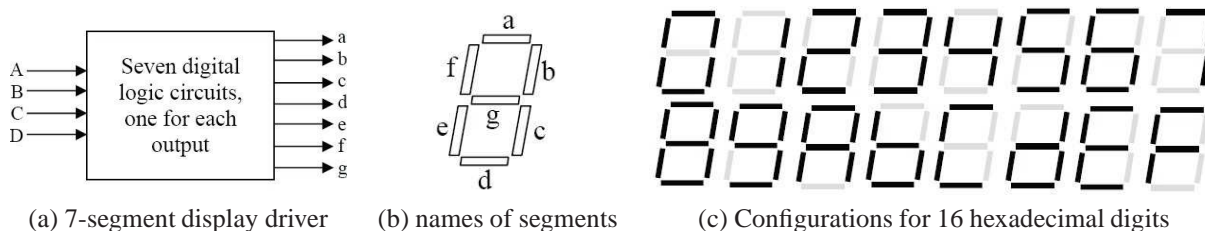


Homework 1

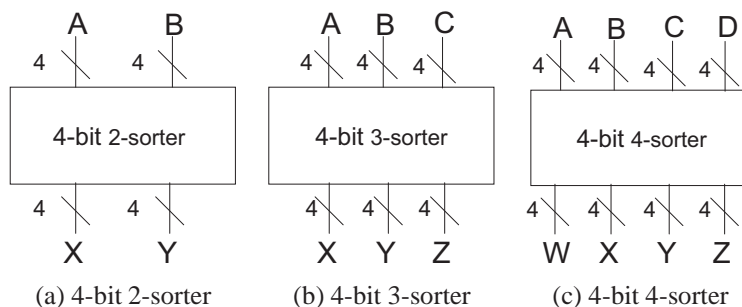
September 28, 2009

Due date: October 12, 2009

- (12%) What is the binary representation of the following hexadecimal numbers? What are the decimal numbers they represent when interpreted as unsigned and signed integers.
 - 25
 - ED
- (8%) Prove that (a) {NOT, OR} and (b) {NAND} are universal.
- (10%) Let $Q = A + B(A + C) + AC$. Prove that (a) $Q = A + BC$. (b) Draw a circuit to implement Q .
- (10%) (a) Create the truth table for the 3-input Boolean function, mod3, which returns $X\%3$ for the input X . If the input $X_2X_1X_0 = 101$, then the output $Z_1Z_0 = 10$ since $5\%3 = 2$. (b) Implement this function with logic gates AND, OR and NOT.
- (20%) Design a 7-segment display driver which accepts a 4-bit input (ABCD where A is the MSB) and outputs 7 bits which controls the on/off status of a 7-segment display as shown in the above figure. (a) List the truth table for the driver. (b) Write down the Boolean expressions for segments a and e.



- (20%) (a) A 4-bit 2-sorter (Figure (a)) has two 4-bit inputs A, B and two 4-bit outputs X, Y. The inputs A and B are unsigned integers. The output X is the larger one of A and B and Y is the smaller one of A and B. Design a 4-bit 2-sorter using the components introduced in the class. [Hint: one possibility is to composite 4-bit comparators and 4-bit 2-multiplexers to complete the task.] (b) A 4-bit 3-sorter (Figure (b)) has three 4-bit inputs A, B, C and three 4-bit outputs X, Y, Z, where X, Y and Z are the result of sorting A, B, C so that $X \geq Y \geq Z$. Use 4-bit 2-sorters to composite a 4-bit 3-sorter. (c) A 4-bit 4-sorter (Figure (c)) has four 4-bit inputs A, B, C, D and four 4-bit outputs W, X, Y, Z with $W \geq X \geq Y \geq Z$. Design a 4-bit 4-sorter.



- (20%) Design a binary multiplier that multiplies two 3-bit unsigned integers, $X = X_2X_1X_0$ and $Y = Y_2Y_1Y_0$, and a 6-bit output $Z = Z_5Z_4 \dots Z_0$ and $Z = X \times Y$, where X_0, Y_0 and Z_0 are LSBs. You may use the notation $X[n..m]$ to identify a portion of wires. For example, $X[2..1]$ means the set of wires, X_2X_1 .