ECSE 330
Introduction to Electronics
(Winter 2008)

SPICE Assignment (Part A)

Deadline: April 10th, 4:00pm

Assignment Drop-off Location:
- Submit the assignments in the ECSE330 assignment box on the 2nd Floor of the Troittier Building.

General Notes:
- You may work in groups of one, two or three persons.

- For *each part* of a SPICE programming question, you should submit the corresponding circuit (.cir) file and printouts of any generated graphs. Submit an output file (.out) only when the question requires it.

- Messy work will lose marks. Typed work is best, but neat hand-drawn schematics are acceptable. Properly organize your code and use comments where appropriate.

- Be sure to answer all questions asked in each part.

Question 1 Diode Rectifier

I) Bridge Rectifier:

Consider the following bridge rectifier. Use the model provided below for all diodes. R is a 4KΩ resistor.
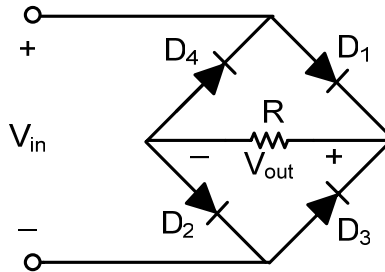
Diode model:
 *.model diode d(Is=2n n=1.8)*

  a) Plot the voltage transfer characteristic (VTC) of the rectifier for -10V<V_i<10V.
  b) Plot V_{out} for a sinusoidal input with zero dc level, a peak value of 10V, and a frequency of 60Hz.

II) Peak Rectifier:

Consider the following peak rectifier. Use the same diode model as the previous section. C is a 50 μF capacitor and R_L is a 5KΩ resistor. V_{in} is a sinusoid with a peak of 10V and a frequency of 60Hz.
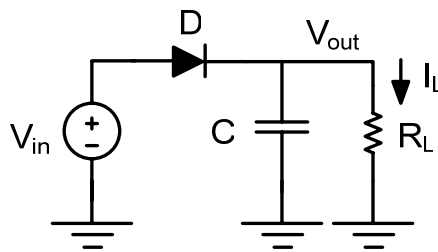
  c) Plot the output voltage and find the approximate value of the ripple voltage.

Now consider the following circuit. It is a combination of the bridge rectifier and the peak rectifier. Again, C is a 50 μF capacitor and R_L is a 5KΩ resistor. V_{in} is a sinusoid with a peak of 10V and a frequency of 60Hz.
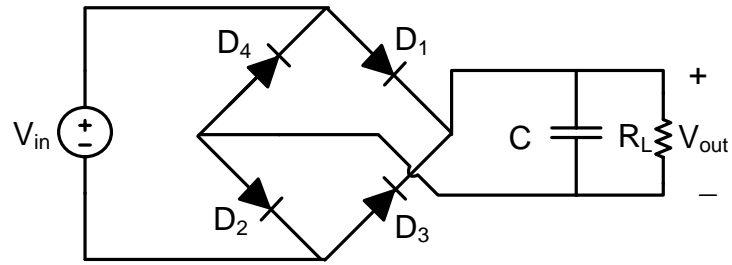
d) Plot the output voltage and find the approximate value of the ripple voltage.

Question 2 CMOS Inverter

Consider the following inverter. Use the models provided below for NMOS and PMOS transistors. $V_{CC} = 5V$, $W_1 = 6\mu m$ $W_2 = 12\mu m$, and $L_1 = L_2 = 1.2\mu m$.
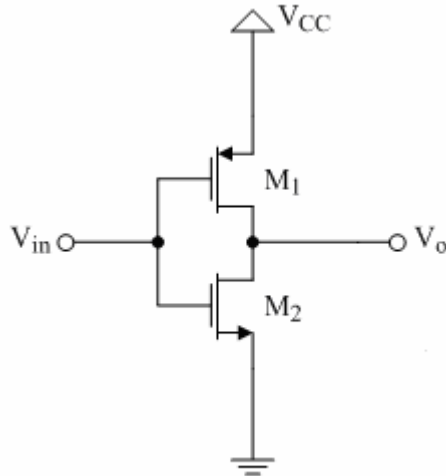
Fig. 2. CMOS inverter.

MOSFET models:
    .model nmos_amp nmos (kp=150u Vto=+1 lambda=0.025 gamma=0.9)
    .model pmos_amp pmos (kp=75u Vto=-1 lambda=0.025 gamma=0.9)

a) Plot the voltage transfer characteristic for this inverter for $0V < V_{in} < 5V$.

b) Determine the states of the transistors at different regions of the VTC.

c) Change the input signal to a sinusoidal signal of magnitude 1mV and a frequency of 1Hz. Choose the DC offset of the input signal such that both transistors are in saturation. Find the small signal gain of the inverter and compare it with its analytical value.

Question 3 is to be added to the assignment after the reading week.