MECH 10
Fundamentals of Electronics

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Class 20
Bipolar Junction Transistors

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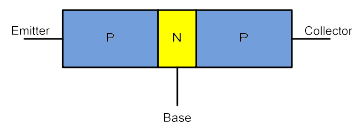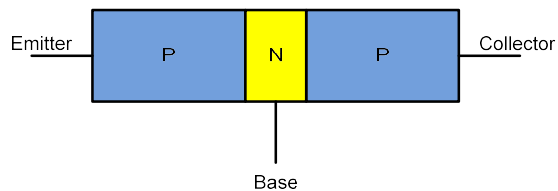
- Bipolar Junction
  - Bipolar – two types of semiconductors
    - N & P type
  - Junction – use current carrying PN junctions
- Transistor
  - Transfer resistor
    - Low resistance input to a high resistance output

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- ## Bipolar Junction
  - Emitter – emits electrons to the base & collector
  - Collector – collects electrons from the emitter
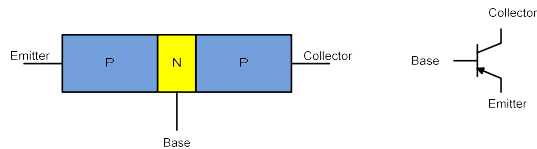 - Base – controls V_{BE} bias

Emitter | P | N | P | Collector
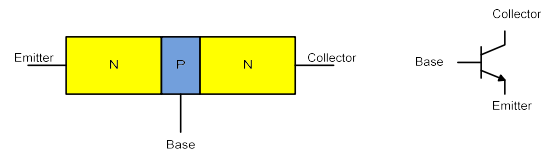
Base

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- ## Bipolar Junction Transistor
- ## Types
  - PNP
    - "pointing in"

    Emitter | P | N | P | Collector

    Base

    Collector
    Base
    Emitter

  - NPN
    - "not pointing in"

    Emitter | N | P | N | Collector

    Base

    Collector
    Base
    Emitter

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- **Bipolar Junction Transistor**
  - Package function
    - Environmental seal
    - Electrical connectivity
    - Dissipate heat
    - Handling
  - Types
    - Through hole
    - Surface mount

TO-3

TO-18

TO-92

LDPAK   TO-220

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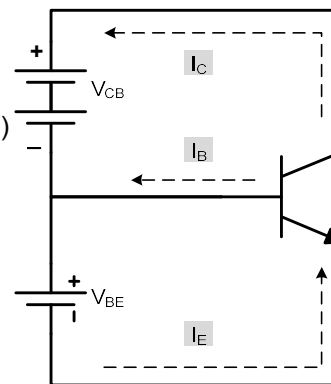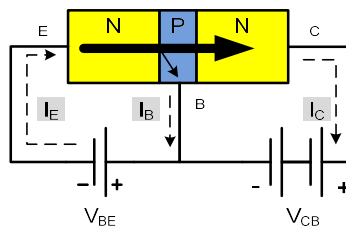
- **Bipolar Junction Transistor** $I_E = I_C + I_B$
  - Bias Voltages & Currents
    - Base-emitter
      - Forward biased (low resistance)
    - Base Collector
      - Reverse biased (high resistance)

E N P N C

I_E I_B B I_C

V_{BE} V_{CB}

$+$ V_{CB} I_C
I_B
$+$ V_{BE} I_E

- **Bipolar Junction Transistor**

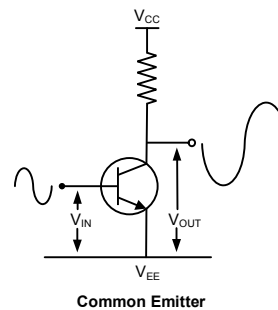 $$\beta_{DC} = \frac{I_C}{I_B}$$

  - Current Gain
    - Collector current **!>** base current
      - I_C is typically 40 to 300 times > I_B
      - Small current controls large current
      - Amplification!
    - AKA
      - h_{FE}
      - DC Beta

Common Emitter

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- **Bipolar Junction Transistor**
  - Current Gain Example
    - A BJT has a base current of 24 µA and a collector current of 1.2mA. Find β_{DC}

  $$\beta_{DC} = \frac{I_C}{I_B}$$

  $$\beta_{DC} = \frac{1.2mA}{24\mu A} = ?$$

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- Bipolar Junction Transistor
  - Current Gain Example
    - The β_{DC} of a BJT is 180. What base current is required to produce collector current of 18mA?

$$\frac{\beta_{DC}}{1} = \frac{I_C}{I_B}$$

$$I_B = \frac{18mA}{180} = ?$$

$$\frac{I_B}{1} = \frac{I_C}{\beta_{DC}}$$

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- Lab 20 – Transistor Gain

  Learning Objectives
  - Test transistor forward and reverse bias values
  - Test transistor gain using a DMM
  - Calculate transistor gain by measuring base and collector currents
  - Plot transistor performance on a scatter plot

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar), Expected and measured values recorded on schematic diagram	10
Setup	NPN / PNP configuration determined with diode test measurements	5
Beta Measurement	HFE measured & recorded, transistor off I_B measured & recorded; I_B, I_C measured & recorded for four transistors, beta calculated accurately	20
Temperature Effect	Temperature impact on I_B and I_C observed and recorded	5
Conclusions	Questions answered completely & accurately.	10
	Total	50