COMPS266F : Computer Architecture

Tutorial 0 : Fundamental Knowledge in Computer Architecture

This exercise is set for the new admitted students to have a brief concept about this course. Also, this exercise can let the teaching team know how familiar you are. After you study this course, you should learn all of them properly. 😊

Instructions :

1. Calculation steps are needed in this exercise.

*Section 1 : Fundamental concepts of a computer*

Question 1 : According to Von Neumann’s architecture, what are the basic components of a computer?

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| Your Answer : |
| According to Von Neumann’s architecture, basic components of a computer are Central Processing Unit (CPU), memory and Input and Output (I/O). |

Question 2 : Central Processing Unit (CPU) is the brain of the computer, it contains several components, what are they?

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| Your Answer : |
| Arithmetic / logic unit (ALU), control unit (CU), registers, cache memory, bus and clock. |

Question 3 : To perform data transmission, computer applies “energy pulses” to transmit a series of data. In fact, what representation is used in this behavior? How to perform a data transmission?

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| Your Answer : | Binary representation. It applies combinations of “1” as an energy pulse and “0” as no energy pulse in a series of cables. |

*Section 2 : Data Representation*

Question 4 : Binary, octal, decimal and hexadecimal representations are common in computers to represent numeric data. No matter what type of the representation, what is the common factor of these representations? You may use an example to support your conclusion.

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| Your Answer : |
| The range of a digit must be 0 to the base value -1.  Examples :  In binary representation, the range of each digit must be 0 or 1. (2 – 1 = 1)  In octal representation, the range of each digit must be in 0 to 7. (8 – 1 = 7) |

Question 5 : Convert with clear steps of the following values to corresponding numbering systems.

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| Example : | | | |
| Binary | Octal | Decimal | Hexadecimal |
| 23 / 2 = 11 … 1  11 / 2 = 5 … 1  5 / 2 = 2 … 1  2 / 2 = 1 … 0  1 / 2 = 0 … 1  0.5 x 2 = 1.0 --- 1  0.0 x 2 = 0.0 --- 0  23.510 = 10111.12  27.48 = 010 111.100  = 1 0111.12 | 23 / 8 = 2 … 7  2 / 8 = 0 … 2  0.5 x 8 = 4.0 --- 4  0.0 x 8 = 0.0 --- 0  23.510 = 27.48  OR  23.5 = 10111.12  = 010 111.1002  = 27.48 | Q : 23.5  24 + 22 + 2 + 1 + 2-1  = 23.510  2 x 8 + 7 + 4 x 8-1  =23.510  1 x 16 + 7 + 8 x 16-1  = 23.510 | 23 / 16 = 1 … 7  1 / 16 = 0 … 1  0.5 x 16 = 8.0 --- 8  0.0 x 16 = 0.0 --- 0  23.510 = 17.816  OR  23.5 = 10111.12  = 0001 0111.10002  = 17.816 |

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| Your Answer : | | | | |
|  | Binary | Octal | Decimal | Hexadecimal |
| (a) | 1101001.1001 | 1 101 001.100 100  = 151.448 | 6 x 16 + 9 + 9 x 16-1  = 105.562510 | 0110 1001.1001  =69.916 |
| (b) | 010 111 101. 100 110  =1011 1101.100112 | 275.46 | 2 x 82 + 7 x 8 + 5 +  4 x 8-1 + 6 x 8-2  =189.5937510 | 1011 1101.1001 1000  =BD.9816 |
| (c) | 509 / 2 = 254 … 1  254 / 2 = 127 … 0  127 / 2 = 63 … 1  63 / 2 = 31 … 1  31 / 2 = 15 … 1  15 / 2 = 7 … 1  7 / 2 = 3 … 1  3 / 2 = 1 … 1  1 / 2 = 0 … 1  0.125 x 2 = 0.25 --- 0  0.25 x 2 = 0.5 --- 0  0.5 x 2 = 1.0 --- 1  0.0 x 2 = 0.0 --- 0  509.12510  =111111101.0012 | 111 111 101.001  =775.18 | 509.125 | 509 / 16 = 31 … 13 (D)  31 / 16 = 1 … 15 (F)  1 / 16 = 0 … 1  0.125 x 16 = 2.0 --- 2  0.0 x 16 = 0.0 --- 0  509.12510 = 1FD.216 |
| (d) | B = 1011  C = 1100  3 = 0011  A = 1010  BC.3A = 10111100.001110102 | 010 111 100 = 274  001 110 100 = 164  BC.3A16 = 274.1648 | 11 x 16 + 12 + 3/16 + 10/256  =188.226562510 | BC.3A |

Question 6 : Binary number cannot represent negative value in general. Scientists applied sign magnitude, 1’s and 2’s complements methods to assign binary numbers to negative values.

2’s complement is the most efficient way in representing negative values. What is the main issue of sign magnitude and 1’s complement in terms of the value zero (0) with examples?

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| Your Answer : |
| In sign magnitude and 1’s complement, in representing the value zero (0), the binary representation contains “positive” and “negative” 0. For example, in 3-bits sign magnitude to represent the 0, it contains 000 (+0) and 100 (-0). Also, in 3-bits 1’s complement, there are +0 (000) and -0 (111) that represent the 0 that they are unreliable and waste memory. |

*Section 3 : Little Man Computer (LMC)*

Question 7 : Little Man Computer (LMC) simulate processes operated in CPU. Study the below LMC program and describe the purpose of the program. Assume only positive values can be entered by user.

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| Program Counter | Instruction | Program Counter | Instruction |
| 00 | IN | 05 | BRP 09 |
| 01 | STO 90 | 06 | LDA 90 |
| 02 | IN | 07 | SUB 91 |
| 03 | STO 91 | 08 | OUT |
| 04 | SUB 90 | 09 | HLT |

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| Your Answer : |
| Calculate the positive difference of two inputted values. |

Question 8 : Write an LMC program to read in two positive numbers X and Y then calculate and return the sum of them.

* Please access <http://learn.hkmu.edu.hk/~mt260/mmo2/unit2/lmc/> to complete this question.

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| Examples : | | |
| Input | | Output |
| X | Y | X + Y |
| 0 | 0 | 0 |
| 1 | 7 | 8 |
| 8 | 1 | 9 |

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| Your Answer : |
| 00 IN  01 STO 90  02 IN  03 ADD 90  04 OUT  05 HLT  90 DAT |