Introduction: Electrical engineering is a vast and interesting field. The foundations of this field where established by engineers, scientists, and mathematicians like Coulomb, Faraday, Henry, Hertz, Maxwell, to name a very select few.

1. List three branches of electrical engineering (five are mentioned in the text, but there are far more).

2. There are three major assumptions made regarding the circuit analysis in this class. In your own words, list all three assumptions. (Can you think of systems where these assumptions may not apply?)

3. All of electromagnetism, which is the foundation of circuit theory, is rooted in the physics of electric charges. There are three fundamental properties of electric charge. In your own words, state the three properties.

Units: The International System of Units (SI) have a total of seven defined quantities, which are (a) the meter (m) for length, (b) the kilogram (kg) for mass, (c) the second (s) for time, (d) the ampere (A) for electric current, (e) the degree Kelvin (K) for thermodynamic temperature, (f) the mole (mol) for the amount of substance, and (g) the candela (cad) for luminous intensity. All other quantities are derived quantities whose units can be rewritten as a combination of the above defined quantities. For each of the quantities given below, rewrite their units in terms of the units of the defined quantities.

Quantity	Unit	Formula
Electric charge	Coulomb (C)	
Energy or Work	Joule (J)	
Voltage	Volt (V)	
Power	Watt (W)	
Electric Resistance	Ohm	
Electric Capacitance	Farad (F)	
Magnetic Flux	Weber (Wb)	
Inductance	Henry (H)	
Frequency	Hertz (Hz)	

Circuit Variables: It is fair and accurate to say that all electrical phenomenon can be attributed to two things: (1) the separation of electrical charges, and (2) the movement of electrical charges. Each of these leads to an electrical parameter of interest. The first of the two is called the "voltage" while the second is called the "current".

1. *Voltage*: Give the mathematical definition of voltage, in terms of work and charge. This should be expressed in the language of calculus, i.e. in terms of derivatives. Explain the concept of a voltage to the person next to you.

2. *Current*: Give the mathematical definition of current, in terms of charges and time. This should be expressed in the language of calculus, i.e. in terms of derivatives. Explain the concept of a current to the person next to you.

Numerical Problems: Circuit Variables

1. There is no charge at the left terminal of the element shown in Figure 1. below for $t < 0\ s$. At $t = 0\ s$ a current of $500e^{-100t}\ mA$ enters the left terminal.

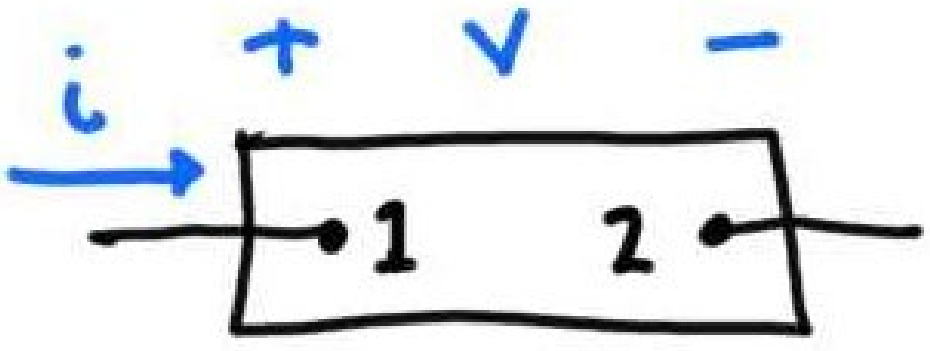

Figure 1.

(a) Derive an expression for the charge that accumulates at the left terminal for $t > 0\ s$.
(b) Find the total charge that accumulates at the left terminal.
(c) If the current is stopped at $t = 2\ ms$, how much charge has accumulated at the left terminal?

2. How much energy is imparted to an 10^6 electrons as they are accelerated through a 1.5V battery from the positive terminal to the negative terminal? Express your answer in mJ.