TITLE: ON TRANSIENTS AND SEMICONDUCTORS IN A DC CIRCUIT idk

Abstract: Electrical components such as capacitors, diodes, and transistors, are the basis for all modern electronics; their inventions paving the way for smaller and cheaper circuitry in radios, televisions, and computers.

This paper characterizes the properties of these components as measured by a variety of experiments over multiple circuits, and compares the observed values with those supplied by the manufacturers. Low error percentages were observed, verifying the manufacturers’ reports. The function V(t) =1.446\*(1-exp(-t/19.707)) was found to model the mechanisms of a capacitor. Further analysis was performed with a transient current, and the function I=(6+-1)E-10\*(e((24.6pm.4)V)) was found to fit the I-V curve observed in the diode with r2=0.98. A piecewise function was also created to approximate the transistor I\_c vs V\_ce curves.

Theory:

In this section we will address the accepted principles and theories used in our circuit analysis. The wires in the circuits are assumed to be ideal conductors, which allows us to give reasonable estimates of the current, resistance, or voltage in a circuit.

The Ohm’s law is used to find the current, voltage, or resistance across an ideal conductor. The general form is:

Where

V= Potential Difference (V)

I=Current(A)

R=Resistance()

From the equation above, it is possible to derive an equation for capacitors:

Where:

I=Instantaneous current through the capacitor(I)

C= Capacitance(F)

dV/dt = Instantaneous rate of voltage change(Vs-1)

Kirchhoff’s Current Law is used to compute current through the analysis of all other currents flowing into the same junction.

KCL:

Ik= The kth current flowing towards or away from the junction

Kirchhoff’s Voltage Law is used to solve the voltage drop at any particular point through the analysis of voltage drops across other every element in a closed path in a circuit.

KVL:

Where:

Vk = The kth voltage drop in around the loop

To obtain the value for the base current of a transistor, the following equation is used:

Where:

Collector current (A)

= Gain/Amplification Factor

= Base current(A)

Shockley’s Ideal Diode Equation is used to relate the diode voltage and the diode current in a p-n junction diode. Note that the ideality factor equals to 1 in the circuits constructed as the semiconductor used is Germanium

Where

ID = Current of diode(A)

IS= Reverse bias saturation current(A)

q= Charge of electron(C)

VD = Voltage of diode(V)

n= Ideality factor: n = 1 for indirect semiconductors

n = 2 for direct semiconductors

k= Boltzmann’s constant

T=Temperature(K)

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Method:

Circuit 1:

2:

3:

Analysis:

**For all circuits: Your report must indicate if your research confirms or challenges the accepted situation and why you think this is so.**

1. RC Circuit (Mandy)
   1. In addition, the capacitor when nearing full charge will behave like a very large resistance. These phenomena will cause your voltmeter to give erroneous readings when in parallel to the capacitor. Part of your methodology will be to devise a work around to this issue and explain it in your paper.
   2. You are expected to discuss the symmetry or lack thereof of the RC Profiles (idk what this means)
2. PN Junction Diode (Julien)
3. Transistors (Jeffrey, Ayon)

Obtain a simple NPN or PNP transistor with known properties from the manufacturer. These specifications can usually be obtained via the Internet if the manufacturer and model number of the transistor are known. You are to select a transistor with an hfe ~ 100 -- 200. Do NOT select a MOSFET or other such switching transistor for this experiment. Effect a basic reading on the function and operation of such a transistor. Perform an experiment of your own design that will measure the amplification curves of your transistor for 4 different base currents. This is a plot of ic versus VCE. You should develop your learned theory so that you can compare it to your observations. (i.e. O – C residuals or other such verification method).

Thevenin and Norton Methods for solving the circuit

Method:

The data for experiment two was collected through the analysis of three separate circuits. The first circuit consisted of the variable power source, the resistor, as well as the PN Junction diode. However, it was concluded that the power source dial was too erratic to take consistent measurements from 0V to 1V.

As such, this prompted the creation of a second circuit, with two resistors in series, and a resistor and PN Diode connected in parallel with the second resistor. This created the effect of a voltage divider: if the ratio between the two resistors was 1:10, theoretically, for every 1V jump in the power source, there would only be a 0.1V jump in the voltage running through the diode, which was acceptable. However, the change in voltage decreased as the power source voltage increased, meaning at 10V, only 0.6V was running through the diode. Thus, a 1:3 ratio was maintained, which created a 1:10 ratio split as voltage was increased. This was acceptable, as seen through the data collected: there is little to no change in current from 0V to 0.1V.

Finally, to measure the leakage current, a transistor was integrated into the circuit. As such, the current, that would originally be in undetectable nanoamps, could be amplified into the range of the multimeter. The value of the current was then adjusted according to the h\_{fe} value measured by a multimeter.

As three ranges of the voltage were found using three different circuits, precautions were taken to minimize the discrepancies between the data sets. The same resistors and equipment were used, each resistor was re-evaluated using the multimeter at the beginning of each lab period, and each experiment was performed in quick succession after the other, the longest delay being no longer than one day. 22h:43m:33s:50ms:158mu s:832ns

SOURCES: <http://www.soloelectronica.net/PDF/BC635.pdf>

Citation:

Halliday, D., Resnick, R., & Walker, J. *Fundamental of Physics*. 2001.

Hirsch, Alan J. *Nelson Physics 11*. 2002.

Kuphaldt, Tony R. *Lesson in Electric Circuits: an Encyclopedic Text & Reference Guide*. 2011.

Makarov, Sergej N., et al. “Practical Electrical Engineering.” 2016.

3. Vbe is constant when Vce>0

* Vbc = Vbe-Vce

Vb-ibrb-vbe=0

vcc-vce-icrc=0

ic=vcc-vce/rc