EE 316: Electrical Circuits and Electronic Design Laboratory.

Lab 09

Characteristics of a Bipolar Junction Transistor.

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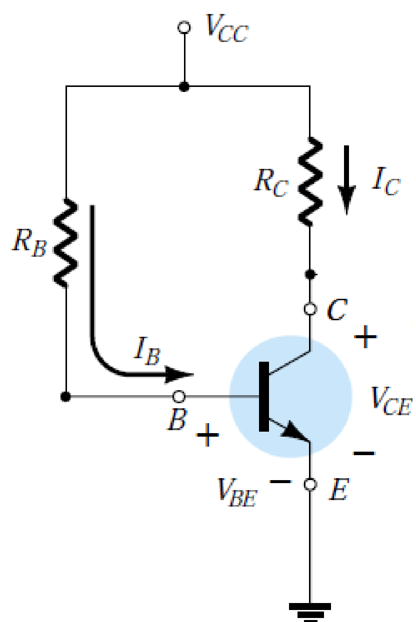
Date of Experiment: 10/24/22.

INTRODUCTION:

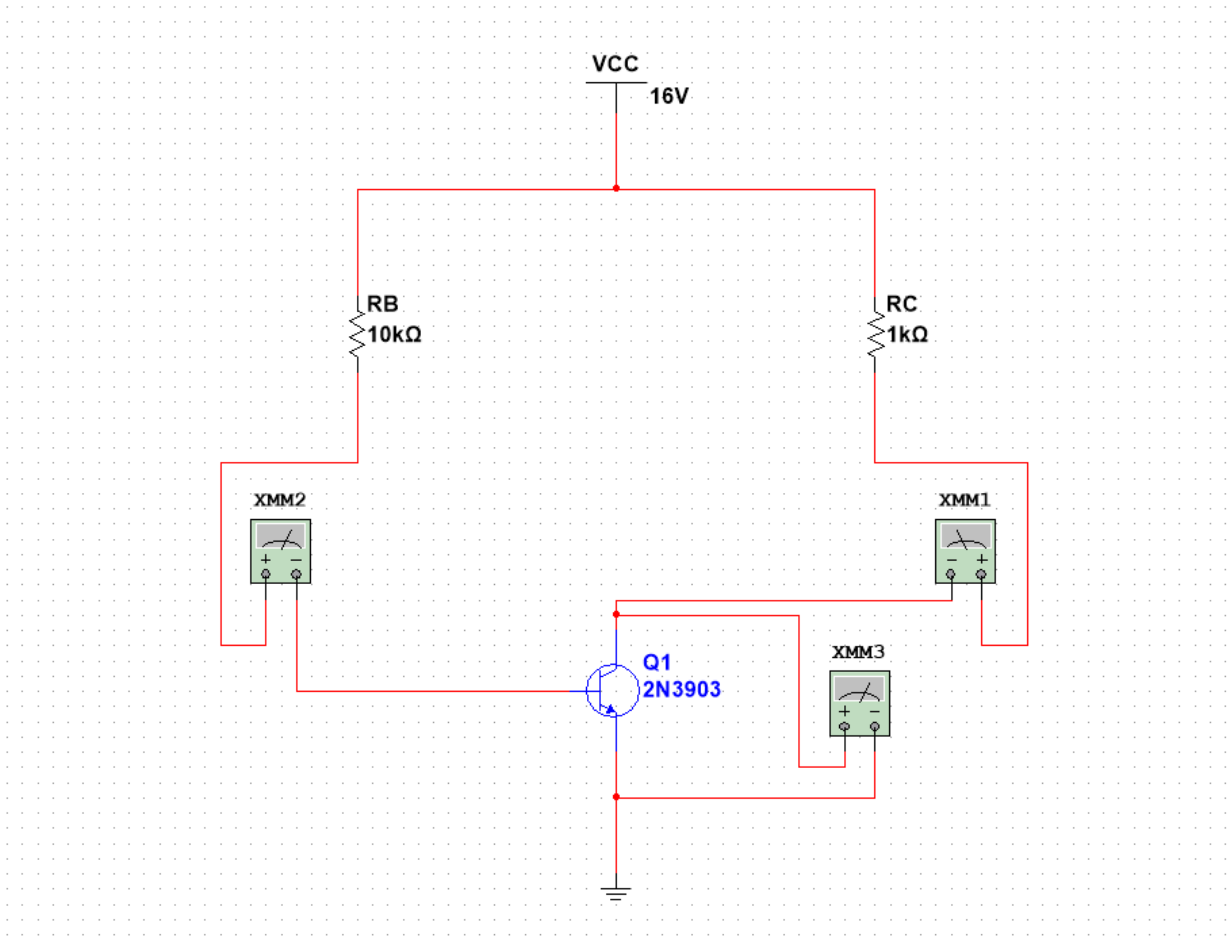
The goal of this lab was to introduce the concept of Bipolar Junction Transistors or BJTs in short. BJTs are components of MOSFETS which are comprised of a collector region, a base region, and an emitter region. We used the 2N3903 or 2N3904 BJTs for this laboratory. When current is allowed to flow through the collector and the emitter and the base is affected by that flow, the base can be referred to as the channel. In this laboratory, we used the 2N3903/04 to design a BJT circuit both digitally and using hardware.

EXPERIMENTATION:

The first part of the lab was to design and simulate the circuit shown below:

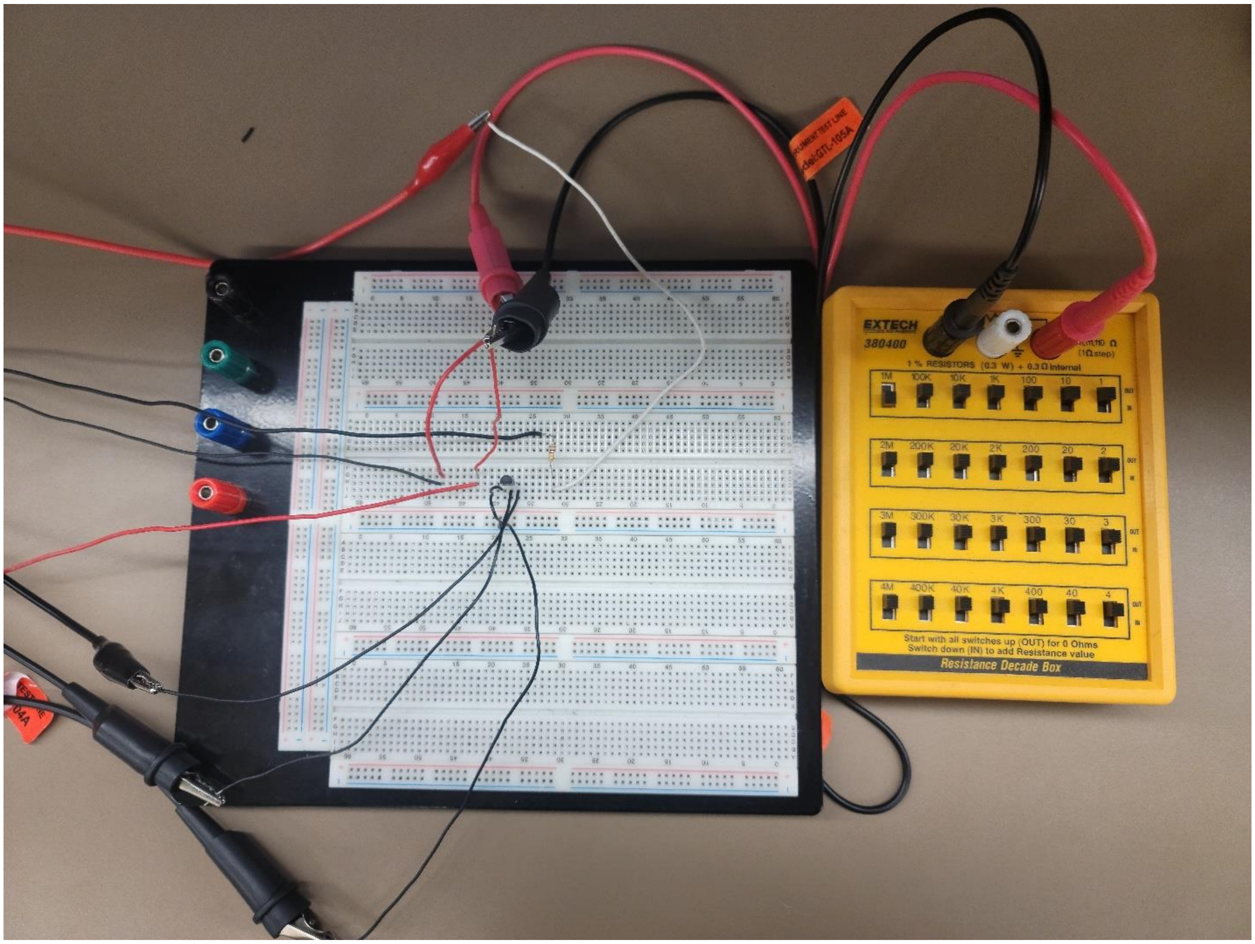


The circuit was completed in Multisim as shown:



R_B values were provided as 10KΩ, 50KΩ, 100KΩ, 150KΩ, 200KΩ and 300KΩ for analysis, R_C was set at 1KΩ and V_{cc} was 16V.

The analytical results from the digital simulation are included in the table further below. The hardware setup for the laboratory was completed as below:



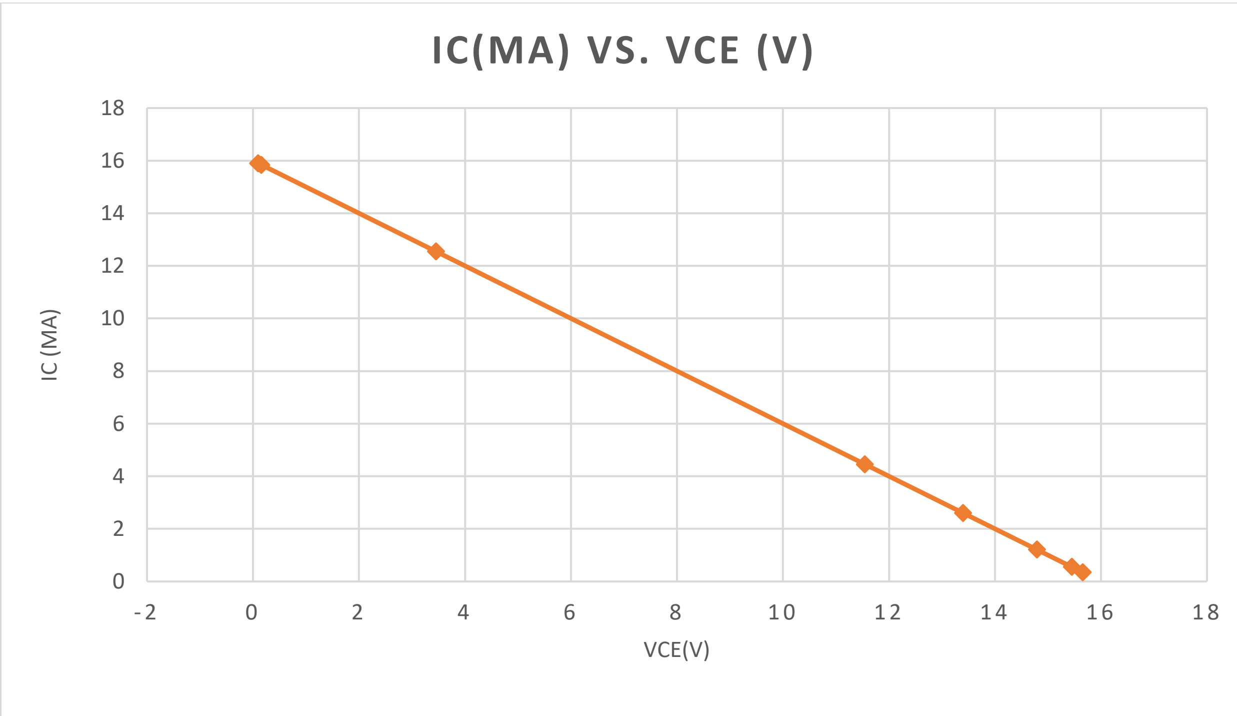
The table below shows the Output Characteristics results for both the simulation and experimental analyses.

Table 7.1

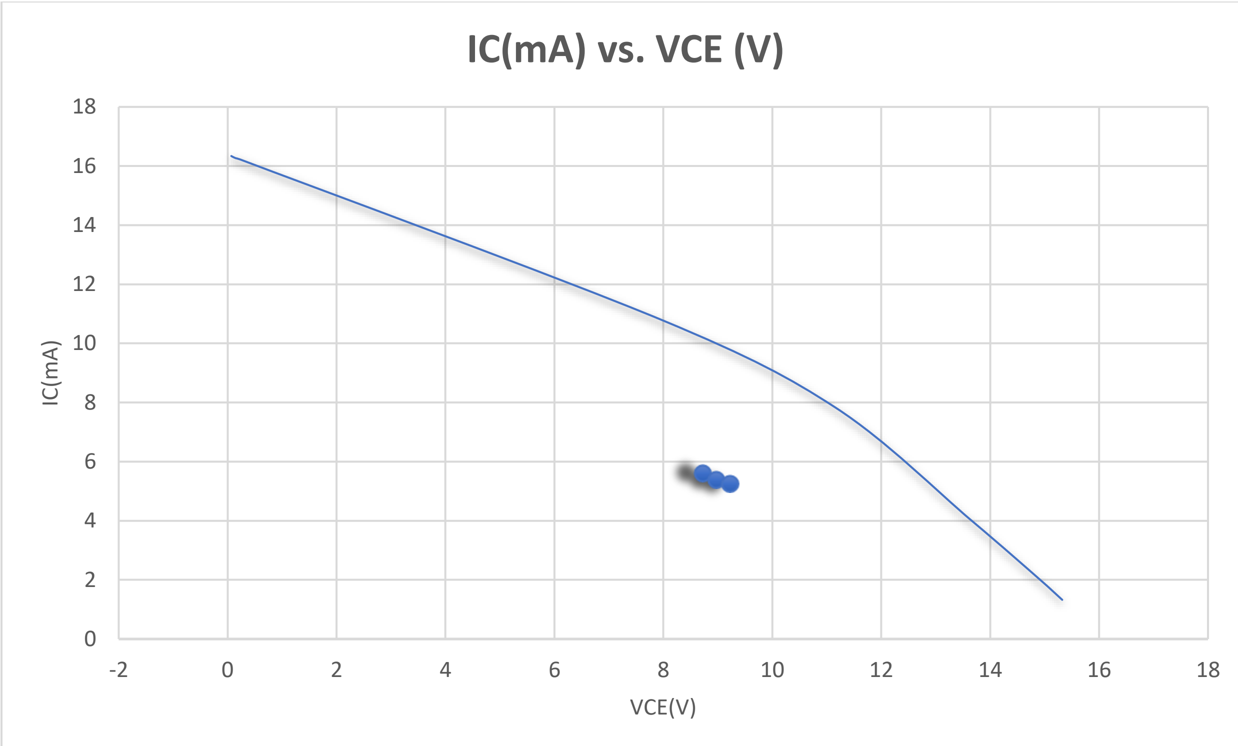
	Multisim Results				**Experimental Results**			
R_B	**I_B (uA)**	**I_C (mA)**	**I_E (mA)**	**V_{CE} (V)**	**I_B (mA)**	**I_C (mA)**	**I_E (mA)**	**V_{CE} (V)**
10KΩ	**1.529**	**15.903**	**17.432**	**0.097**	**1.538**	**16.338**	**17.876**	**0.0667**
50KΩ	**0.307**	**15.841**	**16.148**	**0.159**	**0.307**	**16.266**	**16.573**	**0.1467**
100KΩ	**0.153**	**12.544**	**12.697**	**3.456**	**0.153**	**16.221**	**16.374**	**0.2326**
300KΩ	**0.051**	**4.457**	**4.508**	**11.543**	**0.044**	**10.783**	**10.827**	**7.983**
500KΩ	**0.031**	**2.6**	**2.631**	**13.4**	**0.031**	**7.832**	**7.863**	**11.158**
1MΩ	**0.015**	**1.21**	**1.225**	**14.79**	**0.015**	**4.013**	**4.028**	**13.654**
2MΩ	**0.008**	**0.551**	**0.559**	**15.449**	**0.008**	**2.011**	**2.019**	**14.913**
3MΩ	**0.005**	**0.345**	**0.350**	**15.655**	**0.004**	**1.325**	**1.329**	**15.324**

In the table above, I_E was calculated using KCL, where $I_E = I_C + I_B$. The Output Charateristic Curves for both the Multisim and Experimental results are shown below:

Multisim data Output Characteristic:



Experimental data Output Characteristic.



In the experimental analysis, the Q-point region is at around 7.9V, , while in the Multisim analysis, the Q-Point is approximately at 11.5V, and the saturation region is just under 16mA.

CONCLUSION:

Both the digital and hardware circuits seem to yield the same pattern of results that we can expect from a BJT. The Q-point is determined by selecting a mid-point that allows for amplifying the signal within bounds.