Digital Logic Design Middle Test #1

Date: 2021. 04. 13 Tue.
Time: 18:00 ~ 19:40

1. (10 points) Perform the addition operation in 1's complement and 2's complement systems. The number of bits is 8 (8bits binary number), and check if they are overflows or not. (You should convert the numbers to binary ones before addition.)

1) 34 - 69, 2) -36 - 72,

2. (10 points) For a function, $F = A'B + AC + BC'D' + BEF + BDF$

1) Transform the function into the form, (X+X)(X+X)(X+X+X+X).

2) From the result in (1), transform the function into the form, XX+XX+XX+XX.

3. (15 points) A function is defined as below:

$F(a,b,c,d) = \sum m(0,3,5,7,8,9,10,12,13) + \sum d(1,6,11,14)$.

1) Find all essential prime implicants.
2) Find two minimum sum-of-products expressions out of three ones.
3) In your minimum expressions, which 'don't care's are considered as '1'?

4. (15 points) We want to design a comparator with a fixed 4-bit code 1010. A 4-bit input, ABCD (A is the MSB, D is the LSB), is compared with the code 1010 bit by bit, and the output is an indicator with respect to the number of error bits. For example, when an input is 0000, then two bits are errors, and the output of L2 is 1 (The others are 0). Fig. 1 shows the basic diagram of the comparator. Find the truth table.

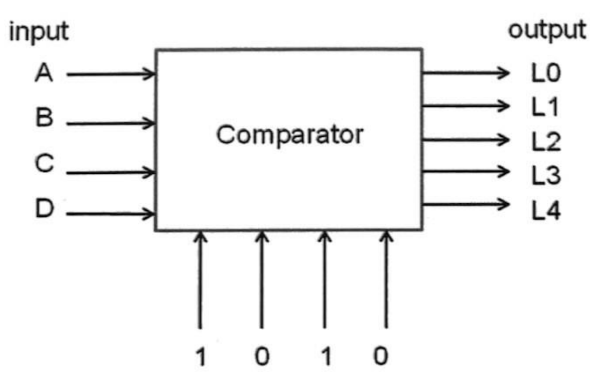

Fig. 1. The diagram of comparator to be designed.

5. (45 points) We want to design a multiplier with two positive 2-bit inputs (AB and CD, B and D are lower bits) as shown in Fig. 2. The output is a 4-bit number ($M_3M_2M_1M_0$).

1) Find the truth table of multiplier.

2) Find the minimum sum-of-product expressions for outputs, M_3, M_2, M_1, M_0.

3) Based on (2), draw gate circuits for M_3, M_2, M_1, M_0, using only 2-input AND/OR gates. (You don't have to draw the invertors.)

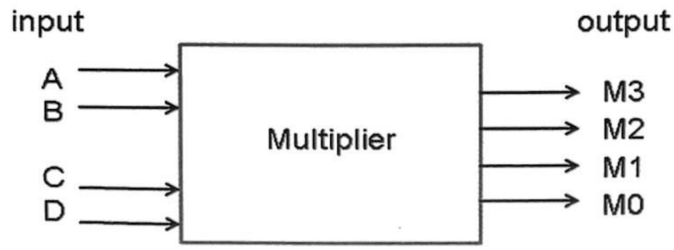

Fig. 2. Multiplier with two 2-bit inputs, AB and CD.

4) Now, the output of multiplier is directly connected to 7-segment indicator. That is to say, the 4-bit output of multiplier is converted to 7-bit 7-segment inputs to turn on the corresponding LED (1~7). Find the truth table to design the circuit in Fig. 3 using the 7-segment shapes of 10 digits as shown in Fig. 4.

5) Find the minimum sum-of-product expressions for X6 and X7.

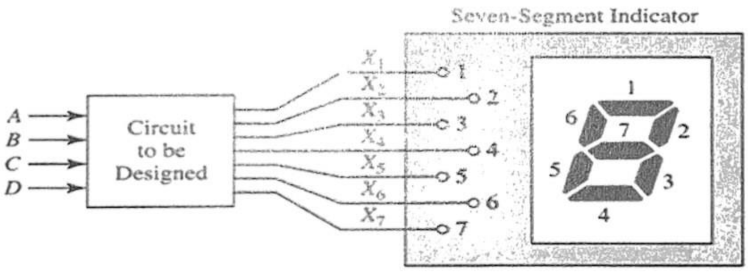

Fig. 3. Multiplier connected to 7-segment indicator.

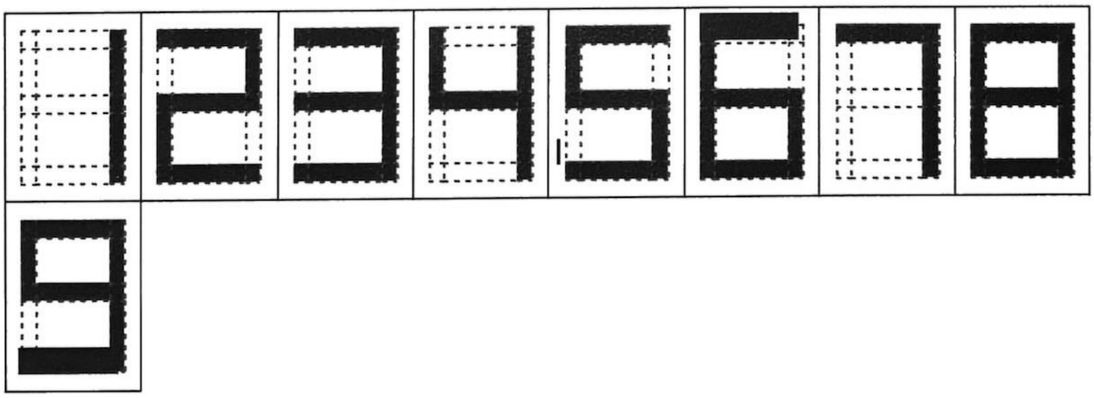

Fig. 4. 7-segment shapes of digits.