Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 - Electronic Circuits
Fall 2000

Homework #4
Handout F00-024

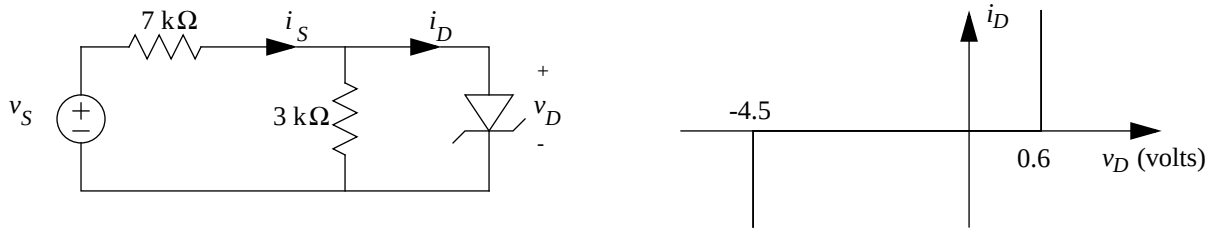
Issued 9/28/2000 - Due 10/5/2000

Read Chapter 4 except Section 4.4.

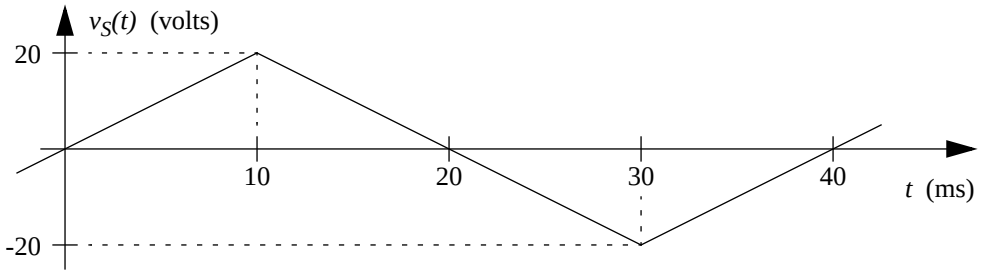
Exercise 4-1: Exercise 4.3, Chapter 4.

Exercise 4-2: Exercise 6.5, Chapter 6.

Problem 4.1: The zener diode in the circuit below has the *v*-*i* characteristic shown at the right.



a) For the input voltage v_S shown below, indicate the time regions where the diode is ON (conducting a current) and OFF (open circuit). Label the boundaries with numerical values.



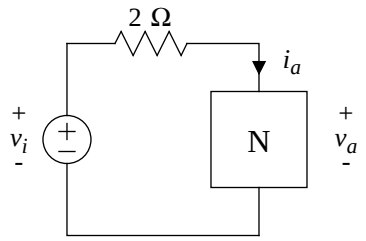
b) For the input voltage v_S shown above, sketch the diode voltage waveform, $v_D(t)$. Label all breakpoint coordinates with values and units.

c) Find the value of the current i_s for v_S = -25.5 volts.

Problem 4.2: Problem 4.3, Chapter 4. Replace the words “piecewise-linear” with “incremental” in parts c) and d), and use as the operating point $v = 3$, $i = 0$.

(over)

Problem 4.3: Consider the circuit containing a nonlinear element N as shown in Figure 4.3. The *i*-*v* relation for the element N is given by $i_a = (10A) \cdot \left(1 - e^{\frac{-v_a}{5V}}\right)$.



a) Write an equation relating the voltage v_a to the input voltage v_i.

b) Solve for the voltage v_a for v_i = 10 volts. Note: This requires that you solve the equation in part a. iteratively for v_a. Hint: Use the exponential term to solve for v_a as a function of v_a and iterate.

c) Find the incremental change in v_a for a 2% increase in v_i and calculate the ratio $\frac{\Delta v_a}{\Delta v_i}$.

d) Find the value for the incremental resistance of the nonlinear element N by linearizing the expression for i_a about the operating point when v_i = 10 volts.

e) Draw the incremental circuit for the circuit in Figure 4.3.

f) Find the ratio $\frac{\Delta v_a}{\Delta v_i}$ from the incremental circuit and compare with your exact value from part c.