

nlmmul.exe Exercises for Chapter nlmmul

Exercice nlmmul00000

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 forward-bias.
- (d) In a MOSFET, how much current will flow from the drain D to the source S when the gate-source voltage is 0.3 V ? Succinctly explain/justify.

Exercice nlmmul00001

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?

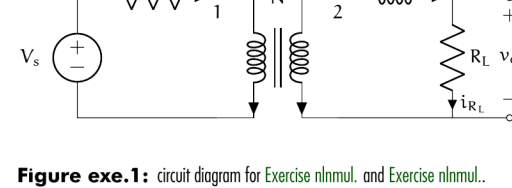


Figure exo.1: circuit diagram for Exercise nlmmul00001 and Exercise nlmmul00002.

Exercice nlmmul00002

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 suddenly switched off, what happens?
- (b) Let the output voltage of a resistor circuit be 5 V and the equivalent resistance 50Ω . What is the Thévenin equivalent circuit?
- (c) In the preceding part of this question, what is the Norton equivalent?
- (d) When can we use impedance analysis?

Exercice nlmmul00003

For the circuit diagram of Fig. exo.1, solve for $v_o(t)$ if $V_s(t) = A \cos \omega t$. Let $N = n_2/n_1$, where n_1 and n_2 are the number of turns in each coil, 1 and 2, respectively. Also let $i_1(0) = 0$ be the initial condition.

Exercice nlmmul00004

Reads Exercise nlmmul00001, but only consider the steady-state response. Use impedance methods!

Exercice nlmmul00005

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

- $v_D = 5.8 \text{ V}$
- $T = 38.21, 28^\circ \text{C}$.

The diode can be assumed to have a saturation current of $I_s = 10^{-12} \text{ A}$. You may find the following helpful:

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

Exercice nlmmul00006

When considering the steady state of circuits with only DC sources, all voltages and currents are constant and all diodes are in constant states (each is ON or OFF). The methods of Lec. nlmmul00001 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 $5 \text{ k}\Omega$ resistor. Treat each diode as an ideal diode.

Exercice nlmmul00007

Repeat Exercise nlmmul00006, but use the piecewise linear model of each diode.

Exercice nlmmul00008

A diode clipping circuit is one that "clips" the tops and/or bottoms of a signal. These circuits can be used to set a 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 $V_1(t) = 12 \cos \omega t$, $V_2 = 5 \text{ V}$, $V_3 = -3 \text{ V}$, and $R_1 = R_2 = 50 \Omega$. Solve for $v_o(t)$. Use the ideal diode model.

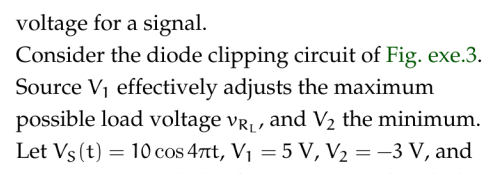


Figure exo.2: diode circuit for Exercise nlmmul00006.

Exercice nlmmul00009

Repeat Exercise nlmmul00006, but use the piecewise linear model of each diode.

Exercice nlmmul00010

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

Exercice nlmmul00011

For the circuit shown in Fig. exo.5, determine the voltage across the load v_o in terms of parameters and the gate voltage source voltage V_g and V_c . The parameters of the MOSFET are K and V_{gs} . Assume MOSFET saturation operation.

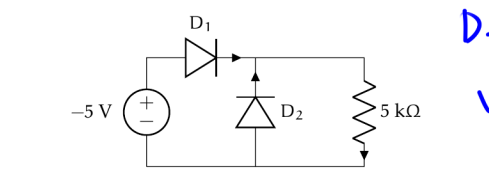


Figure exo.5: circuit diagram for Exercise nlmmul00011.

Exercice nlmmul00012

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

