ECE 142 Computer Organization
Midterm 1
Instructor: Jun Yang

Student Name:____
ID:____

A. (2 pts each) Multiple choices. Select the **only** correct answer from the following questions.

1. What is the Octal representation of value 693_{10}?
   (a) 5321 (b) 1265 (c) 5324 (d) 7265
   Answer:_______(b)___

2. What is the hexadecimal representation of value 11703_{10}?
   (a) 0xB6D3 (b) 0xEDB7 (c) 0x2DB7 (d) 0xB6DC
   Answer: _____(c)____

3. The 32-bit FP number 11111111100000000000000000000000 in IEEE 754 standard represents?
   (a) -0 (b) an unnormalized number (c) Not a number (d) $-\infty$ (e) ∞
   Answer: ______(d)___

4. As we learned from class, to implement a-b in an ALU, we do not perform subtraction directly. Instead, we perform:
   (a) a+b (b) b-a (c) -a-b (d) a+(-b)
   Answer: ______(d)______

5. What is the decimal value of 32-bit FP number 00000000111111111111111111111111 in IEEE 754 standard?
   (a) $(1-2^{-23})\times2^{-126}$ (b) $(1-2^{-23})\times2^{-127}$ (c) $(2-2^{-23})\times2^{-126}$ (d) $(2-2^{-23})\times2^{-127}$
   Answer:____(c)______

6. To test if two numbers are equal, we use the ALU to perform
   (a) An "AND" and test if the result is the same as any of the inputs
   (b) An "OR" and test if the result is the same as any of the inputs
   (c) An "Add" and test if there is a carry
   (d) A "Subtract" and test if the result is zero
   Answer: _________(d)________

7. Given 8-bit storage, how many valid numbers can binary and BCD code represent respectively?
   (a) 256 and 256 (b) 128 and 128 (c) 256 and 100 (d) 256 and 128 (e) 128 and 100
   Answer: _________(c)________

B. (3 pts each) Multiple choices. Select **all** correct answers ($\geq$ 1) from the following questions. Selecting wrong answers results 0pt, and partial but not all correct choices results 1pt.

1. Which decimal value does the two's complement binary number: 00011001 have?
    a) 25 in 8-bit register
    b) -7 in 5-bit register (take the bottom 5 bits)
    c) -7 in 4-bit register (take the bottom 4 bits)
    d) 25 in 6-bit register (take the bottom 6 bits)

   Answer: (a), (b), (c), (d)

2. Which of the following are valid BCDs (binary-coded decimal)?
    a. 0000 0010 0011 0100 1100
    b. 1001 0001 0100 0000 1000 ☺
    c. 0111 0110 0101 1100 1001
    d. 0000 1001 1000 0011 0100 ☺
3. An overflow could occur when
    a) Adding a positive and a negative number
    b) Subtracting two negative numbers
    c) Subtracting a positive from a negative
    d) Subtracting two positive numbers
    e) Adding two negative numbers

    Answer: c), e)
4. Which statements are correct about Booth's Algorithm?
    a) It may reduce the number of additions in a multiplication
    b) It may increase the number of additions in a multiplication
    c) It may involve both addition and subtraction in a multiplication
    d) It cannot be applied to negative multiplicand or multiplier
    e) When the multiplier is negative, perform a subtraction for the MSB

   Answer: a) b) c)

C. (1 pt each blank) Fill in the blanks
  1. Convert the following numbers into corresponding binary/octal/hexadecimal numbers. 63.25_{10} = __0x3F.4____$_{16}$ = ____77.2__$_{8}$ = __111111.0100___$_{2}$
  2. Use a 4-bit representation to fill in the following blanks:
      a) For -7_{10}, its sign-magnitude binary is __1111______________; its one's complement binary is ______1000_______________; and its two's complement binary is _______1001____________.
      b) The value range of two's complement form is ___-8—7______.
  3. The binary representation for 2.5_{10} is ___10.1____. Using the IEEE 754 single-precision floating-point standard, we should shift the above binary to the right by _1__bit which gives you (_1.01_) × $2^{(\_1\_)}$. The IEEE 754 uses 8 bits for exponent and 127 as the bias, thus the exponent of the above number is _10000000__. The significant (23 bits in total) is __01000000000000000000000__. Finally, the sign bit of this value should be __0__.

D. Calculations. Use a **16**-bit register, calculate the result using two's complement binaries as if it was done by an ALU.

$512_{10} - 1025_{10}$

512 =	0000001000000000
1025 =	0000010000000001
-1025 =	1111101111111111
512+(-1025) =	1111110111111111

E. Show the procedure of multiplying these two numbers (both are in 2's complement form) using "Implementation 3", i.e. combining multiplier and partial product in the product register.

$101101_2 \times 1101_2$

101101
000000|1101 +
101101|1101 →
1101101|110 →
11101101|11 +
10100001|11 →
110100001|1 –
000111001|1 →
0000111001|

F. (extra credits, 5pt) Show why Booth's algorithm works for negative multiplier using 2's complement binary

Assume a negative multiplier: $a_{31}a_{30}\ldots a_1a_0 = a_{31}\times(\mathbf{-2^{31}})+a_{30}\times 2^{30}+\ldots+a_1\times 2^1+a_0\times 2^0$

$b\times(a_{31}a_{30}\ldots a_1a_0) = (0-a_0)\times b\times 2^0 + (a_0-a_1)\times b\times 2^1+\ldots+(a_{30}-a_{31})\times b\times 2^{31}$