MILITARY COLLEGE OF SIGNALS
SOLUTION-MIDTERM EXAM
BESE 16 – B
CE 230 Digital Logic Design

Instructor: A/P Dr. Imran Siddiqi **Time: 90 Minutes**
Max Marks: 30

(2+2+3)

Question # 1

a. What is the decimal equivalent of 10000111 if it represents
   a. An unsigned binary number (135)
   b. A signed number in 2's complement form (-121)
   c. A signed number in singed magnitude form (-7)
   d. A number in BCD (8421) (87)

b. Represent the decimal number 37.25 using the following weighted codes.
   a. 6311
      0100 1001 . 0011 0111 OR
      0100 1010 . 0011 0111

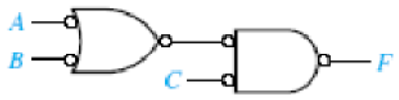
   b. 7321
      0100 1000. 0010 0110 OR
      0011 1000. 0010 0110

c. Give short answers to the following
   a. Inserting even parity to the binary number 0101010 gives_____.
      (10101010)
   b. What is the maximum and minimum decimal number that can be represented in *n-bit* signed-magnitude form. $-(2^{n-1}-1)$ To $+(2^{n-1}-1)$
   c. The 16's complement of C5FA is _____. (3A06)
   d. A register with *n* cells can store a number with _____ bits. (n)
   e. Using BCD addition, 8+7 = _____. (0001 0101)
   f. 2421 is a self-complementing code. True/False? (True)

(3+2+3)

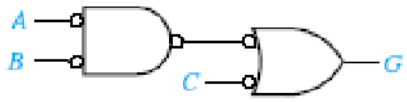
Question # 2

a. Find the Boolean expression for the following circuits.



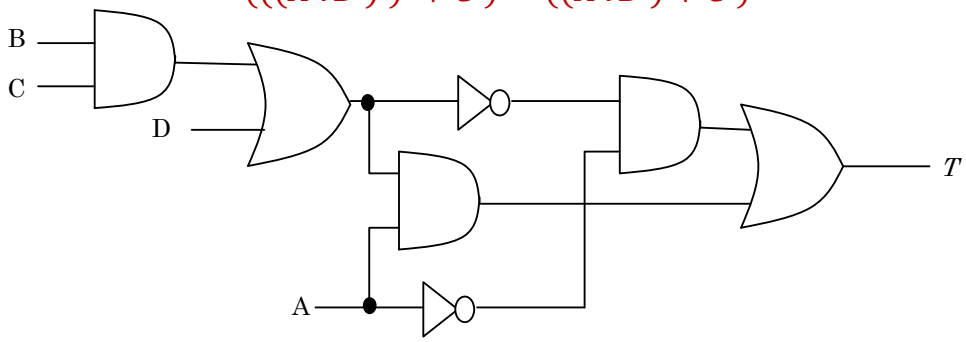
(i)

$$(((A'+B')')'.C')' = \left((A'+B').C'\right)' = A.B + C$$



(ii)

$$(((A'.B')')' + C') = ((A'.B') + C')$$



(iii)

$$T = (BC + D)'.A' + (BC + D).A$$

b. Using DeMorgan's law, express the function $F = \bar{A}BC + A\bar{C} + \bar{A}B$

a. With only OR and complement operations

$$F = ((A'BC + AC' + A'B)')'$$
$$F = ((A'BC)'.(AC')'.(A'B)')'$$
$$F = \big((A + B' + C').(A' + C).(A + B')\big)'$$
$$F = (A + B' + C')' + (A' + C)' + (A + B')'$$

b. With only AND and complement operations

$$F = ((A'BC + AC' + A'B)')'$$
$$F = ((A'BC)'.(AC')'.(A'B)')'$$

c. Express the following function as a sum of minterms and as a product of maxterms.

$F(A, B, C, D) = \bar{B}D + \bar{A}D + BD$

$$F = B'D + A'D + BD$$
$$F = B'D(A + A') + A'D(B + B') + BD(A + A')$$
$$F = AB'D + A'B'D + A'BD + A'B'D + ABD + A'BD$$
$$F = AB'D + A'B'D + A'BD + ABD$$
$$F = AB'D(C + C') + A'B'D(C + C') + A'BD(C + C') + ABD(C + C')$$
$$F = AB'CD + AB'C'D + A'B'CD + A'B'C'D + A'BCD + A'BC'D + ABCD + ABC'D$$
$$F = m11 + m9 + m3 + m1 + m7 + m5 + m15 + m13$$
$$F = \sum(1,3,5,7,9,11,13,15)$$
$$F = \prod(0,2,4,6,8,10,12,14)$$

(4+3)

Question # 3

a. Using 3 variable Kmaps, simplify the following to sum of products form.

a. $F1 = XY + \bar{X}Z + YZ$

$F1 = XY + \bar{X}Z + YZ$

$F1 = XYZ' + XYZ + X'YZ + X'Y'Z + XYZ + X'YZ$

$F1 = XYZ' + XYZ + X'YZ + X'Y'Z$

x \ yz	00	01	11	10
0		1	1	
1			1	1

$F1 = X'Z + XY$

b. $F3 = \prod(3,4)$

Solution is not unique. Possible solutions could be:

x \ yz	00	01	11	10
0	1	1	0	1
1	0	1	1	1

$F3 = X'Y' + XZ + YZ'$

x \ yz	00	01	11	10
0	1	1	0	1
1	0	1	1	1

$F3 = Y'Z + XY + X'Z'$

b. Using 4 variable Kmaps, simplify the following to product of sums.

a. $F1 = AC\bar{D} + \bar{C}D + A\bar{B} + ABCD$

$F1 = AC\bar{D} + \bar{C}D + A\bar{B} + ABCD$

$F1 = ABCD' + AB'CD' + AC'D + A'C'D + AB'C + AB'C' + ABCD$

$F1 = ABCD' + AB'CD' + ABC'D + AB'C'D + A'BC'D + A'B'C'D + AB'CD + AB'CD' + AB'C'D + AB'C'D' + ABCD$

	00	01	11	10
00	0	1	0	0
01	0	1	0	0
11	0	1	1	1
10	1	1	1	1

$$F1' = A'C + A'D' + BC'D'$$
$$F1 = (A + C').(A + D).(B' + C + D)$$

(3+5)

Question # 4

a. In Boolean logic, the majority function is a function with n inputs and one output. The value of the function is true if majority of the input bits are true and is false otherwise. Show the truth table of majority function for n=3 bits and represent the function as a product of maxterms. (You DO NOT need to simplify it).

a	b	c	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$$F = \prod(0,1,2,4)$$
$$F = (A + B + C).(A + B + C').(A + B' + C).(A' + B + C)$$

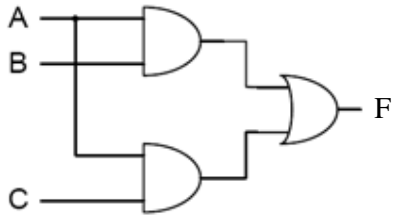
b. Find a function that detects errors in the representation of a decimal digit in BCD. In other words you need to find a function that gives a value 1 when the inputs are any of the six unused bit combinations in BCD and a value 0 otherwise. Simplify the function using K-map and show the circuit diagram of the simplified function

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0

1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

AB \ CD	00	01	11	10
00				
01				
11	1	1	1	1
10			1	1

$$F = AB + AC$$



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