EECS 42 – Introduction to Electronics for Computer Science

Spring 2003, **Prof. A. R. Neureuther**
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Problem Set # 3 Due 2:30 PM Feb 12th, 240 Cory

Reading: Section 5.1, 2.2, 3.1-3.4 Schwarz and Oldham. 4th week 8.1 and Handout

3.1 Capacitance. An airplane has a capacitance to the clouds around it of 1 mF = 0.001F. It flies through a thunderstorm at 900 km/hr picking up 10^{17} electrons per meter. It was uncharged before entering the storm.

Note: Airplanes have thin wires with points that continuously discharge the plane. The values in this problem are just guesses.

a) Find the charge on the plane as a function of time.
b) Find voltage on the plane as a function of time.
c) If lightning strikes when the potential of the airplane reaches 100KV, find the distance it will go into the thunderstorm before lightning strikes?
d) If the lightning strike discharges the plane find the energy that is released.

3.2 Capacitance and voltage versus time. A 1 pF capacitance from a 1 cm wire on a PC board is charged by a current of 1 μA for 2 μs. At 2 μs the current increases to 2 μA for an additional 2 μs. At 4 μs the current reverses to – 4 μA. Now the answers will be between 0 and 10V.

a) Find the voltage versus time from 0 to 6 μs.
b) Find the energy supplied during the interval 0 to 2 μs.
c) Find the energy supplied during the interval 2 to 4 μs.
d) Explain why is c) not proportional to the square of the change in voltage?

3.3 Equivalent Circuits. Consider the circuit in Fig. P3.3.

I_{SS} = 1mA, R_1 = 1kΩ, R_2 = 2kΩ, R_3 = 3 kΩ

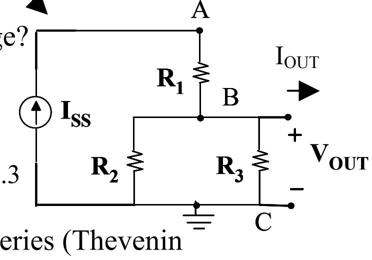

Fig. P3.3

a) Assume V_{OUT} = 1.2V, 0.6V and 0V are caused by three different external loads. Find the corresponding current I_{OUT}.
b) Which of the above values were the easiest to find?
c) Sketch I_{OUT} versus V_{OUT} from your data.
d) Use your graphical results to find a voltage supply and one resistor in series (Thevenin equivalent) that could be used to replace the three resistors and current source.
e) Show that $R_T = -V_{OC}/I_{SC}$.
f) What combination of R_1, R_2 and R_3 gives R_T? Verify that turning the current source to zero and evaluating the resistance looking into the output gives this same result.

3.4 Equivalent Circuits and Ideal Supplies. Consider the circuit in Fig. P3.4.

V_{AA} = 1V, I_{SS} =1mA, R_1 =1kΩ, R_2 = 2kΩ

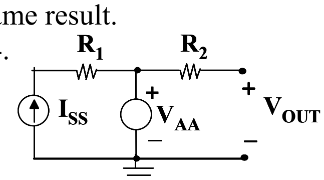

Fig. P3.4

a) Find V_{OC}.
b) Find I_{SC}.
c) Find the Norton equivalent circuit.
d) Find the voltage on the current source when I_{OUT} = 0.
e) Find the current through the voltage source when V_{OUT} = 0.

3.5 Nonlinear Load and Power. Use a graphical method to find the solution for the following loads when attached to V_{OUT} in Fig. P3.3. (No algebra please. Accuracy to 5% is fine. Use your graph from Problem 3.3.)

a) Find V_{OUT} and I_{OUT} **and then the power into the load** when the load is a 4kΩ resistor.
b) Find V_{OUT} and I_{OUT} **and then the power into the load** when the load has
$I_{LOAD} = 1\ (mA/V^2)(V_{OUT})^2$.
c) Find V_{OUT} and I_{OUT} **and then the power into the load** when the load has
$I_{LOAD} = -2\ mA + 1\ (mA/V^2)(V_{OUT})^2$.