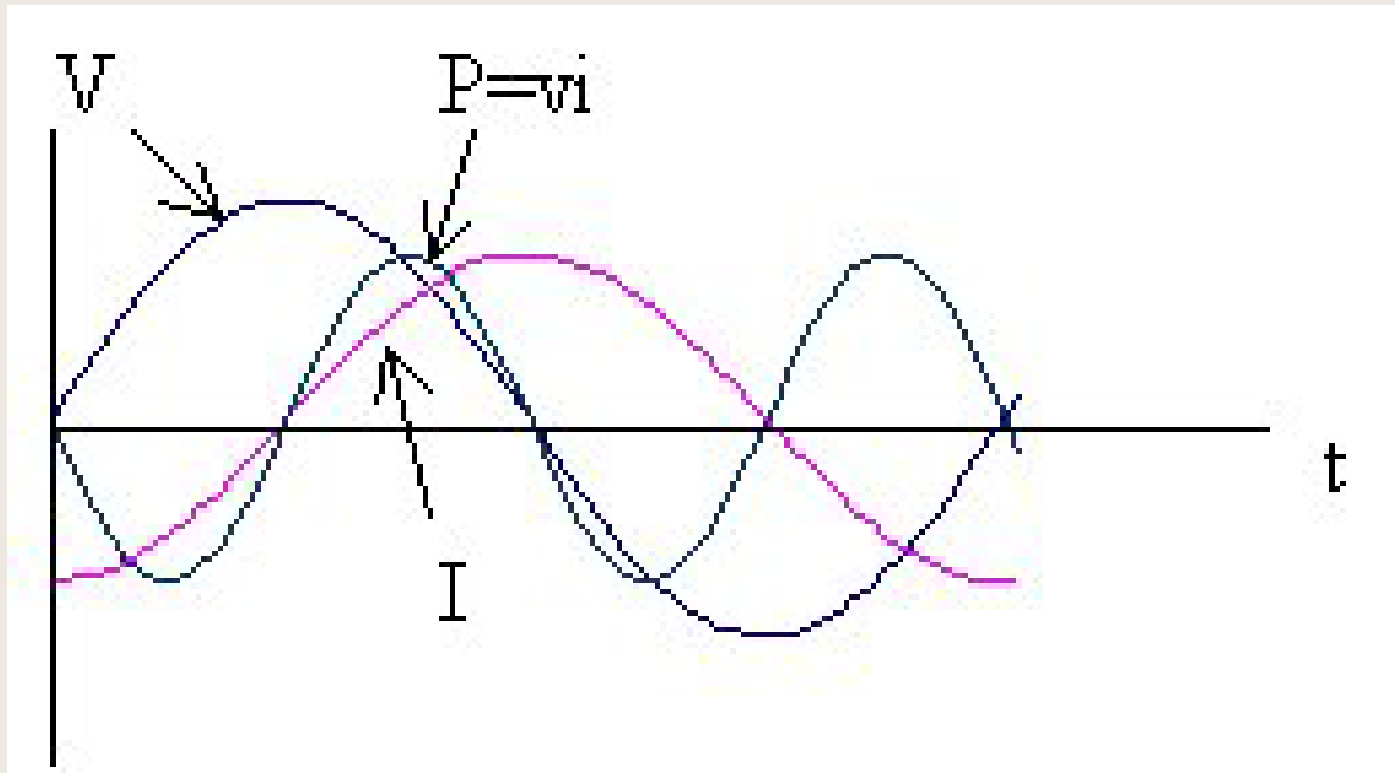
# Power wave in a resistive circuit



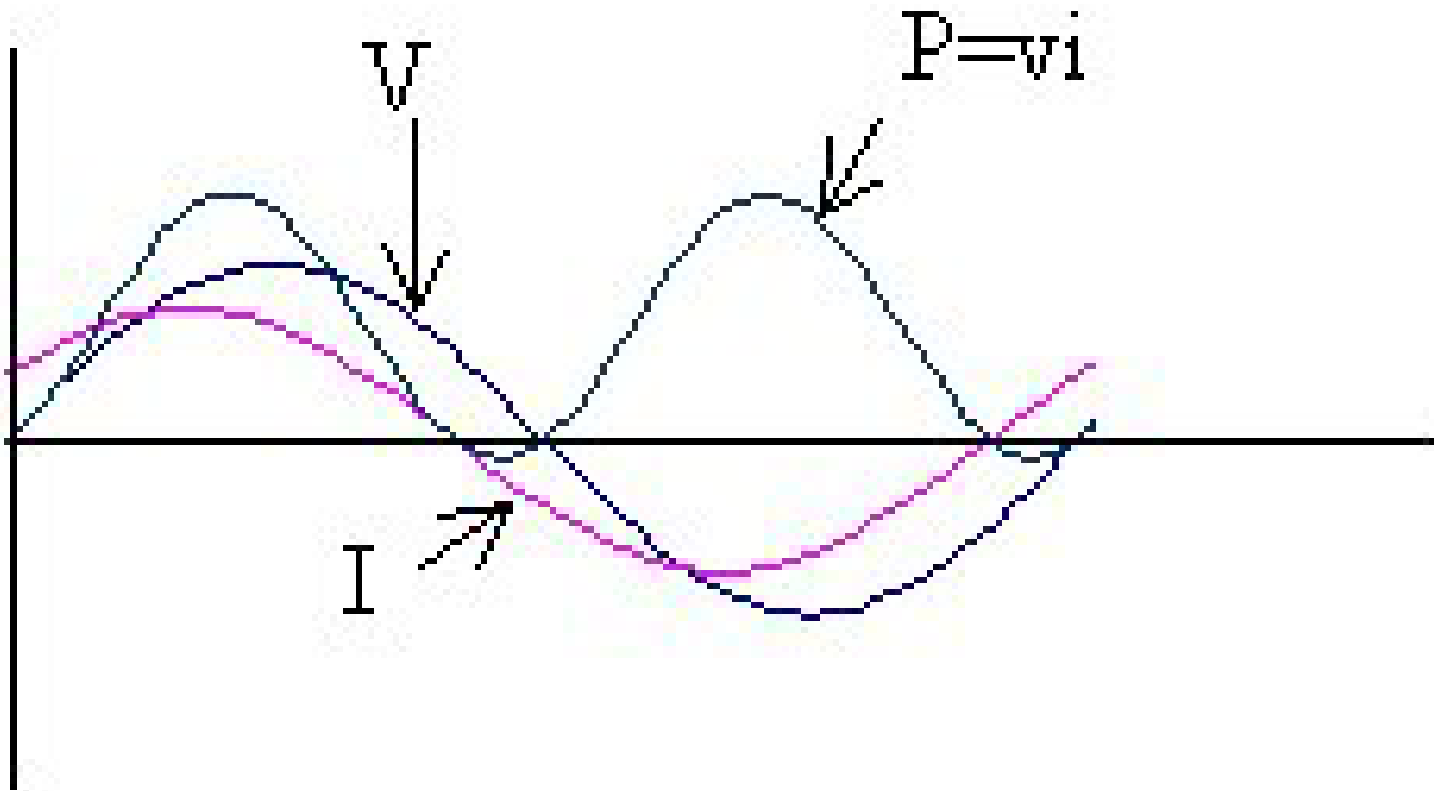
# Power in a capacitive circuit



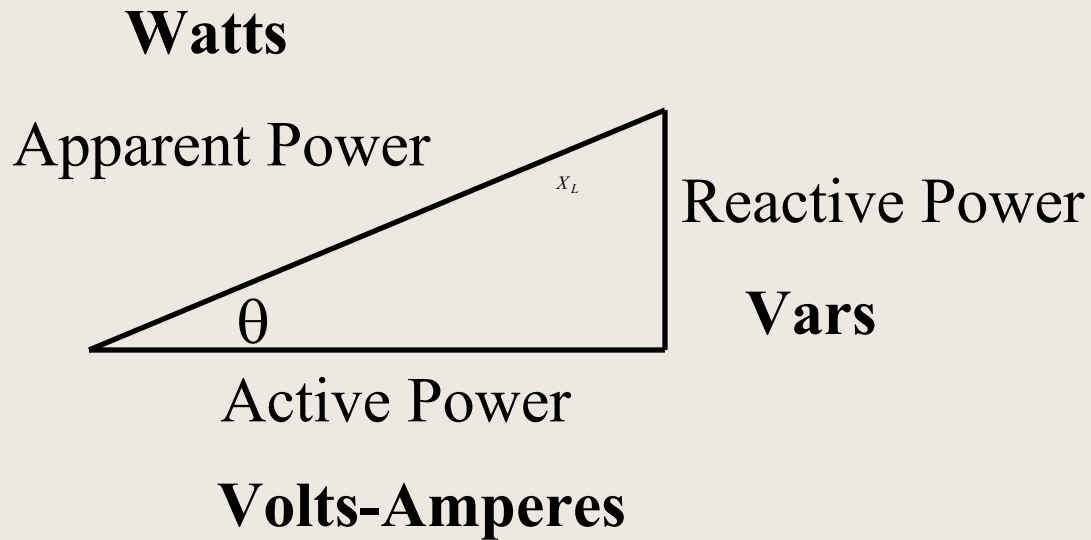
# Power in an inductive circuit



# Power in a real circuit

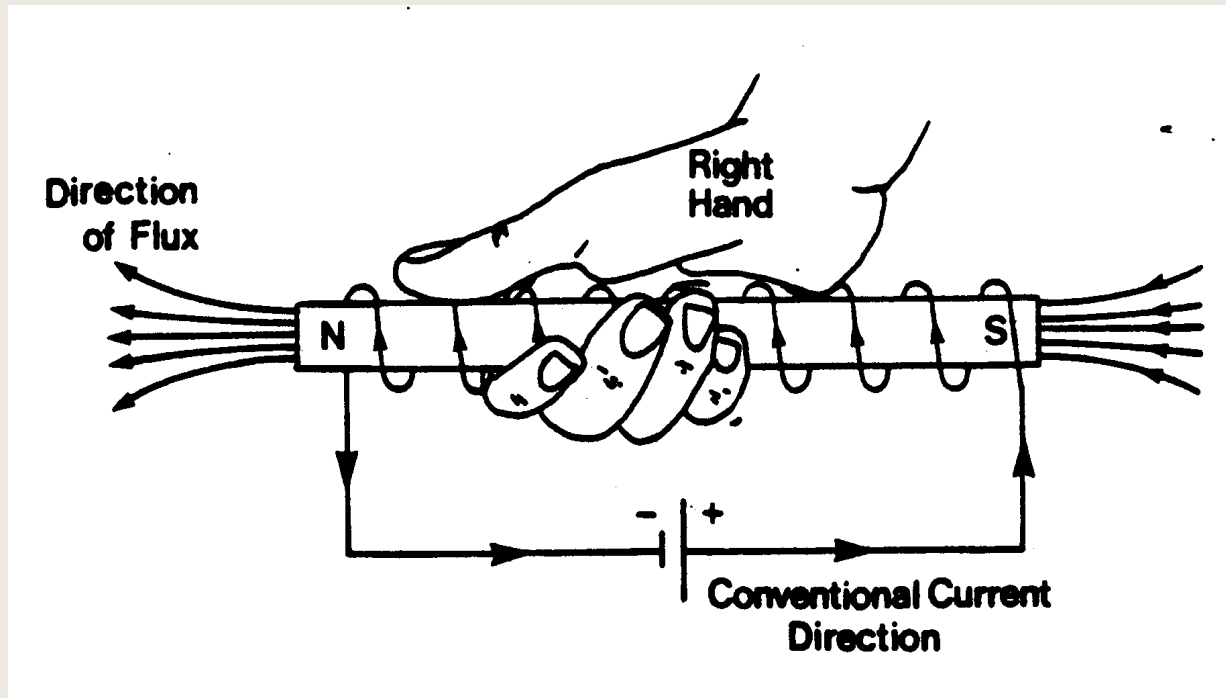


# Power Triangle

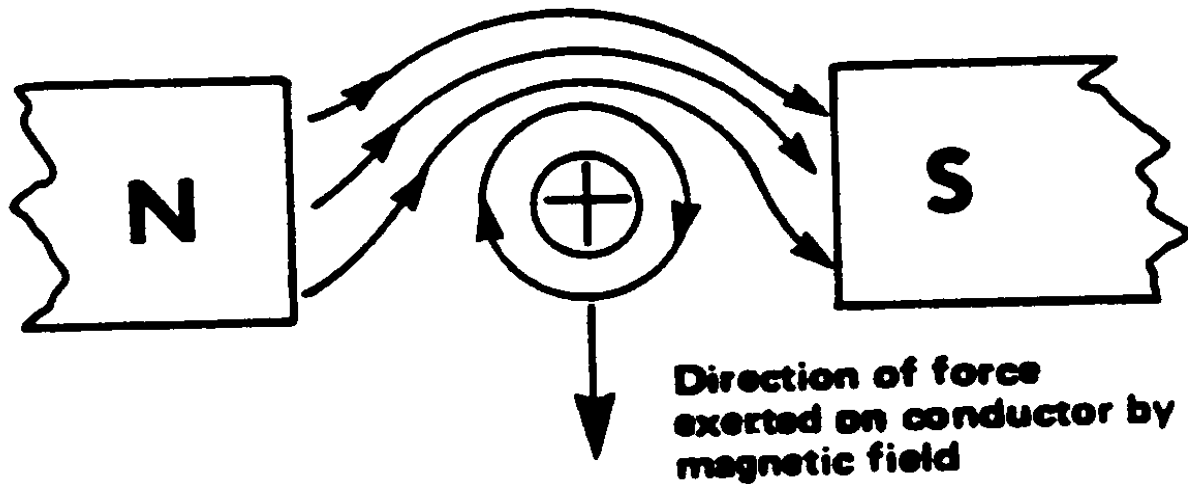




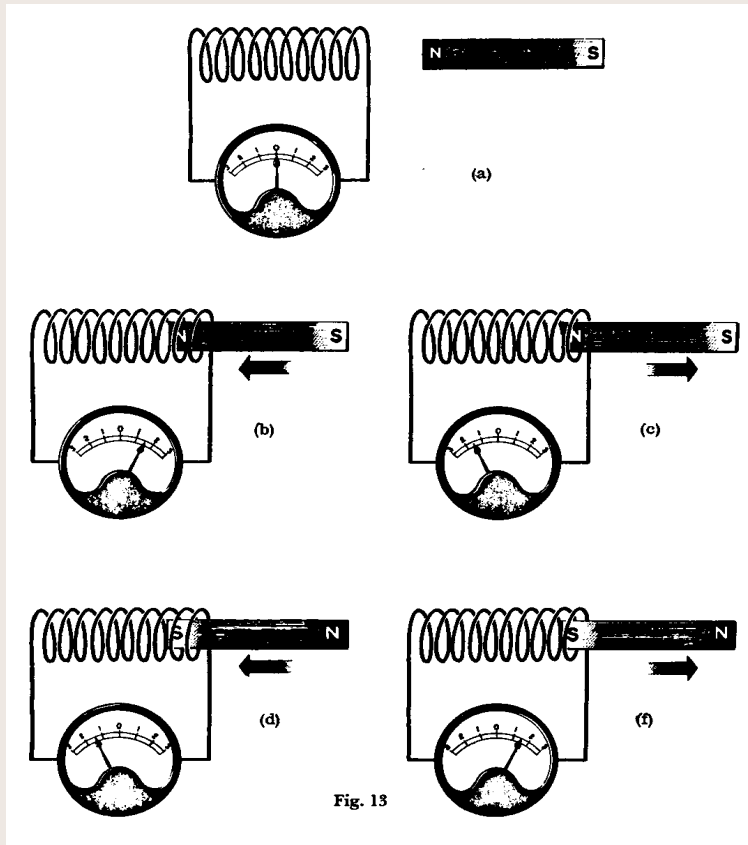
# Direction of magnetic field



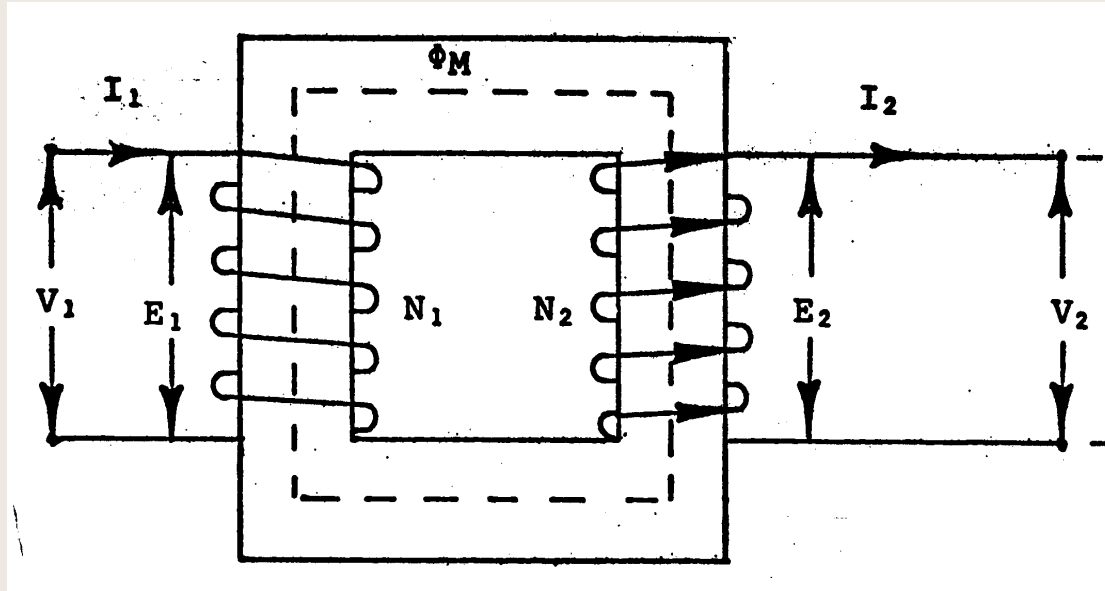
# Motor Action



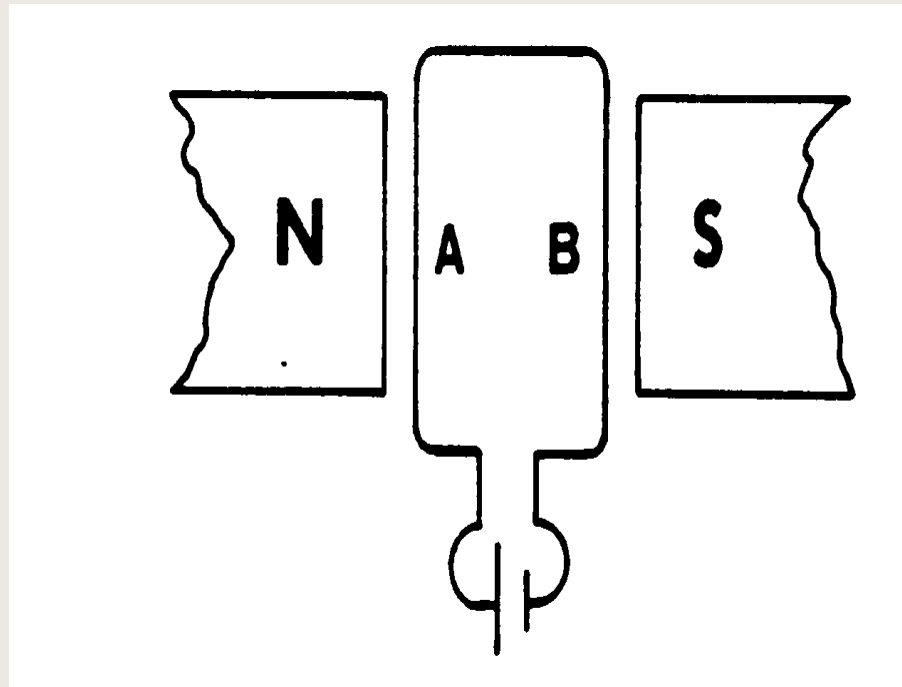
# Electromagnetic Induction



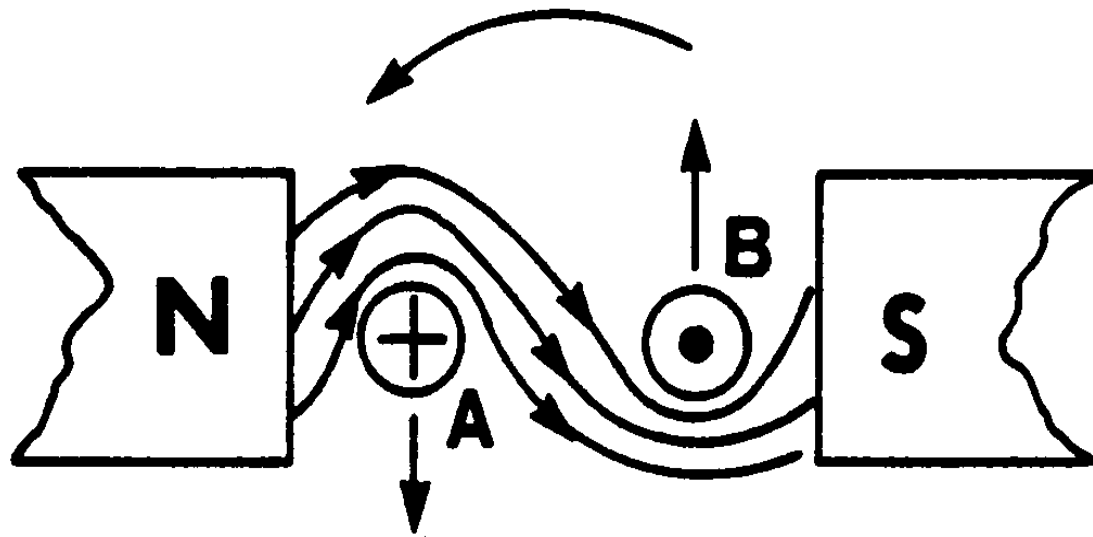
# Transformer



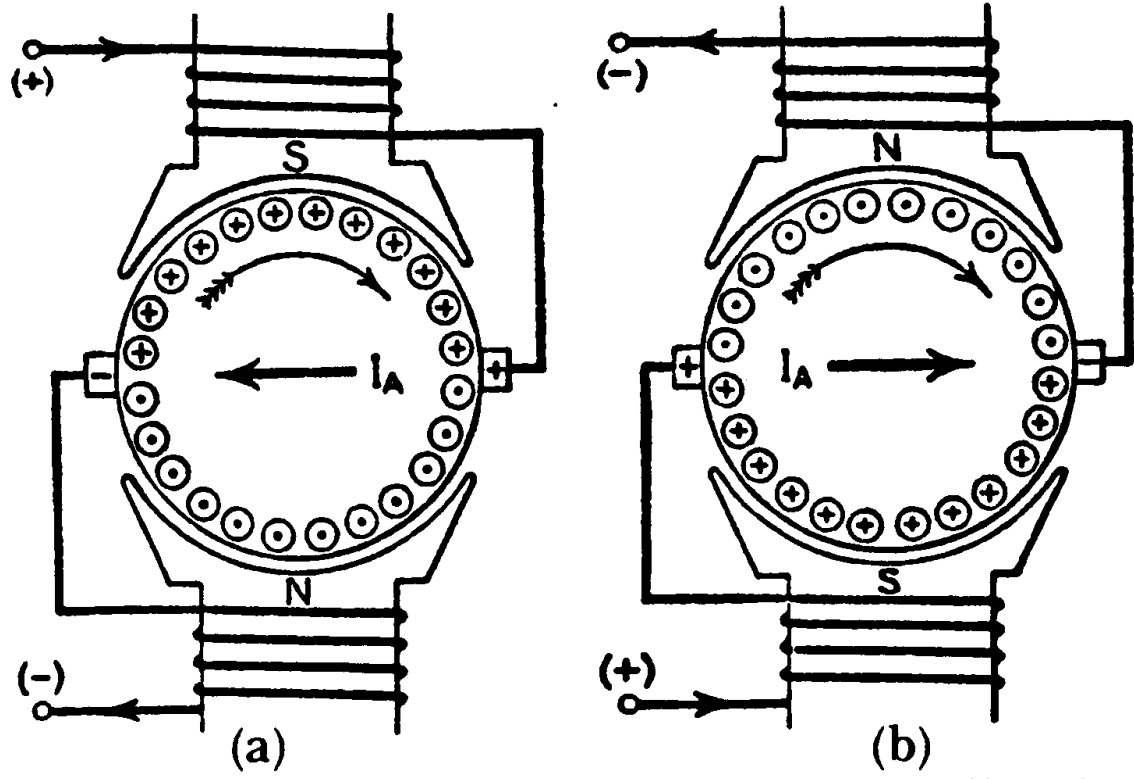
# Motor



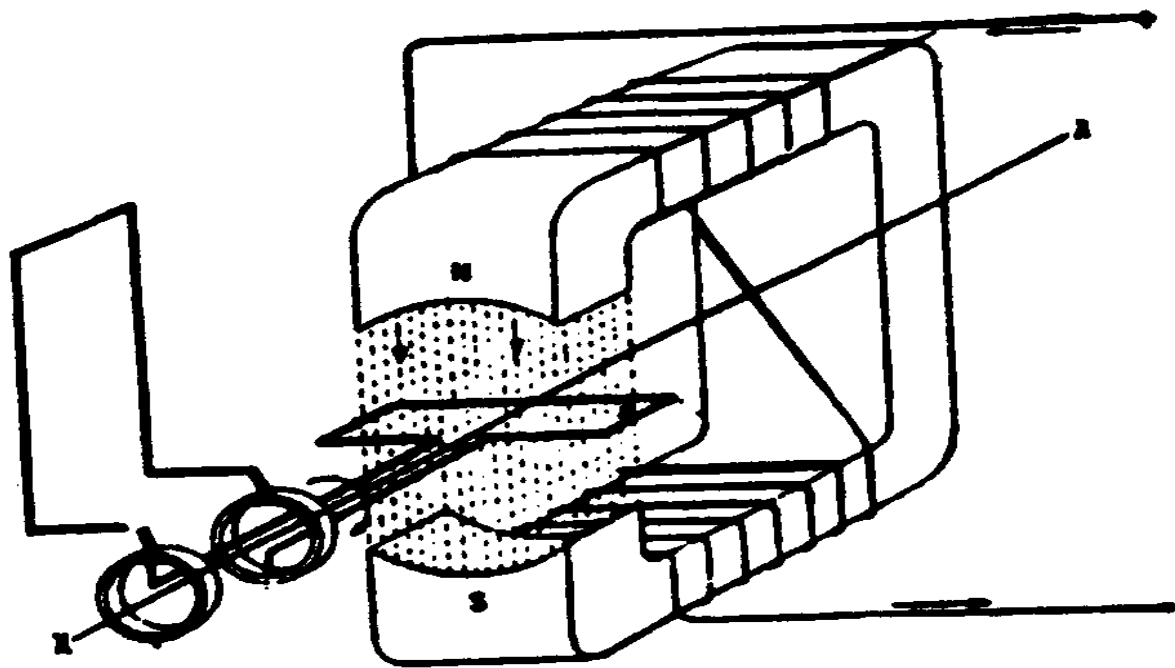
# Motor



# Series Motor

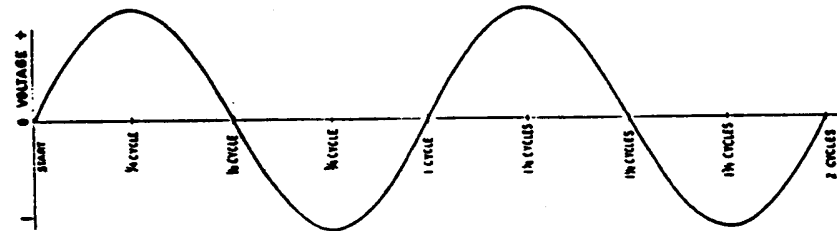
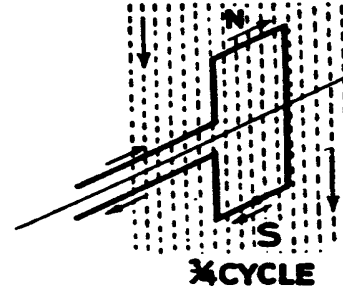
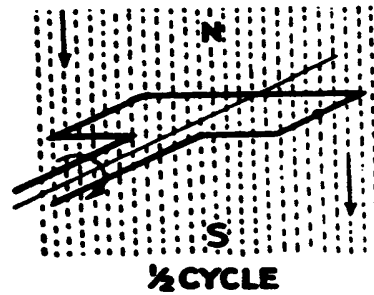
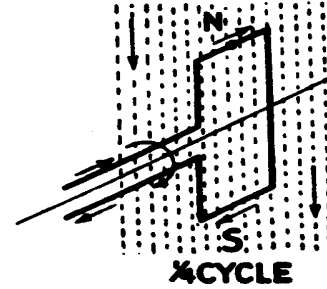
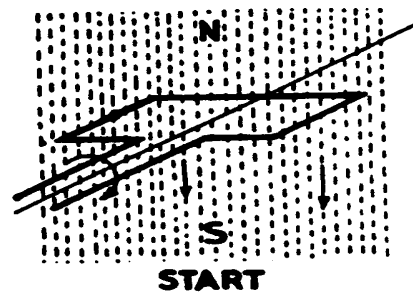


# Basic Generator

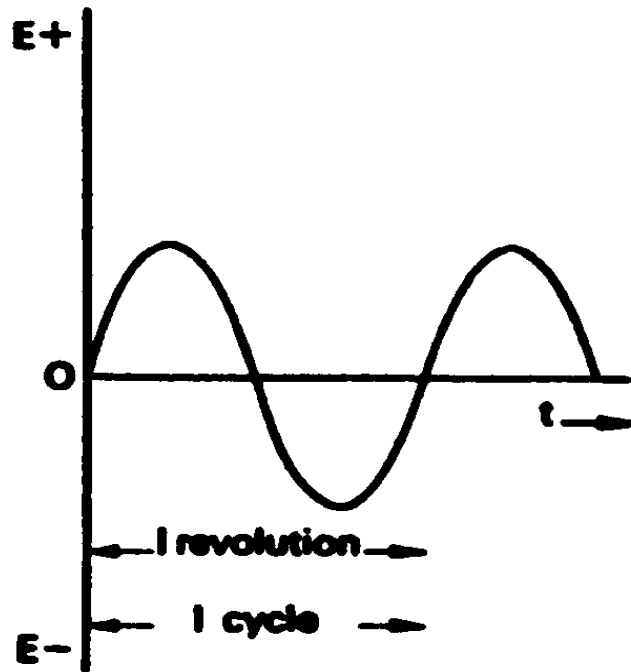
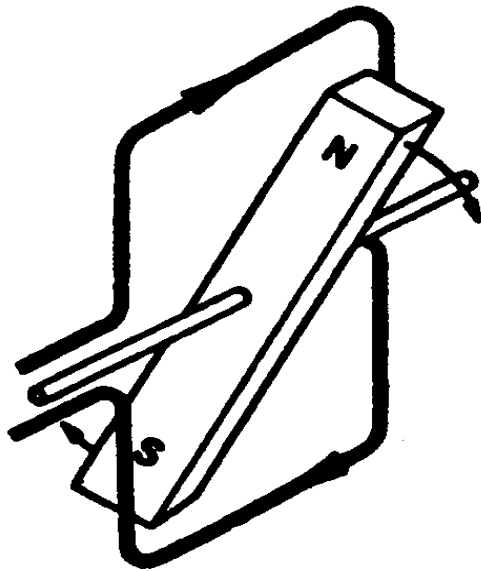




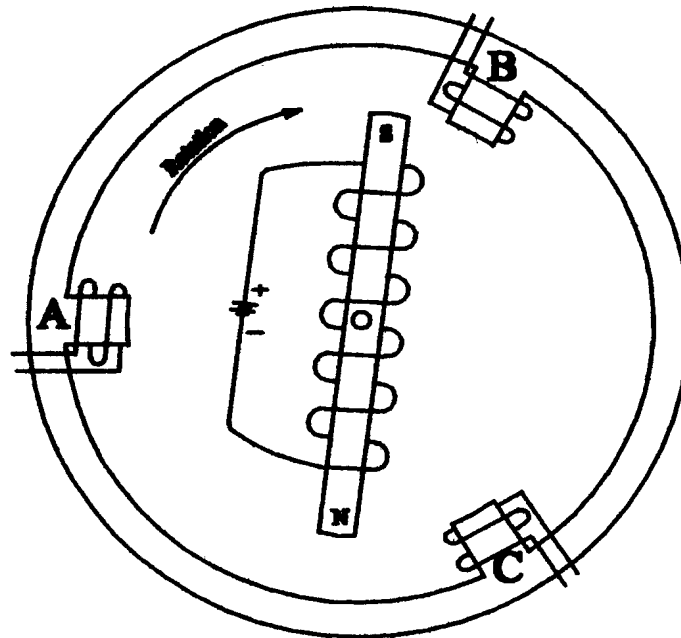
# Generation of Sinusoidal Voltage



# Spinning Magnet

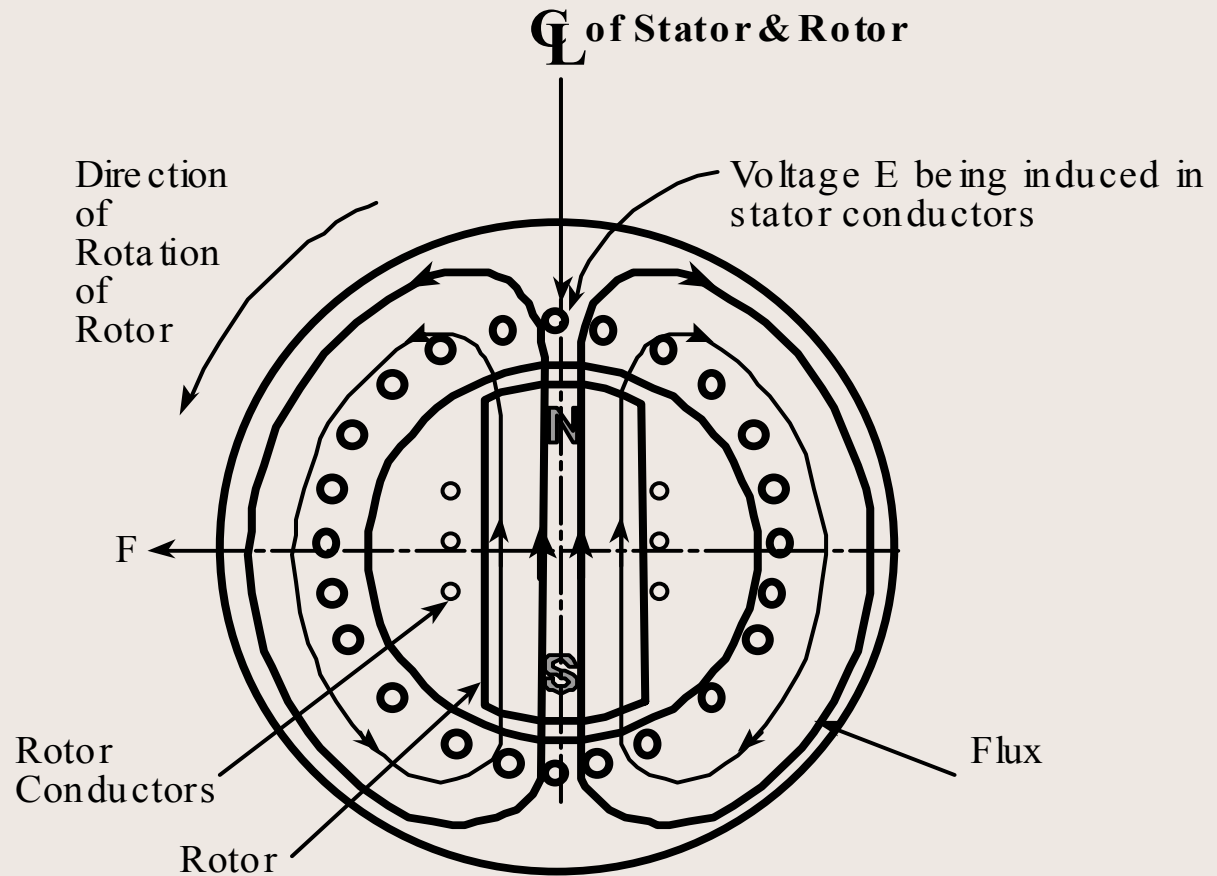


# Three phase Generation

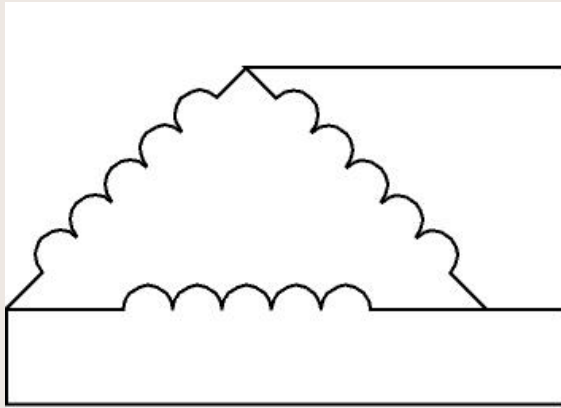


**Simplified 3 Phase AC Generator**

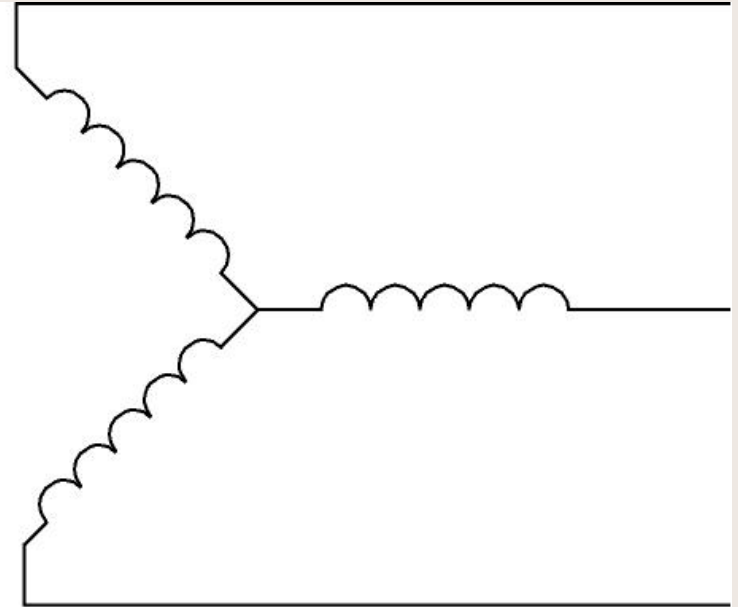
# Field and Stator Windings



# 3 Phase Connections

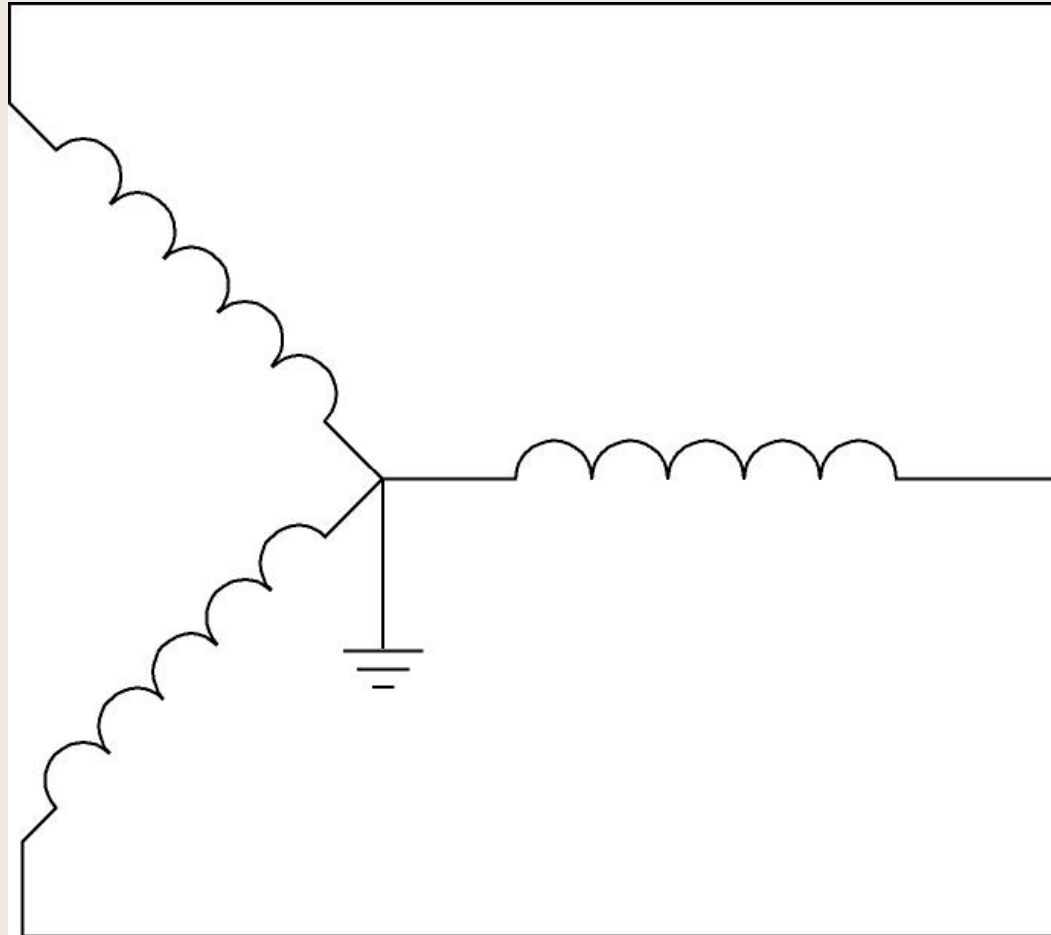


**Delta**



**Star**

# Grounded Star

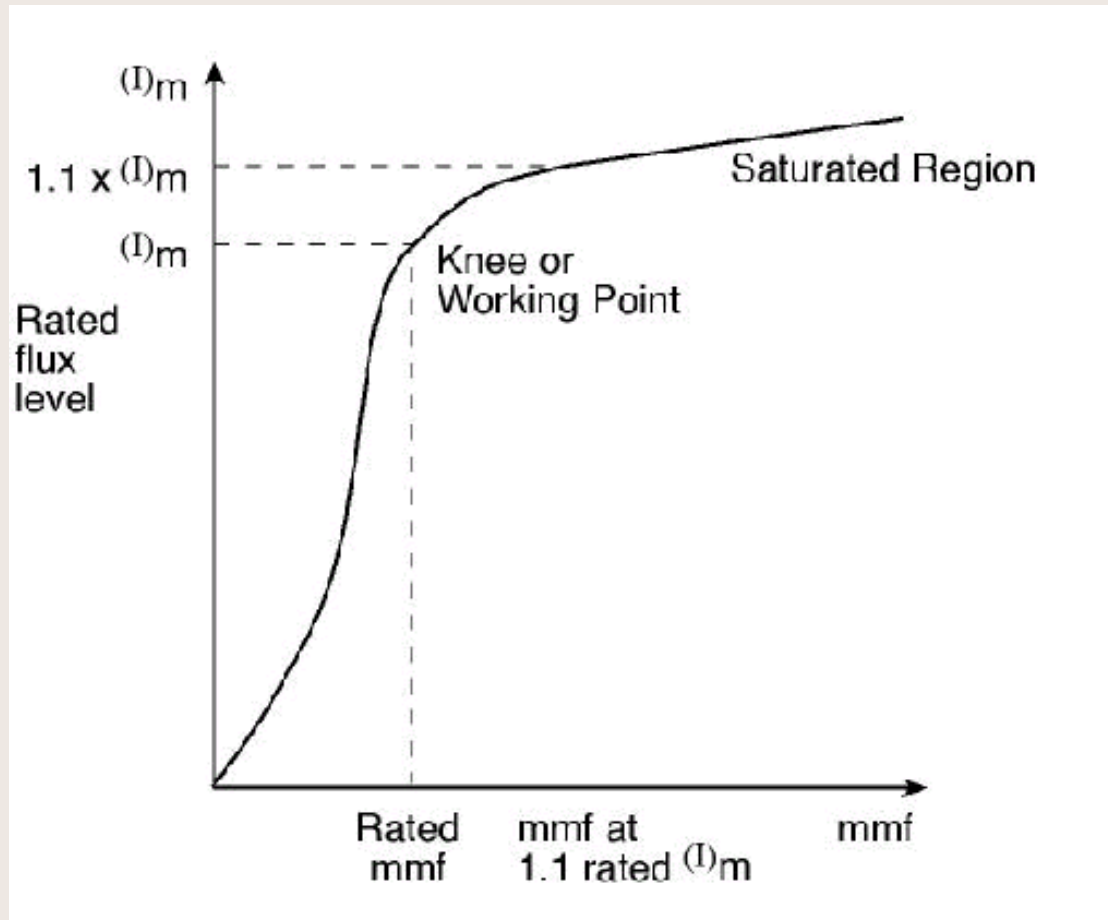


# Magnetic Circuit Losses

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- Hysteresis
- Eddy currents

# Saturation Curve





For you to do

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**Questions**