EBU4202 Digital Circuit Design 2017-18

Week 1 Tutorial Sample Solution

1. Calculate the decimal values of the following numbers:

   a. 101110_2 = 2+4+8+32 = 46_{10}

   b. 6012_8 = 2+1x8+6x8^3 = 3082_{10}

   c. FED_{16} = 13+14x16+15x16^2=4077_{10}

2. Convert 11101101110_2 into hexadecimal and then decimal.

Answer: $(0111)(0110)(1110)_2$ =$76E_{16}$ = 14+6x16+7x256=1902_{10}

3. How many bits do you need at least to represent integers in range [-10, 10] (inclusively)? Explain briefly your answer.

Answer: There are in total 21 distinct integers to be represented, 5 bits can represent up to 32 integers (4 bits are not enough).

4. Convert the following from the given base to the others listed in the table (show only 3 decimal places, no need to round your answers)

Decimal	Binary	Octal	Hexadecimal
335.23	101001111.001	517.165	14F.3AE
77.625	1001101.101	115.5	4D.A
389.25	110000101.010	605.2	185.4
65290.687	1111111100001010.101	177412.54	FF0A.B

5. Find the 10-bit 2's complement representations of 341 and -422, hence perform binary calculation of 341 – 422. Show how you check your answer.

Answer:

10 bit 2's complement of 341 = 0101010101

10 bit 2's complement of 422 = 0110100110

10 bit 2's complement of -422 = 1001011010

   0101010101

+ 1001011010

   1110101111

1110101111 = 2's complement(1110101111) = -(0001010001) = -81_{10}

So the answer is correct.

6. Convert the number **145.84375** to a IEEE-754 binary floating point representation.

Answer:

$145.84375 = 10010001.11011$

$= (-1)^0 1.001000111011 * 2^{134-127}$

$= (-1)^0 1.001000111011 * 2^{10000110_2 - 127}$

So IEEE-754 representation is:
0 10000110 00100011101100000000000

7. An advanced computer represent information in groups of 64 bits. How many different integers can be represented in a) binary, b) BCD without signs, and c) 8-bit ASCII, all using 64 bits?

a) 2^{64} b) $10^{64/4}$=1016 c) $10^{64/8}=10^8$

8. Simplify algebraically
a) F = AB'(C+D)+C'D'
b) G = (A + B)(A + C')(A + D)(BC'D + E)

Answer:
a) F = AB'(C+D)+C'D'
= AB'(C'D')'+C'D' [DeMorgan's Theorem]
= AB' + C'D'

b) G = (A + B)(A + C')(A + D)(BC'D + E)
= (A+BC'D)(E+BC'D) [T8']
= AE+BC'D [T8']

9. Consider the Switching Algebra expression

F(A, B, C) = A'C' + A'BC' + (A+B')(A+B'+C)

and answer the following questions:
a. Explain in your own words the concept of *minterm*.
b. Derive the Truth Table for F and write the *maxterm* expansion for F'.
c. Simplify the expression for F using theorems of Switching Algebra

Answer:

a) Minterm is a product term containing all the variables (or their complement) of the circuit it refers to.

b) The truth table is:

A	B	C	A′C′	A′BC′	A+B′	A+B′+C	(A+B′)(A+B′+C)	F	F′
0	0	0	1	0	1	1	1	1	0
0	0	1	0	0	1	1	1	1	0
0	1	0	1	1	0	0	0	1	0
0	1	1	0	0	0	1	0	0	1
1	0	0	0	0	1	1	1	1	0
1	0	1	0	0	1	1	1	1	0
1	1	0	0	0	1	1	1	1	0
1	1	1	0	0	1	1	1	1	0

The *maxterm* expansion for **F** (and **F’**) is the product of *maxterms* with variables **A**, **B** and **C**. A *maxterm* is a sum term that is *0* in one row only of the Truth Table. Therefore, the *maxterm* expansion for **F’** is,

F’(A,B,C) = ∏M(0, 1, 2, 4, 5, 6, 7).

c) F(A,B,C) = A’C’ + A’BC’ + (A+B’)(A+B’+C)

= A’C’(1+B) + AA + **AB’** + AC + **AB’** + B’B’ + B’C -> using (T8), (T1’)

= **A’C’ + A** + AB’ + AC + **B’ + B’C** -> using (T2), (T1’), (T3), (T3’)

= **A** + **C’** + **AB’** + **AC** + B’(1+C) -> using (T*), (T8), (T1’)

= A(1+B’) + A + C’ + B’ -> using (T*), (T8), (T1’), (T2)

= A + A + B’ + C’ -> using (T1’), (T2)

= A + B’ + C’ -> using (T3)