

# Technician License Course

## Chapter 3

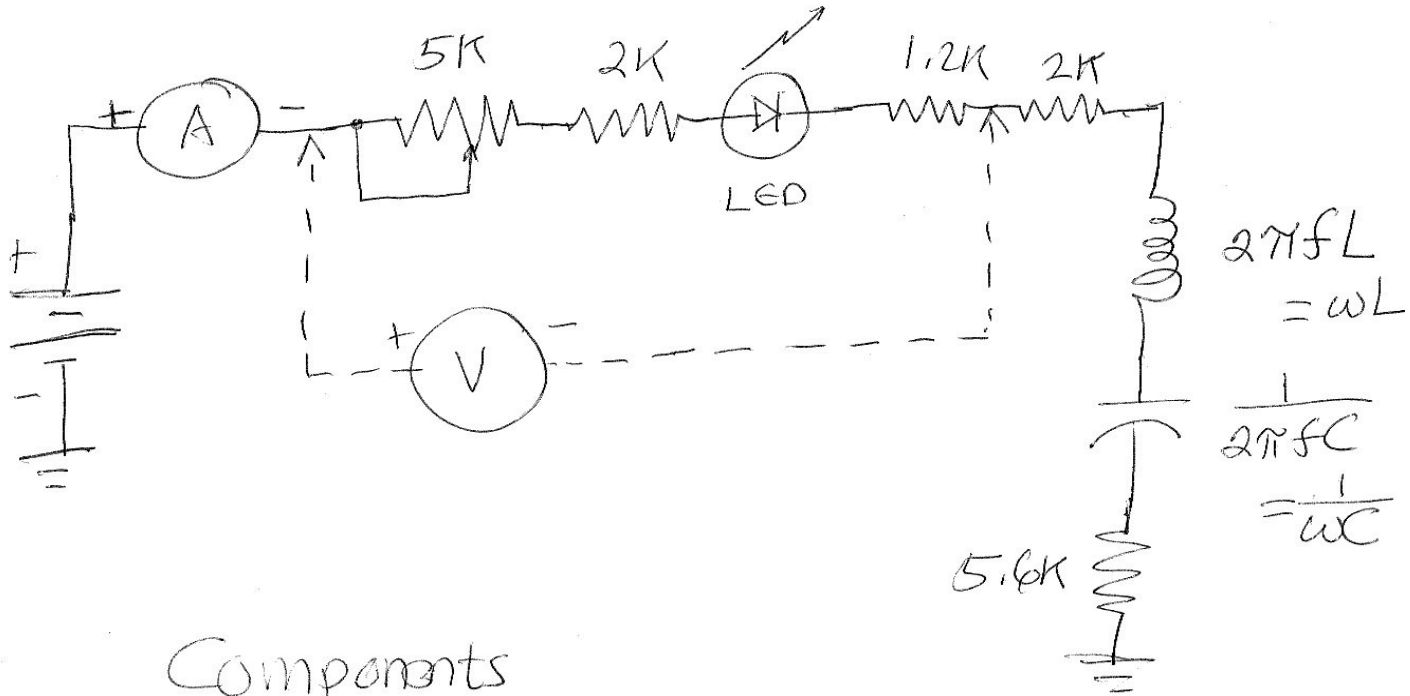
Lesson Plan Module 6 – Part 1  
Electrical Components  
21 March 2015



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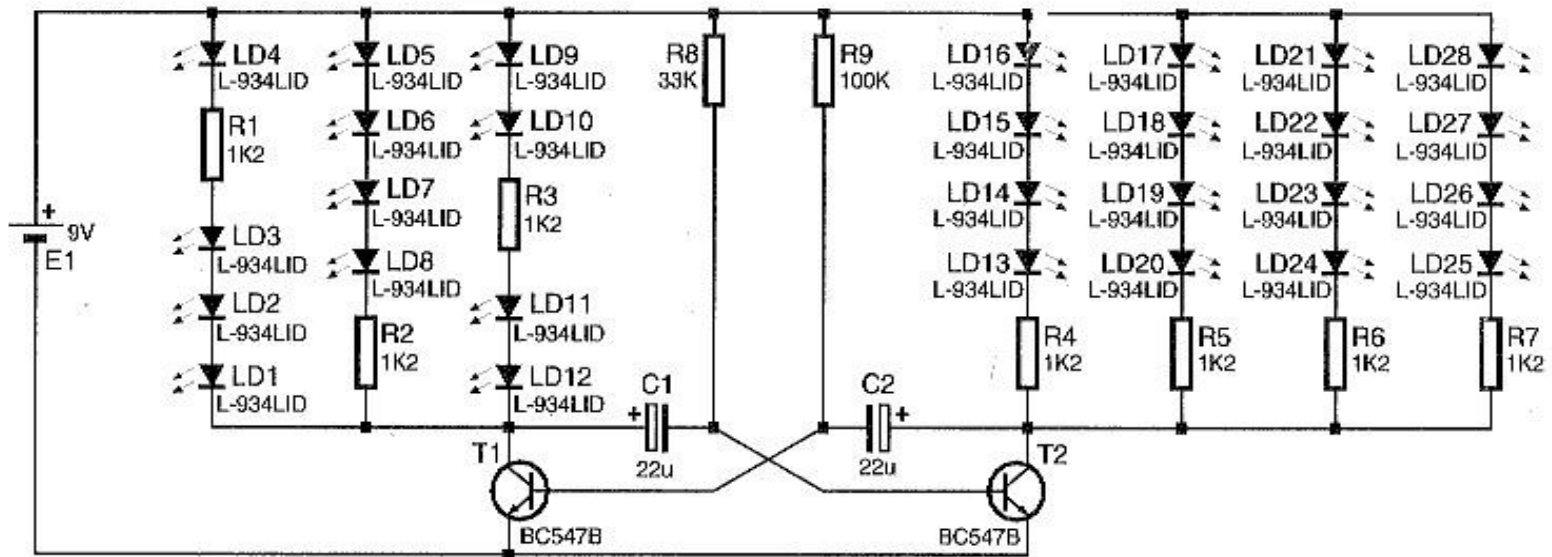
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# Components Demo



Components  
Demo

# Hearts Circuit





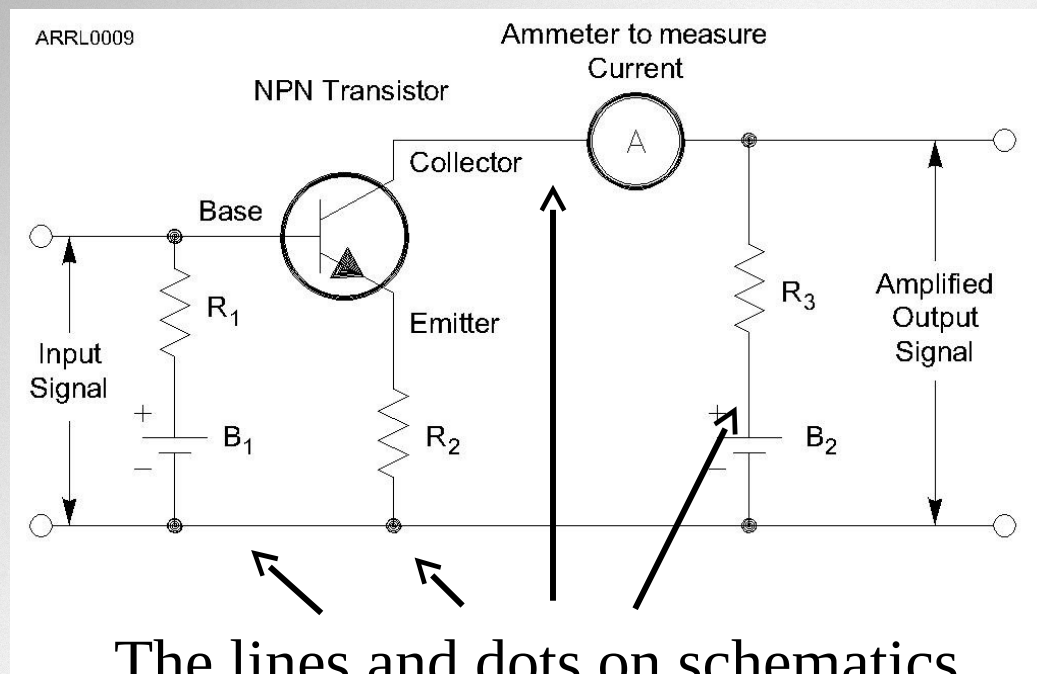
# Electronics – Controlling the Flow of Current

- To make an electronic device (like a radio) do something useful (like a receiver), we need to control and manipulate the flow of current.
- There are a number of different electronic components that are used to do this.

# Schematic Diagrams

- We can draw pictures of electronic components forming circuits, such as for the parallel and series circuit examples. This is too cumbersome for most circuits.
- Schematic diagrams use symbols with different components, each having a different symbol.

# Schematic Diagrams



The lines and dots on schematics represent electrical connections between the components.



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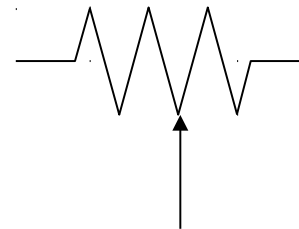
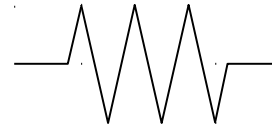
# The Resistor

- The function of a resistor is to restrict the flow of current.
- Remember Ohm's Law:

$$I = E / R$$

$$E = I \times R$$

- Schematic symbol

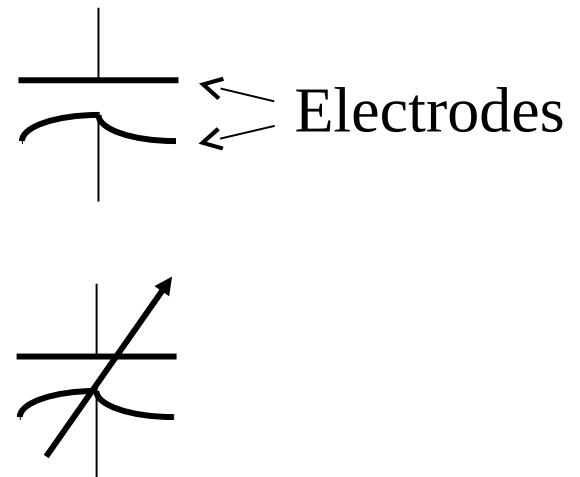


Potentiometer  
or "Pot"

Arrow indicates adjustable value,  
such as for a volume control.

# The Capacitor

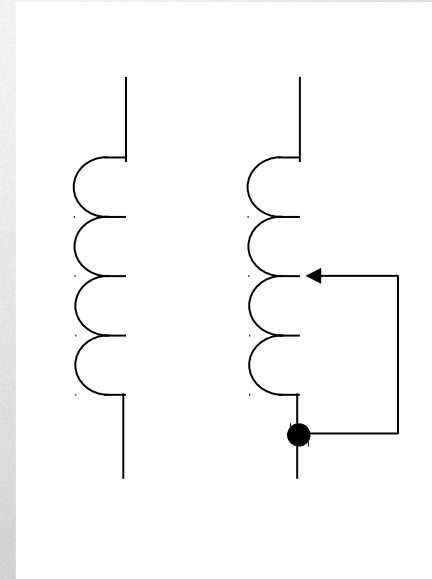
- The function of a capacitor is to store electrical energy – called *capacitance*.
  - Acts like a battery
  - Stores energy in an electric field created by voltage between the electrodes with insulating *dielectric* material between them
- Schematic symbol





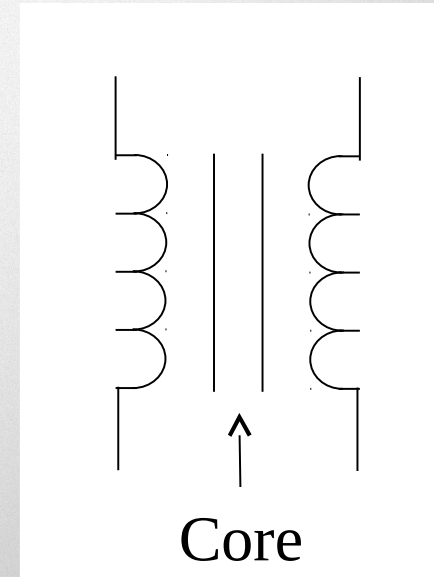
# The Inductor

- The function of an inductor is to store magnetic energy – called *inductance*.
  - A coil of wire around a *core* of air or magnetic material like iron or ferrite
  - Stores energy in a magnetic field created by current in the wire
- Schematic symbol



# The Transformer

- A pair of inductors sharing a common core
  - Also share their magnetic field
  - Used to transfer energy from one circuit to another without a direct connection
  - Changes the ratio of voltage and current
- Schematic symbol



# Electrical Units

- Each type of component has a value measured in specific units:
  - Resistors > resistance > ohms ( $\Omega$ )
  - Capacitors > capacitance > farads (F)
  - Inductors > inductance > henrys (H)



# Component Designators

- Each schematic symbol has a *designator* to denote which component it refers to. For example, the 10<sup>th</sup> resistor in a circuit is R10.
- Resistors (R), capacitors (C), inductors (L).

# Indicators and Displays

- Indicators communicate status
  - ON/OFF, ready/stand-by, left/right
  - LEDs, light bulbs, symbols, audio tones
- Displays communicate values or text
  - Numeric values, warnings, messages
  - Digital and analog meters, LCD screens



# Reactance

- Capacitors and inductors store energy, rather than dissipating it like resistors.
- Energy storage creates an effect called *reactance* (symbol  $X$ ) that acts like a resistance in opposing the flow of ac current.
  - Capacitors create *capacitive reactance* ( $X_C$ )
  - Inductors create *inductive reactance* ( $X_L$ )
  - The effects of each are complementary



# Impedance

- The combination of resistance ( $R$ ) and reactance ( $X$ ) is called *impedance*, represented by the symbol  $Z$ .
- Impedance represents a circuit's opposition to both ac and dc currents.

# Resonance

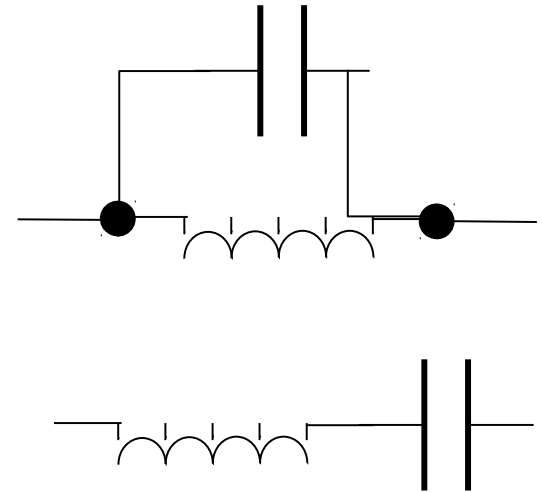
- A component's reactance depends on frequency:  $X_L$  increases with frequency while  $X_C$  decreases.
- At the frequency for which a circuit's  $X_L$  and  $X_C$  are equal, their effects cancel. This is the circuit's *resonant frequency*.
- At *resonance*, a circuit has only resistance, which affects ac and dc current equally.



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# Resonant or Tuned Circuit

- Capacitors and inductors connected together create a *tuned circuit*.
  - When  $X_L$  and  $X_C$  are equal, the circuit is *resonant*.
  - If C or L are adjustable the resonant frequency can be varied or tuned.



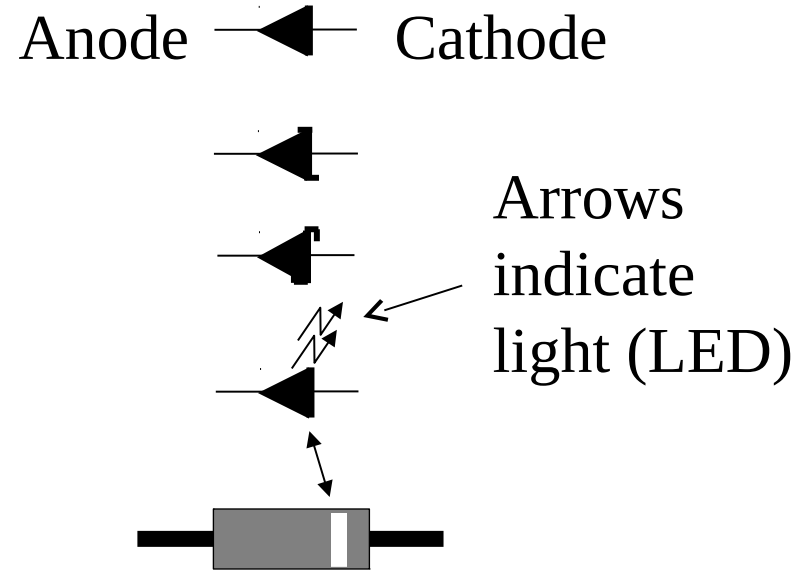


# Semiconductor Components

- Made of material like silicon that are “OK” conductors but not as good as metals.
- Impurities added to semiconductors create material with more than usual electrons (*N-type*) and fewer than usual (*P-type*) electrons.
- Structures of N and P material can control current flow through the semiconductor.

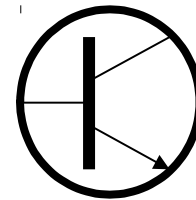
# The Diode

- Allows current to flow in only one direction.
  - Two electrodes: *anode* and *cathode*
  - AC current is changed to varying pulses of dc – called *rectification*
  - Diodes used to change ac power to dc power are called *rectifiers*
- Schematic symbol
- Designator (D or CR)

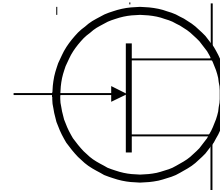


# The Transistor

- The function of a transistor is to control large signals with small ones.
  - An “electronically controlled current valve”
  - When used as an amplifier a transistor produces *gain*
  - Transistors can also be used as a switch
- Schematic symbol
- Designator (Q)



Bipolar  
Junction  
Transistor (BJT)



Field-Effect  
Transistor (FET)

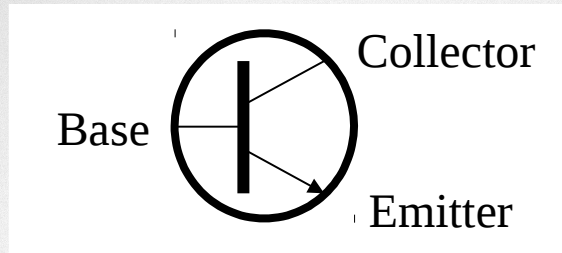


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# The Transistor

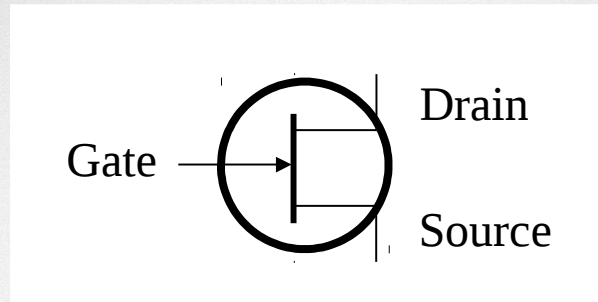
- The Bipolar Junction Transistor (BJT) has three layers of N or P material connected to electrodes:



- Depending on the arrangement of layers, a BJT is either an NPN or PNP transistor.

# The Transistor

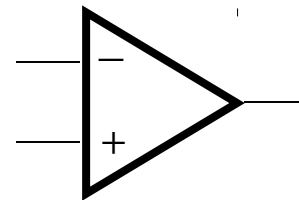
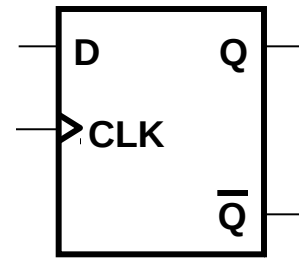
- The Field-Effect Transistor (FET) has a conducting path or channel of N and P material connected to the drain and source electrodes.



- Voltage applied to the gate electrode controls current through the channel.

# The Integrated Circuit

- The integrated circuit is a collection of components contained in one device that accomplishes a specific task.
- Schematic symbol
- Designator (IC or U)





# Protective Components

- Fuses and circuit breakers are designed to remove power in case of a circuit overload.
  - Fuses blow – one time protection
  - Circuit breakers trip – can be reset and reused
  - Always use proper rating
- Schematic symbol
- Designator (F or CB)



Fuses



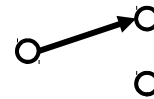
Circuit  
Breaker

# Switches

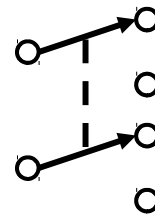
- Switches are used to interrupt or allow current to flow.
  - Each circuit controlled by the switch is a *pole*
  - Each position is called a *throw*
- Schematic symbol
- Designator (S or SW)



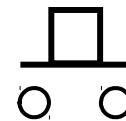
SPST



SPDT



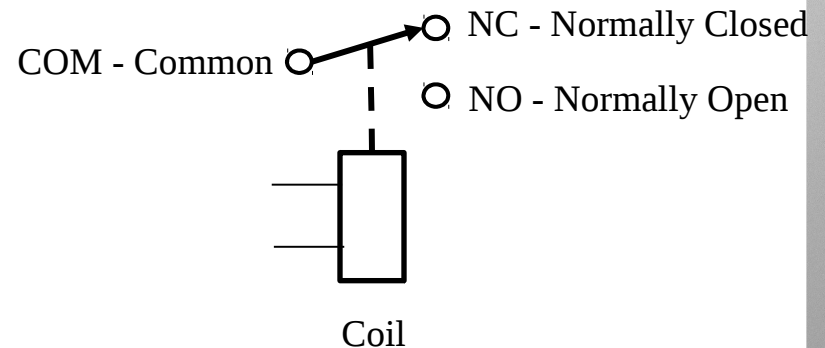
DPDT



Pushbutton

# Relays

- Relays are switches activated by current in a coil (electromagnet)
  - Relays use the same pole/throw names as switches
  - The moving switch is called the *armature*
  - *Contacts* are named by when they are connected
- Schematic symbol
- Designator (K or RLY)

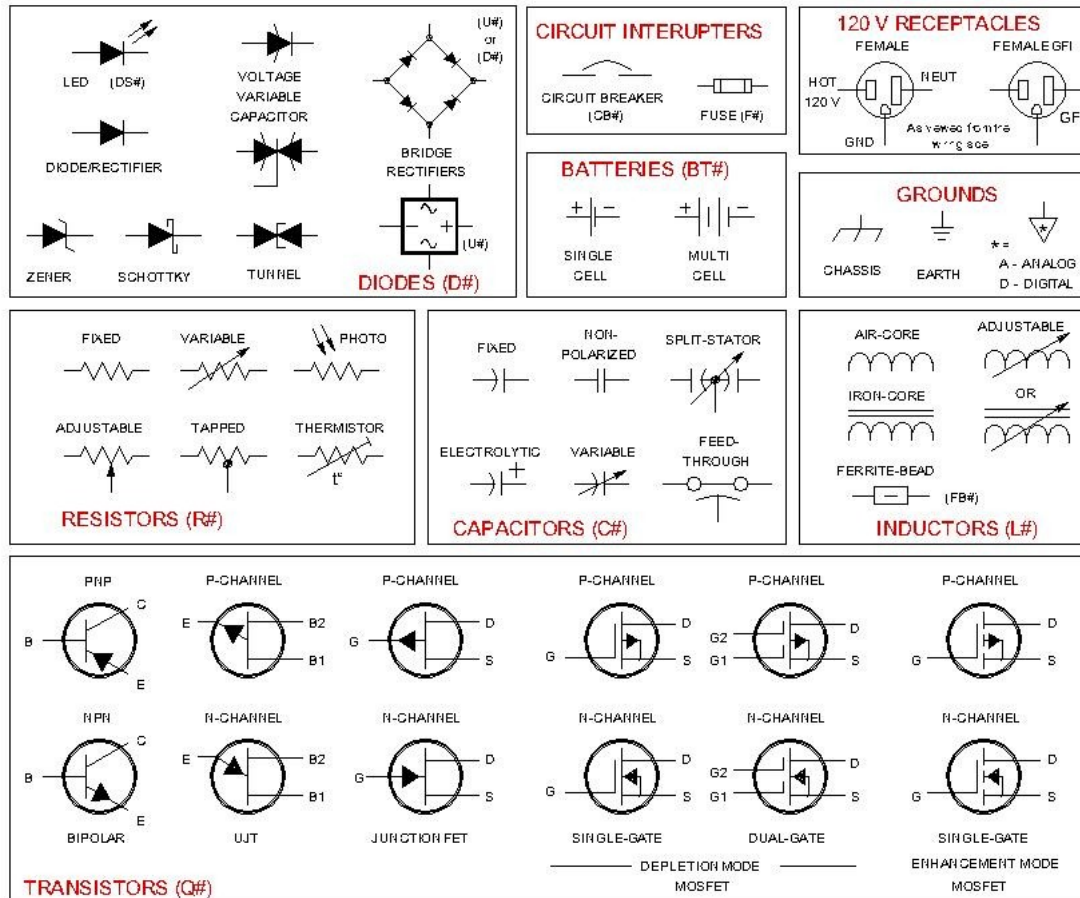




# Other Circuit Symbols

## Schematic Symbols Used in Circuit Diagrams

Labelling conventions: # is a sequential number. (X#) is the component designator. Examples - C3, L11, R8, Q3



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# Practice Questions

