COMP7300 Fall 2021 HW01

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1 What are the decimal and hexadecimal representations of the maximum and minimum numbers which can be represented by 32-bits in 2's complement and unsigned representation?

	Min, Dec	Max, Dec	Min, Hex	Max, Hex
2's complement	- 2,147,483,648	+ 2,147,483,647	80000000	7FFFFFFF
Unsigned	0	4,294,967,295	00000000	FFFFFFFF

1. Two's Complement:
   - Dec_{max} = (0111 1111 1111 1111 1111 1111 1111 1111)$_2$ = + 2,147,483,647$_{10}$
   - Dec_{min} = (1000 0000 0000 0000 0000 0000 0000 0000)$_2$ = - 2,147,483,648$_{10}$
   - Hex_{max} = (0111 1111 1111 1111 1111 1111 1111 1111)$_2$ = 7FFFFFFF$_{16}$
   - Hex_{min} = (1000 0000 0000 0000 0000 0000 0000 0000)$_2$ = 80000000$_{16}$
2. unsigned representation:
   - Dec_{max} = (1111 1111 1111 1111 1111 1111 1111 1111)$_2$ = 4,294,967,295$_{10}$
   - Dec_{min} = (0000 0000 0000 0000 0000 0000 0000 0000)$_2$ = 0$_{10}$
   - Hex_{max} = (1111 1111 1111 1111 1111 1111 1111 1111)$_2$ = FFFFFFFF$_{16}$
   - Hex_{min} = (0000 0000 0000 0000 0000 0000 0000 0000)$_2$ = 00000000$_{16}$

2 Convert the following numbers from the given base to the other three bases listed in the table (for octal conversion assume numbers are unsigned, otherwise assume they are signed 2's complement)

	16 bits	8 bits	16 bits	16 bits
Decimal	**369**	-37	403	- 15383
Binary	0000 0001 0111 0001	**1101 1011**	0000 0001 1001 0011	1100 0011 1110 1001
Octal	561	333	**623**	141751
Hex	171	DB	193	**C3E9**

- Decimal 369:
  $369 = (0000\ 0001\ 0111\ 0001)_2 = (561)_8 = (171)_{16}$

Bit	Divide by 2	Quotient	Remainder
0	369/2	184	1
1	184/2	92	0
2	92/2	46	0
3	46/2	23	0
4	23/2	11	1
5	11/2	5	1
6	5/2	2	1
7	2/2	1	0
8	1/2	0	1

- Binary 1101 1011:
  The most left bit is "1", thus this is a negative number.
  1. reverse of $1101\ 1011_2 + 1 = 0010\ 0101_2$
  2. Convert to Decimal: $- 0010\ 0101_2 = - 25_{16} = - (2x16+5)_{10} = -37_{10}$
  3. Conver to Octal and Hex: $1101\ 1011_2 = DB_{16} = 333_8$

- Octal 623:
  Hex and Binary: $623_8 = (0000\ 0001\ 1001\ 0011)_2 = 193_{16}$
  Decimal: $623_8 = (6 \times 8^2) + (2 \times 8^1) + (3 \times 8^0) = 403_{10}$

- Hex C3E9:
  Binary and Octal: $C3E9_{16} = 1100\ 0011\ 1110\ 1001_2 = 141751_8$
  Bits Reversed: -> $0011\ 1100\ 0001\ 0110_2$
  +1: -> $0011\ 1100\ 0001\ 0111_2$
  Signed: $- 0011\ 1100\ 0001\ 0111_2$ -> $- 3C17_{16}$ -> $- 15383_{10}$

3 Provide the packed and unpacked BCD and ASCII representations of the decimal number 927 . Express your answer in hexadecimal. Hint for ASCII conversion - Convert to hex and then translate each hex digit to ASCII.

- Packed BCD: 927_{10} –> $1001\ 0010\ 0111_2$ –> 927_{16}
- unpacked BCD: 927_{10} –> $0000\ 1001\ 0000\ 0010\ 0000\ 0111_2$ –> $09\ 02\ 07_{16}$
- ASCII: 927_{10} –> $39F_{16}$ –> $33\ 39\ 46_{HexAscii}$

4 In Fig 1.6 what do the words MAR, MBR, IBR stand for? List and explain the main structural components of a computer and processor

- Fig 1.6
  1. MAR:Memory Address Register
  2. MBR: Memory Buffer Register
  3. IBR: Instructions Buffer Register
- Structural components of a computer:

1. CPU: Controls the operation of the computer and performs its data processing functions.
2. Main Memory: stores data
3. I/O: Moves data between the computer and the its external environment
4. System Bus: Some mechanism that provides for communication among CPU, Main Momory and I/O.

- Structural components of a processor:

1. Control Unit: controls the operation of the CPU and hence the computer
2. ALU: performs the computer's data processing functions.
3. Registers: provide storage internal to the CPU
4. CPU interconnection: Some mechanism that provides for communication among the contraol unit, ALU and registers.

5 Explain Moore's Law. What are its consequences?

1. Moore's Law: The number of components on chip doubles every 18 months.
2. The consequences of Moore's Law:
   (a) The cost of computer logic and memory circuitry has fallen at a dramatic rate
   (b) The electrical path length is shortened, increasing operating speed
   (c) Computer becomes smaller and is more convenient to use in a variety of environments
   (d) Reduction in power and cooling requirements
   (e) Fewer interchip connections

6 Discuss the differences between an embedded computer system and a general-purpose computer.

1. The embedded system refers to the use of electronics and software within a product
2. Millions of computers are sold in a year, while billions of products with an embedded system are sold.
3. Embedded systems are tightly coupled to their environment.
4. Embedded systems often interact with external world through sensors and actuators and hence are typically reactive systems
5. simple or even no human interface
6. The diagnostic port may be used for diagnosing the system being controlled
7. FPGA, ASIC or non-digital hardware may be used
8. Software often has a fixed function and is specific to the application
9. Embedded systems are optimized for energy, code size, execution time , weight and dimensions and costs

7 What are the advantages of using a family based approach to computer architecture?

The family based architecture provides the compatibility among the models that a program written for one model should be capable of being executed by another model in the series, whit only a difference in the time it takes to execute. Therefore, a customer with modest requirements and a budget to match could start at a cheaper model. And later the customer can upgrade it to a faster machine without sacrificing the investment in already-developed software.