# Electrical Engineering I

## Machines Lab Assessment:

## DC Motor: Voltage Control and H-Bridge

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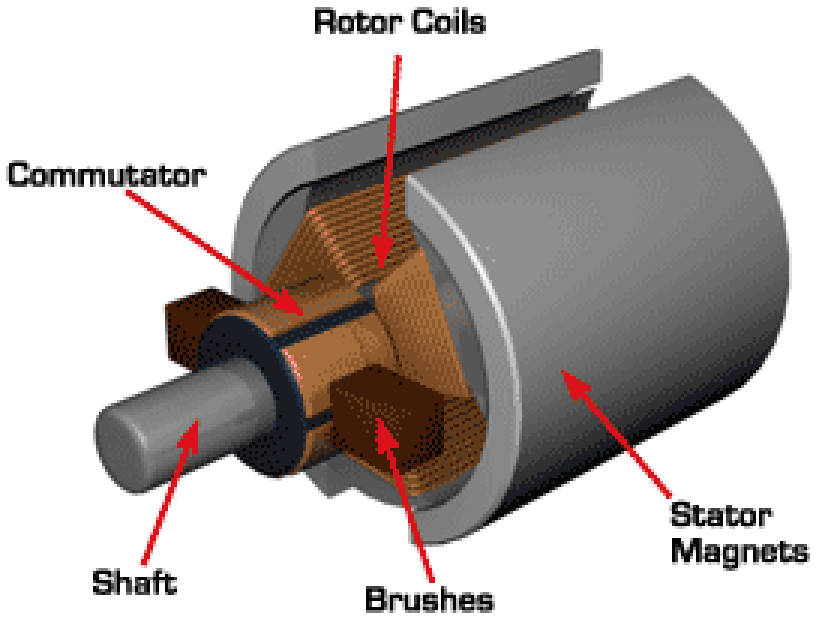
# Why DC Motors?

- Speed Control: Speed variation is accomplished by changing either the armature voltage or field voltage, or a combination of both.
- Constant Torque: Supplies constant torque over a wide speed application

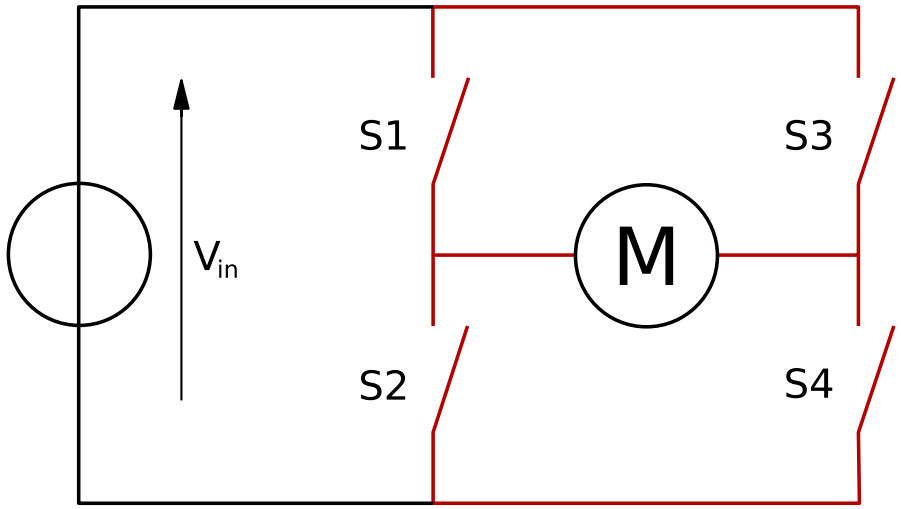
# Permanent Magnet DC Motor




- Simplest form of DC Motor
- Stator armature is substituted by permanent magnets
- Reduced size, applications in various fields (robotics etc.)

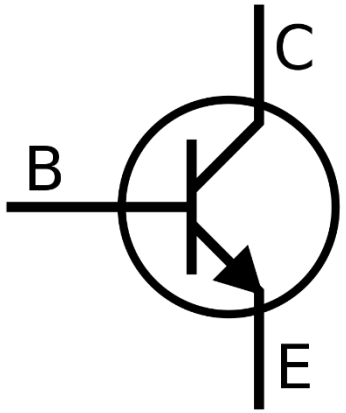
# Applications of DC Motors

# H-Bridge Controller

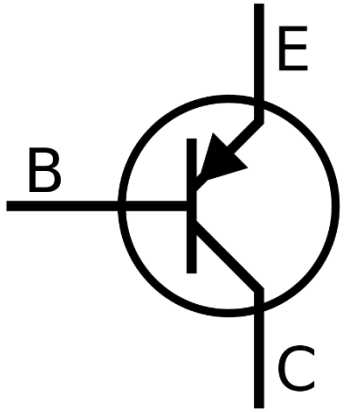



- A circuit that allows control over the direction of the applied voltage to the motor
- Traditional switches are mechanical components
- Implementation of a electrical switch
- Control of the direction through digital signals
- Utilization of Transistors as electronic switches

# BJT Transistor




NPN Transistor

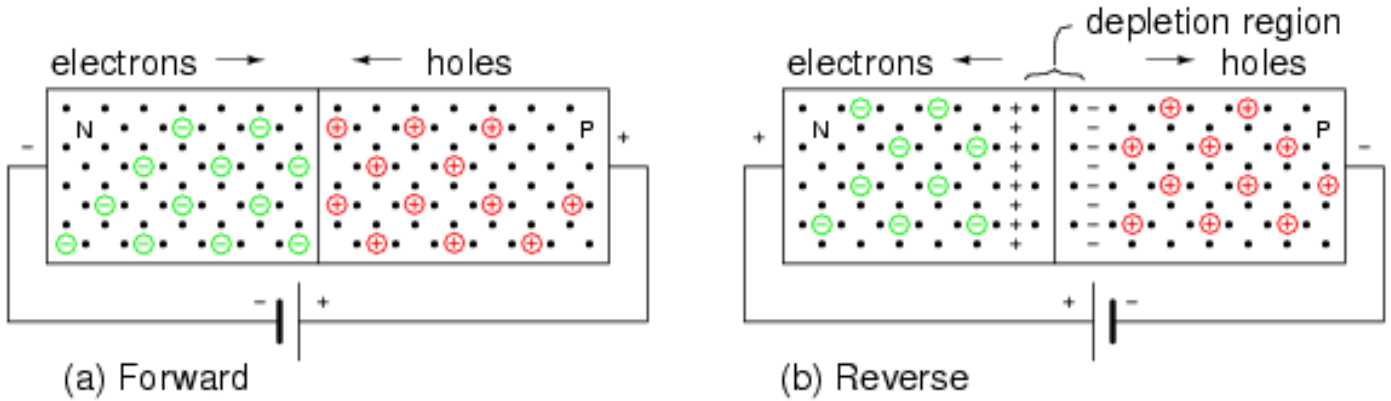



PNP Transistor

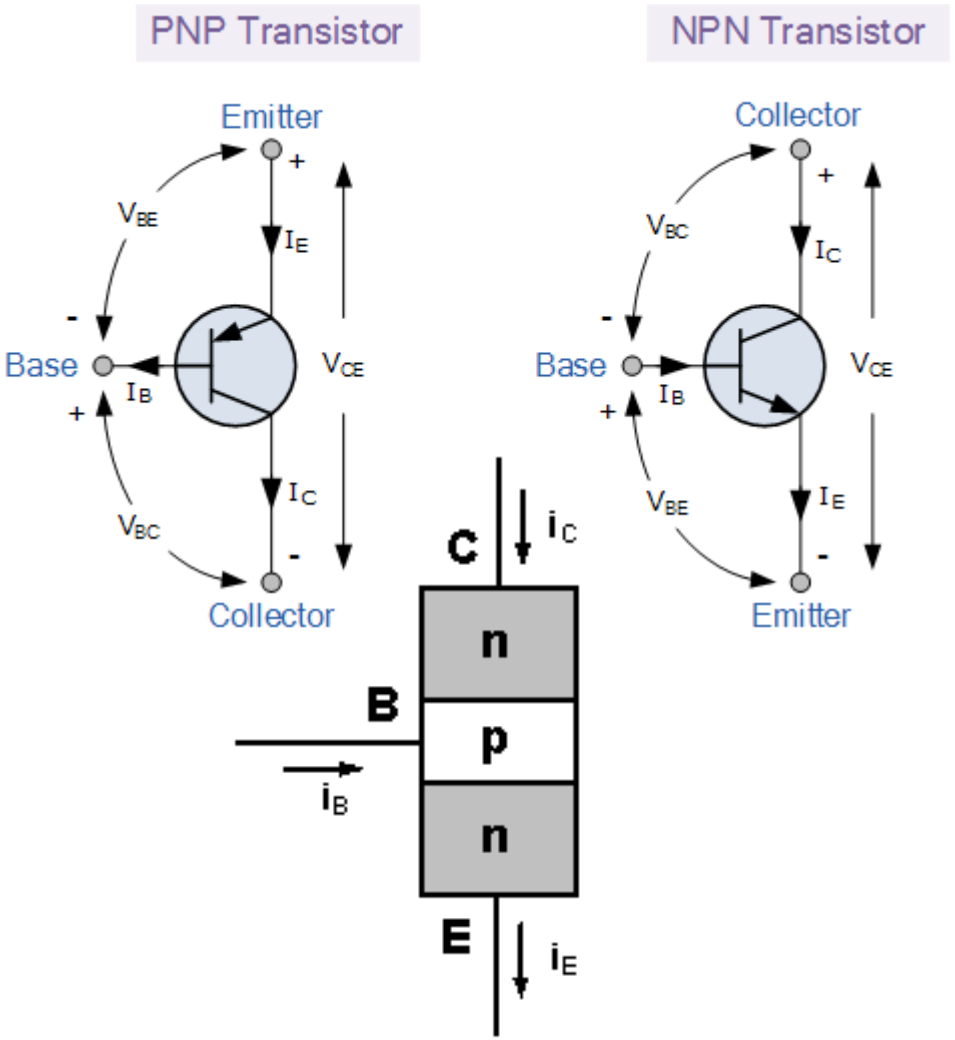
- Fundamental semiconductor component in all electronic devices
- Can amplify AC signals (analog circuits) or used as a switch (digital circuits)
- Effectively two n-p junctions in cascade mode

# N-P Junction

- An n-type region with increase free electron concentration
- An p-type region with increase hole (lack of electrons) concentration
- Can effectively conduct or not depending on the applied external voltage (bias)



# BJT Transistor




- Four modes of operation: Active, Reverse Active, Cut – Off, Saturation
- **Cut-off**: No current flowing between Collector and Emmiter. **CE contact acts as an open switch.**
- **Saturation**: Currents IC and IE are equal. The current flowing between CE contacts is independent of the voltages applied. **CE contact acts as a closed switch.**

# BJT Transistor

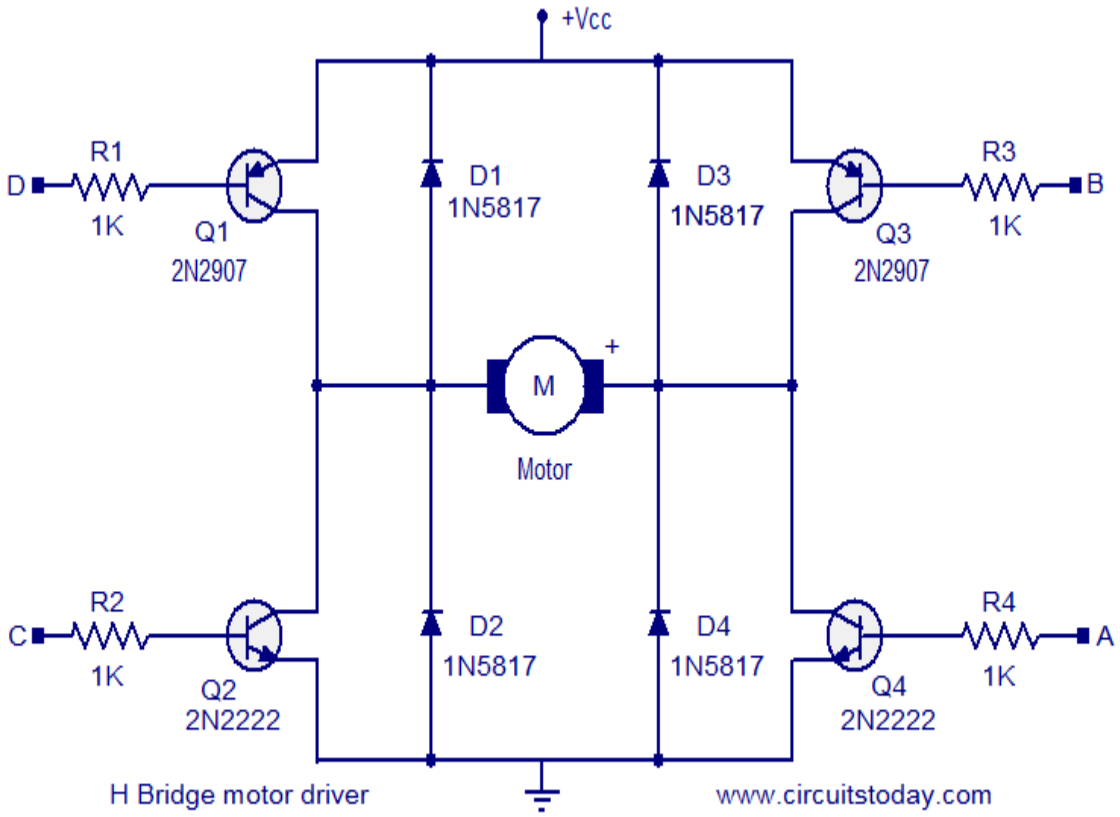
## NPN Transistor

| | Voltage | |
|---|---|---|
| Operation Mode | $V_{BE}$ | $V_{BC}$ |
| Active | positive | negative |
| Reverse Active | negative | positive |
| Saturation | positive | positive |
| Cut-off | negative | negative |

## PNP Transistor

| | Voltage | |
|---|---|---|
| Operation Mode | $V_{BE}$ | $V_{BC}$ |
| Active | negative | positive |
| Reverse Active | positive | negative |
| Saturation | negative | negative |
| Cut-off | positive | positive |

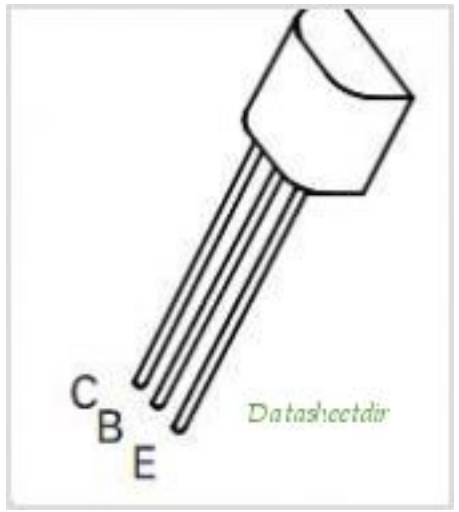
# H-Bridge circuit




- Simplest implementation of the H-Bridge
- Application of digital signals on inputs A-D to "open" or "close" the transistors
- Resistances $R_1$ - $R_4$ reduce the input current
- Diodes $D_1$ - $D_4$ are used as protection to prevent unwanted currents

| | Input Voltage $V_B$ | |
|---|---|---|
| Transistor Type | Low | High |
| NPN | Open | Close |
| PNP | Close | Open |

# Components




- 5V max PMDC-Motor
- ZTX751 PNP Transistor, 2 A, 60 V
- ZTX651 NPN Transistor, 2 A, 60 V
- 1N4001 Diode, 50V 1A
- Hall Effect Sensor
- 1kΩ resistors