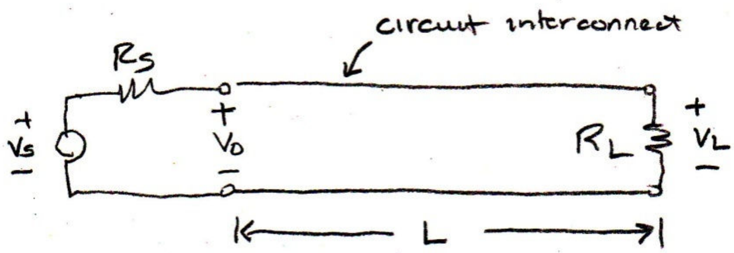
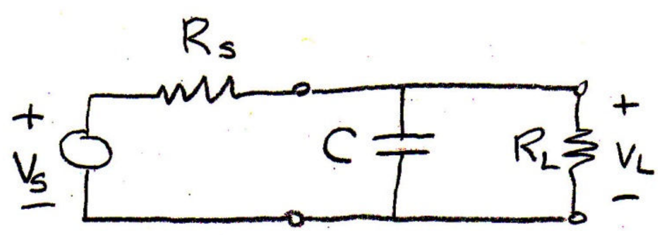
ELEC 353 – Assignment #1

Note: In ELEC353, assignments are not handed in. Do the assignments week-by-week and then evaluate your work in comparison to the solution.

1. What is an "ideal" short circuit?



2. In the circuit shown above, V_s and R_s are the Thevenin equivalent circuit for the output of a logic chip. The output of the chip is connected to a load R_L with a circuit interconnect of length L. The load represents the input of another logic chip. The source is step-function generator that steps up from 0 volts to $V_s = 10$ volts at $t = 0$, and has internal resistance $R_s = 30$ ohms. The load resistor is $R_L = 1000$ ohms. Find the voltage across the generator terminals $v_0(t)$ and across the load terminals $v_L(t)$. Treat the circuit interconnect as an *ideal short circuit*. Plot the voltage at the source terminals and at the load terminals as a function of time. This problem is trivially simple and represents the "ideal" behavior of a circuit interconnect.
3. The connection from the generator to the load resistor actually behaves a "transmission line" having inductance-per-unit length ℓ H/m and capacitance-per-unit-length c F/m. The speed-of-travel of voltages on the transmission line is $u = \dfrac{1}{\sqrt{\ell c}} = 20$ cm/ns. The "characteristic resistance" is $R_c = \sqrt{\dfrac{\ell}{c}} = 50$ ohms. (This will be explained in the next few lectures of the course.) Find the value of the inductance-per-unit-length ℓ and the capacitance-per-unit-length c of the transmission line.



4. The length of the transmission line is $L = 5$ cm. What is value of the capacitance of the transmission line, C? When the step-function generator switches on, the capacitor charges exponentially, starting at zero volts. What is the time constant? Use circuit analysis to find the voltage across the load, $v_L(t)$. Plot $v_L(t)$ as a

function of time for a time interval of five time constants. The values of V_s, R_s and R_L are given in problem 2. What is the "final value" of the load voltage?

5. Suppose that the "step function" generator represents a logic signal with a "rise time" of 0.1 ns. Using the "rule-of-thumb" in the class notes, for what transmission line lengths L can lumped circuit analysis be used? For what lengths L must distributed circuit analysis be used? In which range does L=5 cm fall?
6. Download the BOUNCE program from the course web site. Use BOUNCE to model the circuit shown above. Then use BOUNCE to graph the voltage across the load resistor R_L as a function of time for: (i) $L = 1$ mm; (ii) $L = 1$ cm; (iii) $L = 5$ cm; and $L = 10$ cm. For what lengths L is the load voltage approximately a copy of the source voltage V_s? For what lengths L is the output significantly different from the input?
   Hint: you can find instructions for running BOUNCE in the class notes, set #2.