EE 112 Mid-Sem Exam (MBP)

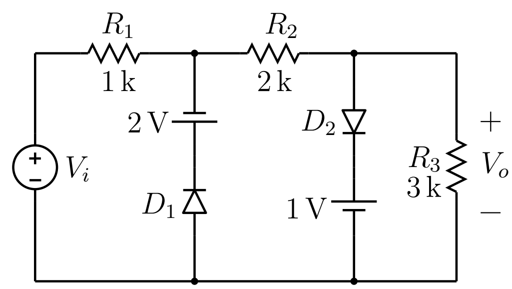
(Feb. 23, 2017)

1. In the circuit shown in the figure, assume that the diodes have $V_{\text{on}} = 0.7\,\text{V}$.

   (a) Find the range of V_i for which (i) only D_1 conducts, (ii) only D_2 conducts, (iii) both D_1 and D_2 conduct, (iv) neither D_1 nor D_2 conducts.

   (b) Calculate the slope $\dfrac{dV_o}{dV_i}$ in each of the above regions.

   (c) Plot V_o versus V_i for $-10\,\text{V} < V_i < 10\,\text{V}$, showing clearly the voltage levels, break points, and slopes. [6]



2. Consider a logical function X of four variables A_3, A_1, A_2, A_0. Let d be the decimal number corresponding to the binary number $A_3A_1A_2A_0$. X is `1` if either of the following conditions is met. (i) $d \leq 7$, (ii) The number of `1`'s in the input variables is odd.

   (a) Write the truth table for X.

   (b) Write X in the standard product-of-sums form. [4]

3. Implement the function $Y = A\,\overline{B}\,C + \overline{C}\,D$ using

   (a) an 8-to-1 MUX,

   (b) only 2-input NAND gates,

   (c) only 2-input NOR gates. [6]

4. We want to design a synchronous counter with the state transition table given in the figure.

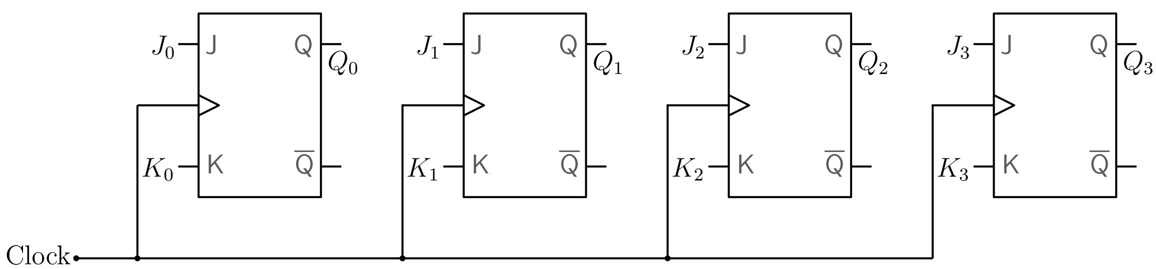
   (a) Write the transition table for a JK flip-flop (i.e., a table showing J, K, Q_{n+1}).

   (b) From the above table, construct a table showing Q_n, Q_{n+1}, J, K, where the J and K values for all possible transitions (from Q_n to Q_{n+1}) are listed. Explain how you obtained *one* of the entries.

   (c) Using the above table and the counter state transition table, prepare K-maps for J_1 and K_1 (K-maps for J_0, K_0, J_2, K_2, J_3, K_3 are not required).

   (d) From the K-maps, obtain minimal expressions for J_1 and K_1.

   (No marks for writing the answers by any other method.) [8]



Q_3	Q_2	Q_1	Q_0
0	0	0	0
0	0	0	1
0	0	1	1
0	1	1	1
1	1	1	1
1	1	1	0
1	1	0	0
1	0	0	0
0	0	0	0

repeats

5. The capacitor in the figure is initially uncharged, and a pulse $V_s(t)$ shown in the figure is applied. Assume that the diodes have $V_{\text{on}} = 0.7\,\text{V}$.

   (a) Sketch $V_o(t)$ to scale, showing all salient features, including time points and voltage levels. Justify your answer with calculations.

   (b) What is V_o at $t = 2\,\text{msec}$?

   (c) What is V_o at $t = 15\,\text{msec}$? [6]