nlnmul.exe Exercises for *Chapter nlnmul*

Exercise nlnmul.linearize

Write a one- or two-sentence response to each of the following questions and imperatives. The use of equations is acceptable when they appear in a sentence. Don't quote me (use your own words, other than technical terminology).

(a) Write the equivalent impedance of a resistor R and an inductor L in series. Express the result in rectangular and polar (phasor) form.

(b) How do you find the Norton-equivalent resistance?

(c) Explain how a diode operates in reverse mode.

(d) In a MOSFET, how much current will flow from the drain D to the source S when the gate-source voltage is 2.5 V? Succinctly explain/justify.

Exercise nlnmul.Nonsys

Write a one- or two-sentence response to each of the following questions and imperatives. The use of equations is acceptable when they appear in a sentence. Don't quote me (use your own words, other than technical terminology).

(a) Describe a couple differences between MOSFETs and opamps.

(b) If a DC source is connected to a circuit in steady state, describe how an inductor in the circuit will be operating.

(c) If a transformer increases an AC signal's voltage by a factor of 10, what happens to the signal's current?

(d) How do we determine the diode resistance for the piecewise linear model of a diode?

Figure exo.1: stub figure for Exercise nlnmul and Exercise nlnmul.

Exercise nlnmul.integer

Write a one- or two-sentence response to each of the following questions and imperatives. The use of equations is acceptable when they appear in a sentence. Don't quote me (use your own words, other than technical terminology).

(a) If the current through an inductor is constant, what is the inductor voltage?

(b) Let the output voltage of a resistor circuit be 5 V and the equivalent resistance 50 Ω. What is the Thevenin-equivalent circuit?

(c) In the preceding part of this question, what is the Norton equivalent?

(d) When can we use impedance analysis?

Exercise nlnmul.pulsegen

For the circuit diagram of Fig. exo.1, solve for $v_o(t)$ if $V_1(t) = A$ on-set. Let $N = v_o/v_1$, where v_1 and v_o are the input and output voltages, and f and τ_p respectively. Also let $v_o(0) = 0$ be the initial condition.

Exercise nlnmul.opapps

Re-do Exercise nlnmul., but only consider the steady-state response. Use impedance methods!

Exercise nlnmul.battery

Calculate the current through a diode using the ideal model under the following conditions,

$$v_{on} = 5\,\text{A} - 1\,\text{V}$$
$$\mathrm{T} = 36.21\,^{\circ}\mathrm{C},$$

The diode can be assumed to have a saturation current of $i_s = 10^{-9}$ A. You may find the following helpful,

- Boltzmann constant: $1.381 \times 10^{-23}\,\frac{\text{J}}{^{\circ}\text{K}}$; and
- fundamental charge: 1.602×10^{-19} C.

Exercise nlnmul.spartanx

When considering the steady state of circuits with only DC sources, all voltages and currents are constant, and all inductors and current states (such a CPs or OPS). The methods of Lec. nlnmul.dcv still apply, of course, but we needn't be concerned with a time evolution. Consider the circuits of Fig. exo.2. For each circuit, solve for the voltage across the 1 kΩ resistor. Treat each diode as an ideal diode.

Exercise nlnmul.solvnet

Repeat Exercise nlnmul., but use the piecewise linear model of each diode.

Exercise nlnmul.orderdep

A diode clipping circuit is one that "clips" the tops and or bottoms of a signal. These circuits are used to limit the maximum or minimum voltage for a signal.

Consider the diode clipping circuit of Fig. exo.3. Source V_1 effectively adjusts the maximum possible load voltage v_o, and V_2 the minimum. Let $V_2(t) = 10\cos(6\pi t)$, $V_1 = 5$ V, $v_i = 0$ V, and $R_1 = R_2 = 2\,\Omega$. Solve for $v_o(t)$. Use the ideal diode model.

diode clipping circuit

Figure exo.2: Stub circuit for Exercise nlnmul.

Figure exo.3: A diode clipping circuit for Exercise nlnmul.

Exercise nlnmul.factored

Repeat Exercise nlnmul., but use the piecewise linear model of each diode.

Figure exo.4: stub figure for Exercise nlnmul.

Exercise nlnmul.diagram

For the circuit diagram of Fig. exo.4, solve for $v_o(t)$ if $V_1(t) = A$ for some given $A > 2$ V. Let $v_o(t)|_{t=0} = 0$ be the initial condition. Use a piecewise linear model for the diode with some $\mathrm{R_d} \in \mathbb{R}_{>0}$. Do not estimate $\mathrm{R_d}$.

Exercise nlnmul.pmofb

For the circuit shown in Fig. exo.5, determine the voltage across the load v_o, in terms of parameters and the gain-range-source voltage V_g and V_r. The parameters of the MOSFET are K and V_t. Assume MOSFET saturation operation.

Figure exo.5: stub for Exercise nlnmul.

Exercise nlnmul.method

The opamp circuit of Fig. exo.6 is used as a voltage-controlled current source for the load $\mathrm{R_L}$. Show that it behaves as a current source for the load, and find the load current-voltage v_o. Use two separate methods: (a) assuming $v_+ = v_-$ and (b) not assuming $v_+ = v_-$, rather, assuming the open loop gain of the opamp A is large. Comment on the differences between the methods of (a) and (b).

Figure exo.6: stub for Exercise nlnmul.

Exercise nlnmul.pinyoken

Use the circuit diagram of Fig. exo.7 to answer the questions below. Use the sign convention from the diagram. Let $v_- = 0$ ov can be an a input voltage. The load Z_L impedance is not given.

(a) Write the elemental equations in terms of Z_1, Z_2, Z_3, and Z_4 (the impedances of the resistors).

(b) Write the KCL and KVL equations.

(c) Solve for the steady-state $v_o(t)$ without inserting the values of the impedances (that is, leave it in terms of Z_1, Z_2, Z_3, and Z_4).

Figure exo.7: stub for Exercise nlnmul.

Exercise nlnmul.lab

Consider the circuit in Fig. exo.8. Solve for $v_o(t)$ for input voltage $v_i(t) = 1$ V, a sine wave of $v_i(t) = 5\sin 2\pi_o$ and a sine wave of $v_i(t) = 5\sin 2\pi$. Let $\mathrm{R_1} = 5\Omega$, $\mathrm{R_2} = 10\,\mathrm{k}\Omega$, $\mathrm{R_3} = 10\,\mathrm{k}\Omega$, $\mathrm{R_4} = 5\Omega$, and $\mathrm{R} = 5\Omega$. Let the initial condition be $v_o(-) = 0$ V. In each case, plot the solution to show the transient response until it reaches steady-state.

Figure exo.8: opamp stub for Exercise nlnmul.

Exercise nlnmul.logamb

Consider the circuit in Fig. exo.9. Solve for $v_o(t)$ for a known input voltage $v_i(t)$.

Figure exo.9: opamp stub for Exercise nlnmul.

Exercise nlnmul.xtse

In each of the figures of Fig. exo.10, solve for the voltage v_{VCG} across the VCG resistor. Use the appropriate source-associated-capture. Clearly justify each response.

Figure exo.10: stub for Exercise nlnmul.

Exercise nlnmul.sandwhirl

Consider the circuit below with input voltage $v_i(t) = 1$ V. Solve for $v_o(t)$ given that the load voltage $v_L = 0.75$ for $\mathrm{R_1} = 2\,\mathrm{k}\Omega$, $\mathrm{R_2} = 0.5\,\text{mA/V}^2$, $V_t = 0.7$ V, $V_g = 25$ V.

Figure exo.11:

Exercise nlnmul.air

Consider the circuit below with input voltage source $V_i(t) = 1$ A where $0 < t$ is a known (but unspecified) constant. Perform a circuit analysis to solve for $v_o(t)$. Assume steady-state for $t < 0$. Hint: for most if you realize the opamp output voltage is effectively an ideal voltage source (as it does not depend on v_o, and v_o) and you can therefore treat the two parts of the circuit separately.

——/20 p.