Equipment

- Protoboard Workstation
- Digital Oscilloscope

Objective

Understand bipolar transistors

- Basic NPN and PNP conceptual operation
- Collector, Emitter and Base connections
- Gain (β) calculation (in terms of voltage and/or current)

Create and analyze circuits using PNP and NPN transistors

Conceptual (C-level)

- Read about the theory of bipolar transistors (section 4.3.2).
- Identify (PNP vs NPN) and determine the pin-out diagrams for 2N3904 and 2N3906 transistors.
- Draw and describe a conceptual picture for each type of transistor.
- How can a transistor be used as an amplifier?

Basic Lab (B-level)

Build the transistor switch circuits shown in Figure 4.5.3. Use a $V_{CC} = 5$ volts.

- Replace the light bulb with a LED resistor combination. Show your calculations to determine your resistance.
- Characterize the operation of the circuits.
 - Determine voltage drops and hence currents for each branch of the circuit.
 - What is the smallest base current needed?
 - What base condition turns off the different transistors?

Build and characterize the two circuits shown in Figure 1 and Figure 2. R₁=22 k Ω , R₂=470 Ω , R₃=470 k Ω , C₁= 10 μ F, Q₁=NPN, Q₂=PNP,



Figure 1



Figure 2

Build and characterize a night light circuit. In Figure 1 replace the switch with a $100k\Omega$ potentiometer (variable resistor) and the capacitor with a light detecting resistor LDR = $1 M\Omega$ (dark).

Advanced/Extended Lab (A-level)

Explore three more advanced circuits.

- Alternating current operation such as in Figure 4.57
- Voltage Regulator with Darlington pair such as in Figure 4.58
- Astable multivibrator such as in Figure 4.69

Substitutions may be considered.