Birzeit University

Faculty of Engineering and Technology

Department of Electrical and Computer Engineering

First Semester – 2023/2024

ENCS2340 - Digital Systems

Homework # 1 - Due Thursday October 19, 2023

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Section A	**THIS SECTION CONSISTS OF SIX QUESTIONS. YOU MUST ANSWER ALL THE QUESTIONS IN THIS SECTION.**

Question 1 (12 points):

Find the value of ***X*** that satisfies the following equations:

a) $(739)_{10} = (X)_7$
b) $(110010.101)_2 = (X)_9$
c) $(10101.10101)_4 = (X)_{16}$
d) $(2699)_{10} = (BEE)_X$
e) $(24)_X + (17)_X = (40)_X$
f) X = the 10's complement of $(935)_{11}$

Question 2 (21 points):

Perform the following arithmetic operations on the given *unsigned numbers* using the designated bases without converting to decimal (Don't use r's complement or (r – 1)'s complement methods). You may verify your result by converting the numbers to decimal and then performing the operation in decimal:

a) $(10111011)_2 - (1001111)_2$
b) $(1101)_2 * (1011)_2$
c) $(52E9)_{16} - (133F)_{16}$
d) $(11011.0111)_2 + (11.1101)_2$
e) $(27.61)_{16} + (25.9F)_{16}$
f) $(AE.F3)_{16} - (103.111)_4 = (X)_2$ (Find X)
g) $(110100.01)_4 - (111.101)_2 = (Y)_2$ (Find Y)

Question 3 (20 points):

Conversion between different numbering systems. Fill the table below with the different representations of numbers. BCD stands for binary-coded decimal. For fractions, stop after 4 digits after the base point.

Decimal	Binary	Octal	Hexadecimal	BCD
19.22				
	10001.10011			
		745.347		
			1DF.23	
				10010011.0010

Question 4 (6 points):

Perform $(669)_{10}$ + $(835)_{10}$ using BCD addition. That is, convert the two decimal numbers to BCD code and add the two to get the result in BCD.

Question 5 (5 points):

A new university has 2,000 students. It is required to give each student a *unique* binary code (inside the registration software):

a) How many bits would we need?
b) If it is anticipated that the number of students will double every 3 years, how many bits would we need after 15 years?
c) For the sake of documentation, how many Hex digits would we need to represent these codes (now and after 15 years)? Comment on the number of Hex digits needed as compared to the binary bits needed.

Question 6 (12 points):

If 6-bit registers are used, perform the following signed 2's complement arithmetic operations on the provided *signed 2's complement binary numbers*. Check for overflow and mark clearly any overflow occurrences.

a) 101101 + 110011
b) 01101 – 101101
c) 010011 – 01101
d) 1011 – 110000

Section B

YOU MUST ANSWER TWO QUESTIONS FROM THIS SECTION. ANSWER ALL THE PARTS FOR THE TWO QUESTIONS YOU CHOOSE.

Question 7 (12 points):

Determine the decimal value of the 7-bit binary numbers **A** = (1001100) and **B** = (0101010) when interpreted as:

a) Unsigned numbers.
b) Signed-magnitude numbers.
c) Signed 1's complement numbers.
d) Signed 2's complement numbers.

Question 8 (12 points):

If you type the phrase '**ENCS2340**' on your keyboard, what is the binary sequence sent to the computer using 8-bit ASCII with the 8th most-significant bit being an **even parity** bit. Note that the 7-bit ASCII code of 'A' and '0' in hexadecimal are 41 and 30, respectively.

Question 9 (12 points):

If 6-bit registers are used, show the binary number representation of the decimal numbers **23** and **-23** using the following representation systems:

a) Unsigned system.
b) Signed-magnitude system.
c) Signed 1's complement system.
d) Signed 2's complement system.

Section C

EXTRA CREDIT, THE FOLLOWING QUESTION IS BONUS.

Question 10 (5 points):

In *2's complement representation* with 5-bits.

a) What is the largest positive number that can be added to $(10)_{10}$ without causing an overflow.
b) What is the largest positive number that can be subtracted from $(10)_{10}$ without causing overflow.

GOOD LUCK

Question 18-

a)

739	7
15	4
2	1
0	2

$X = (214)_7$

b) $(110010.101)_2 = (X)_9$

32 16 8 4 2 1   -1 -2 -3

- Decimal إلى Binary من تحويل ①

$= 2+16+32$ | $2^{-1}+2^{-3} = \frac{4+1}{4\times2} = \frac{1}{2}+\frac{1}{8} = \frac{5}{8} = 0.625 \Rightarrow (50.625)_{10}$

$= 50$

$(50.625)_{10} \rightarrow (55.\bar{5})_9$

50	9
5	5
0	5

$0.625 \times 9 = 5.625$

$0.625 \times 9 = \ldots$

⋮

c) $(10101.10101)_4 = (X)_{16}$

$(10101.10101)_4 \longrightarrow (0100010001.0100010001)_2$ $2^4 = 16$

$(111.444)_{16}$.

d) $(2699)_{10} = (BEE)_x$

$(BEE)_x \longrightarrow (2699)_{10}$

$x^2(11) + x^1(14) + x^0(14) = 2699$

$11x^2 + 14x + 14 = 2699$

$11x^2 + 14x - 2685 = 0$

$\frac{-b \mp \sqrt{b^2-4AC}}{2A} = \frac{-14 \mp \sqrt{(14)^2+(4)(11)(2685)}}{22} = \frac{-14 \mp 344}{22} =$ $x = 15$ or $x < 0$

e) $(24)_x + (17)_x = (40)_x$

$$\begin{array}{r} 24 \\ +\ 17 \\ \hline 40 \end{array}$$

$\boxed{X = 11}$

f) X = the 10's complement of $(935)_{11}$

$X = r^n - 1 - N$

$= (11)^3 - 1 - 935$

$= 1331 - 1 - 935$

$= 395$

Question 2 :

a) $(1011011)_2 - (1001111)_2$

128 64 32 16 8 4 2 1

1 0 1 1 0 1 1

1 0 0 1 1 1 1 −

1 1 0 1 1 0 0

187 − 79 = 108

b) $(1101)_2 * (1011)_2 =$ $13 * 11 = 143$

1 1 0 1

1 0 1 1 X

1 1 0 1

1 1 0 1 0 +

0 0 0 0 0 0 +

1 1 0 1 0 0 0 +

1 0 0 0 1 1 1 1

c) $(52E9)_{16} - (133F)_{16}$

A B C D E F

10 11 12 13 14 15

4 16 13 16

5 2 E 9 −

1 3 3 F

$(3FAA)_{16}$

d) $(1011.0111)_2 + (11.1101)_2$

1 1 0 1 1 . 0 1 1 1

1 1 . 1 1 0 1 +

1 1 1 1 1 . 0 1 0 0

e) $(27.61)_{16} + (25.9F)_{16}$

2 7 . 6 1

2 5 . 9 F +

4 D . 0 0

f) $(AE.F3)_{16} - (103.111)_4 = (X)_2$

$(10101110.11110011)_2 - (01\ 00\ 11.01\ 01\ 01)_2$

1 0 1 0 1 1 1 0 . 1 1 1 1 0 0 1 1

0 0 0 1 0 0 1 1 . 0 1 0 1 0 1 0 1 −

$(10011011.10011111)_2$

(g) $(110100.01)_4 - (111.101)_2 = (Y)_2$

$$
\begin{array}{r}
(010100010000.0001)_2 \\
-\quad (111.1010)_2 \\
\hline
(010100001000.0111)_2
\end{array}
$$

Question 3 :-

Decimal	Binary	Octal	Hexadecimal	BCD
19.22	10011.0011	23.14	13.3	0001 1001 . 0010 0010
17.5625	10001.10011	21.46	11.98	0001 0111 . 0101 0110
485.251	011100010.011100011	745.347	E2.718	0100 1000 0101 . 0010 0101 0001
479.1367	000111011111.00100011	0727.106	1DF.23	0100 0111 1001 . 0001 0011 0110
93.2	1011101.0011	135.14	$5D.\bar{3}$	10010011.0010

Question 4 :-

$(669)_{10} + (835)_{10}$

```
  0110  0110  1001
  1000  0011  0101  +
  ----------------
  1111  1010  1110
  0110  0110  0110  +
  ----------------
0001  0101  0000  0100
```

1504

Question 5 :-

(a) $2^{10} < 2000 < 2^{11}$

so the number of bits equals 11.

b) $2^{10} \times 2^5 < 2000 \times 2^5 < 2^{11} \times 2^5$

so we need 16 bit after 15 years.

c) 0000 0000 0000 0000 ⇒ for 15 years we need 16 bit in binary and 4 bit for Hex

4 3 2 1

Question 6 :-

(a) $101101 + 110011$

1100000 → Carry 1, overflow 0

result (100000).

(b) $011101 - 101101$

$011101 + 010011$

100000

2's Comp $(101101) = 010011$

overflow = $1 \oplus 0 = 1$

Carry = 0

result = 100 000

(c) $010011 - 01101$

$010011 + 110011$

000110

Carry = 1

overflow = $0 \oplus 1 = 1$

result = (000110).

(d) $1011 - 110000$

$111011 + 010000$

001011

Carry = 1

overflow = $1 \oplus 1 = 0$

result = $(001011)_2$

Question 7 :- $A = (1001100)$, $B = (0101010)$

a) $A = +76$ $B = +42$

b) $A = -12$, $B = +42$

c) $A = -51$, $B = +42$

0110011

d) $A = -52$, $B = +42$

0110100

Question 9 :- 23 , -23

(a) $(010111)_2 = (23)_{10}$, $(-23)_{10} = (\text{not exist})_2$

(b) $(23)_{10} = (010111)_2$, $(-23)_{10} = (110111)_2$

c) $(23)_{10} = (010111)_2$, $(-23)_{10} = (101000)_2$

d) $(23)_{10} = (010111)_2$, $(-23)_{10} = (101001)_2$

Question 10 :- 2's Complement representation with 5-bit.

A) Range $-2^{n-1} \rightarrow 2^{n-1}-1$

$-16 \rightarrow +15$

$(10)_{10} = (01010)_2$

```
  01010
+ [     ]
-------
  01111

  01111
  01010 -
  -------
  00101
```

↳ the largest positive number.

B) the largest positive number that could be subtract from $(10)_{10}$ without causing over flow.

$(15)_{10} = (01111)_2$

```
  01010
- 01111
-------
  11011
```

Cary = 0, overflow = 0