EET 2010
Electronics Principles

Lab Exercise #5

BJT Switching Circuit

Equipment

1. Function Generator
2. Oscilloscope
3. DC Power Supply
4. Multimeter

Materials

1. 2N3906 PNP Transistor
2. 330 Ω Resistor
3. 220 Ω Resistor
4. Green LED

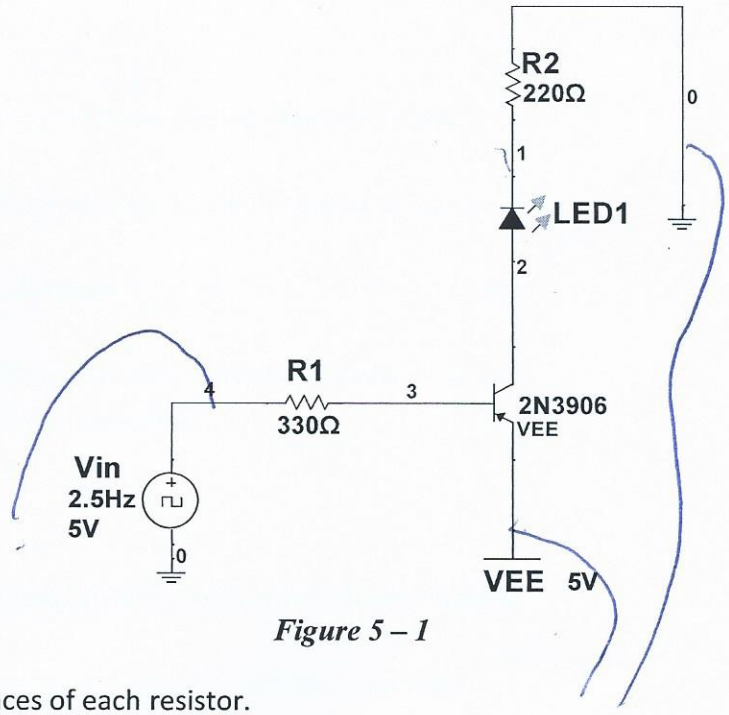

Figure 5 – 1

Procedure

1. Using the multimeter, measure the resistances of each resistor.

   R_1 = 324.4 Ω R_2 = 227.6 Ω

2. Measure the forward voltage of the LED using the multimeter (Diode button). Polarity matters! V_F = _____

3. Construct the circuit shown in ***Figure 5-1***.

4. The function generator will need to be set as a square wave with peak-peak amplitude of 5 V, frequency of 2.5 Hz, and an offset value of 2.50V. (Vin = 0 to 5 V step signal)

5. Using the appropriate settings above, it should be observed that the light turns on and off at a constant rate.

   Question 1: For how long is the LED on and for how long is the LED off?

   Question 2: Increasing the frequency slowly, at what frequency does the light appear to stay on (the LED no longer blinks)? *f* = 42. Hz

6. Turn the frequency back down to 2.5 Hz. Use *Channel 1* of the oscilloscope to measure the input waveform (Node 4) minimum and maximum voltages. Use *Channel 2* of the oscilloscope to measure the minimum and maximum voltages at the collector (Node 2).

$I_C = \frac{V_{RC}}{R_C} = \frac{V_1}{\quad}$

$I_B = \frac{V_{RB}}{R_B} = V_4 + V_3$

Take a screenshot including measurements in the following order: *Channel 1* Min, *Channel 1* Max, *Channel 2* Min, *Channel 2* Max.

Question 3: Is the LED ON or OFF when Vin is min? ON

Question 4: Is the LED ON or OFF when Vin is max? OFF.

7. Leaving Channel 2 in place, measure the voltage at Node 3 using Channel 1. Take a screenshot including measurements.
8. Leaving Channel 2 in place, measure the voltage at Node 1 using Channel 1. Take a screenshot including measurements.
9. Create ***Table 5-1*** including the voltages at V_1 through V_4 when the LED is ON and when the LED is OFF.
10. Using measured voltages, calculate I_B, I_C and I_E for the case when the circuit is ON and then when the circuit is OFF. Add these values to **Table 5-1**.

Submittal:

1. **Lab Cover Sheet** (filled in appropriately)
2. **Title Page** (Appropriate information is described in the 'Format of a Technical Report' found on Blackboard)
3. **OBJECTIVE** – This section is in paragraph form comprised of complete sentences stating the purposes for doing the experiment. (What theory was this experiment supposed to verify?)
4. **DATA** section including:
    a. **Circuit**
    b. **Any measured quantities taken in the course of completing this experiment.**
    c. **Screenshots (3)**
    d. **Table 5-1**
    e. **Calculations (6)** of each current: I_B, I_C and I_E for ON and OFF conditions.
    f. **Answers to Questions 1 - 4 in Steps 5 and 6**.
5. **DISCUSSION** – be sure to discuss when the circuit is switched ON and OFF in relation to the value of the input voltage. Also include discussion on when saturation and cutoff are occurring

    Hint: For a successful submittal, make sure your submittal components are presented in the above order. This makes organized and logical sense for an explanation of data. Be sure headings are stated (for example: **DATA**) and all components of the **DATA** section (for example: **TABLE 5-1, CURRENT CALCULATIONS**) are labeled.

BONUS: Simulate an NPN equivalent of this circuit. Use a 4-channel oscilloscope to show all the node voltages at once. Discuss the ON / OFF (saturation/cutoff) conditions of this circuit. (10 percentage points)