Embedded Systems (CS [45]163)
Homework 3

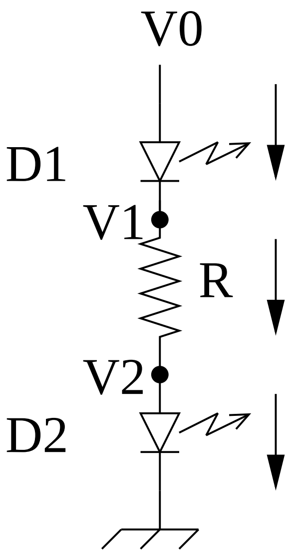
February 10, 2010

This homework assignment is due on Thursday, February 18th at 5:00pm. Your work may be handed in electronically (use the **Homework 2** digital dropbox on D2L) or in hardcopy form (in person or under office door).

This assignment must be done individually: do not share/discuss your answers with others or look at the answers of others.

Question 1

Consider the following circuit:



1. (10pts) What properties are **always** true for this circuit? You may assume that the following are known: $V0$, R, V_{f1} and V_{f2}.

2. (20pts) Derive equations for the currents and intermediate voltages as a function of the known variables. Make sure to address all cases and determine the ranges of $V0$ for which they apply.

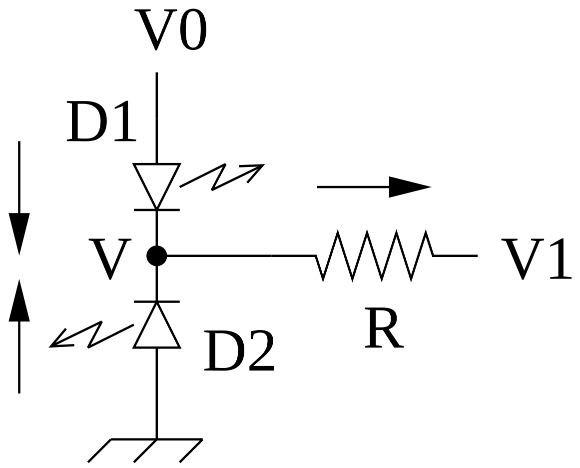
   Hint: the state of a resistor that is not connected to a circuit is technically undetermined. We can assume that current through the resistor is zero in this case, but the voltages are not constrained (but note that in the Q1 circuit, the voltages are constrained by the diodes, even when current is not flowing).

3. (10pts) Assume that $V_{f1} = V_{f2} = 1.4V$. Show I_R as a function of $V0$ (which varies from $-5V$ to $5V$).

4. (10pts) Show $V1$ and $V2$ as a function of $V0$ (which varies from $-5V$ to $5V$).

Question 2

Consider the following circuit:



1. (10pts) What properties are **always** true for this circuit? You may assume that the following are known: $V0$, $V1$, R, V_{f1} and V_{f2}.

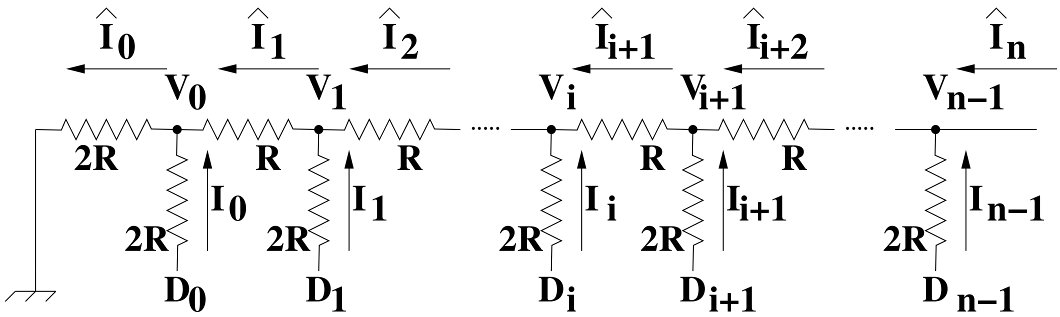
2. (20pts) Derive equations for the currents and V. Make sure to address all cases and determine the ranges of $V0$ and $V1$ for which they apply.

3. (10pts) Assume that $V_{f1} = V_{f2} = 1.4V$ and $V0 = 5V$. Show I_R as a function of $V1$ (which varies from $-10V$ to $10V$).

4. (10pts) Show V as a function of $V1$ (which varies from $-10V$ to $10V$).

Question 3

Consider the following digital-to-analog conversion circuit. Note that there are only two types of resistors in this network. The output is V_{n-1}. Our task is to solve for the output given the binary digital inputs.



Note that $\hat{I}_n$ is given for mathematical convenience, but you should assume that it is equal to zero. $D_i \in \{0, 1\}$, so you can assume that the voltage at the pin is $5D_i$.

1. (10pts) List the equations that are given to us by Ohm's law. Be as generic as possible.

2. (10pts) List the equations that are given to us by Kirchhoff's current law.

3. (30pts) Solve for V_{n-1} as a function of $D_0 ... D_{n-1}$ (there will be no other parameters or variables). Undergraduates: you may assume that $n = 3$; Graduates: solve for a generic $n > 2$.

   Hint: Start by solving for V_0 as a function of D_0 and $\hat{I}_1$ (and there will be an R term as well). Then solve for V_1 as a function of D_0, D_1, and $\hat{I}_2$. Follow the recursion from there.

Question 4 (ALL)

How much time did you spend on this homework assignment?