University of California, San Diego
Department of Electrical and Computer Engineering

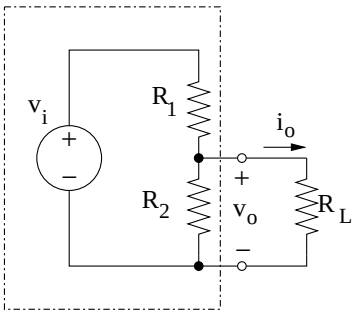
ECE65, Fall 2010

Lab 1, Introduction to PSPICE Simulations

Note: Each student has to turn in this assignment (treat this as a homework, do not use the lab report format).
Attach the simulation circuit and all simulation results to your work.

Problem 1: Voltage Divider (Bias Point, DC Sweep, Parametric sweep, plotting)

In many occasions we need to bias the circuit components with a voltage that is different than the power supply voltage. Other times we need to feed back a signal proportional to the output signal of one part of the circuit to another part. The voltage divider circuit below (circuit in the "box") is the simplest circuit that does these functions and, therefore, is used extensively in the electronic circuits.



1) Calculate the Thevenin equivalent circuit of the voltage divider (the "box). Use the Thevenin equivalent circuit to find v_o and i_o in terms of v_T, R_T and R_L. Prove that for $R_L \gg R_T$, $v_o = v_T$.

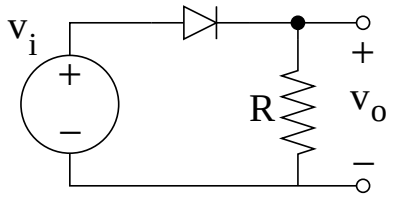
2) Use PSpice to simulate the above circuit with $R_1 = 2$ kΩ, $R_2 = 2$ kΩ, $R_L = 100$ kΩ, and $v_i = 6$ V. Use "Bias Point Details" option to find the value of v_o and i_o (attach the circuit with bias-point details).

3) Use PSPICE to simulate the above circuit with $R_1 = 2$ kΩ, $R_2 = 2$ kΩ, and $R_L = 100$ kΩ. Use DC SWEEP to generate a plot of v_o as a function of v_i for v_i ranging from 0 to +10 V. Does it match the expression from part 1 (Hint: Note $R_L \gg R_T$)?

4) Use PSPICE to simulate the above circuit with $R_1 = 2$ kΩ and $R_2 = 2$ kΩ, and $v_i = 6$ V. Use parametric SWEEP to generate a plot of v_o/v_i as a function of R_L for R_L ranging from 0 to 100 kΩ (choose the increment in R_L such that you have a meaningful plot, *i.e.,* the curve looks nice and smooth). Does it match your expectations (consider cases of $R_L \to 0, R_L \to \infty$, and $R_L = R_T$)?

5) Use the simulation in part 4 above and plot i_o (current in R_L) versus v_o. Does it match your expectations (consider cases of $R_L \to 0, R_L \to \infty$, and $R_L = R_T$)?

Problem 2: Rectifier Circuit (Time-dependent analysis, plotting)

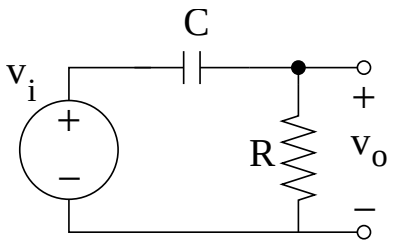


Simulate the circuit above with a sinusoidal source (v_i) with a period of 20 ms, an amplitude of 5 V, and zero DC offset. Diode is a 1N4148 general purpose diode and $R = 1$ kΩ.

1) Plot v_o and v_i as a function of time for two periods (both traces on the same plot!).

2) Plot $v_o + v_D$ as a function of time for two periods. Compare to v_i in part 1 (explain).

Problem 3: RC circuit (VPULSE function, time-dependent analysis, plotting)



Simulate the circuit above with $R = 1$ kΩ and v_i being a square wave function with a frequency of 500 Hz, a peak to peak amplitude of 6 V, and zero DC bias (i.e., v_i switches between -3 and 3 V).

1) Plot v_o and v_i as a function of time for two periods (both traces on the same plot!) for C = 100 nF, 1 μF, and 10 μF.

2) Repeat part 1 for v_i having a peak to peak amplitude of 10 V, and zero DC bias.

3) Compute the time constant, $\tau = RC$, of the three circuits (*i.e.,* 3 different values of capacitor) and compare them to the half-period of the input voltage. What do you conclude from the above two simulations?

Note: For this problem you may need either to run the simulation long enough so that the v_o has reached steady state (i.e., it is identical between the two period that you are plotting) or instruct PSpice to ignore initial transients.