Institute of Technology of Cambodia

Telecommunication and Network

# Computer Architecture

# TP 2

| Name | ID | Score |
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| An Vanneath | e20220208 | ……. |

Lecture: Course: Mr.CHUN Thavorac

TP: Mr.OL Phearun

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Questions:

1. The word bit is contraction for what two words?
2. Explain how the terms bit, byte, nibble, and word are related.
3. Why are binary and decimal called positional numbering systems?
4. How many bits long is a double-precision number under the IEEE-754 floating-point standard?
5. What is a Hamming code? What is meant by Hamming distance and why is it important? What is meant by minimum Hamming distance?
6. What is normalization and why is it necessary?
7. How many bits does a Unicode character require? Why was Unicode created?
8. What is systematic error detection?

# Exercise

1. Perform the following base conversions using subtraction or division remainder:
a) $(420)_{10} = ()_3$
b) $(677)_{10} = ()_5$
c) $(4401)_{10} = ()_9$

2. Convert the following decimal fractions to binary with a maximum of six places
a) 26.78125
b) 298.79676

3. Represent the following decimal numbers in binary using 8-bit signed magnitude, one's complement, and two's complement:
a) 75
b) -106
c) 118
d) -42

4. Using a "word" of 3 bits, list all of the possible signed binary numbers and their decimal equivalents that are representable in:

a) Signed magnitude
b) One's complement
c) Two's complement

5. Perform the following binary multiplications:
a) 1100×101
b) 10101×111

6. Perform the following binary divisions:
a) 101101 ÷ 101
b) 1001010010 ÷ 1011

7. Use the double-dabble method to convert $10212_3$ directly to decimal.
(Hint: you have to change the multiplier.)

8. Decode the following ASCII message, assuming 7-bit ASCII characters and no parity:
1001010 1001111 1001000 1001110 0100000 1000100 1000101

9. Compute the Hamming distance of the following code:
a) 0011010010111100
b) 0001011010011110

# ANSWER

## Question:

1. The word bit is contraction for what two words?
- The word bit is contraction two words is binary digit.
2. Explain how the terms bit, byte, nibble, and word are related.
- The term bit, byte, nibble and word are data types which are ordered lists of binary digits often have the following name:
    - Bit: 1 digit
    - Nibble: 4 digits
    - Byte: 8 digits
    - Word: The standard memory bus width in your architecture
    - (e.g. 16-bit, 32-bit, 64-bit words).
3. Why are binary and decimal called positional numbering systems?
- The binary and decimal called positional numbering system because binary is based on 2 and decimal is based on 10 that why we called positional numbering systems.
4. How many bits long is a double-precision number under the IEEE-754 floating-point standard?
- Double-precision numbers use a signed 64-bit word consisting of an 11-bit exponent and 52-bit significand.

5. What is a Hamming code? What is meant by Hamming distance and why is it important? What is meant by minimum Hamming distance?

- Hamming code is Data communications channels are simultaneously more error-prone and more tolerant of errors than disk systems.
- Hamming distance is the number of bit positions in which two code words differ and it important is context of error detection.
- Minimum Hamming distance is the smallest Hamming distance found among all pairs of the code words

6. What is normalization and why is it necessary?

- Normalization is an essential part of product information management, preventing data from being replicated in two tables at the same time or unrelated product data being gathered together in the same table. In addition, normalization helps to streamline your data, simplifying your database and making it more concise

7. How many bits does a Unicode character require? Why was Unicode created

- Unicode is a 16-bit alphabet that is downward compatible with ASCII and the Latin-1 character set. Unicode created because in

8. What is systematic error detection?

- systematic error detection scheme, meaning that the error-checking bits are appended to the original information byte.

# Exercise

1. Perform the following base conversions using subtraction or division remainder:

a. $(420)_{10} = (120120)_3$

- $420 \div 3 = 140$ the reminder is 0
- $140 \div 3 = 46$ the reminder is 2
- $46 \div 3 = 15$ the reminder is 1
- $15 \div 3 = 5$ the reminder is 0
- $5 \div 3 = 1$ the reminder is 2

b. $(677)_{10} = (10202\ )_5$

- $677 \div 5 = 135$ the reminder is 2
- $135 \div 5 = 27$ the reminder is 0
- $27 \div 5 = 5$ the reminder is 2
- $5 \div 5 = 1$ the reminder is 0

c. $(4401)_{10} = (6030)_9$

- $4401 \div 9 = 489$ the reminder is 0
- $489 \div 9 = 54$ the reminder is 3
- $54 \div 9 = 6$ the reminder is 0

2. Convert the following decimal fractions to binary with a maximum of six places

a. $26.78125 = (11100.11001)_2$

For 26 the binary equivalent is 11100.

- $26 \div 2 = 14$ the reminder is 0
- $14 \div 2 = 7$ the reminder is 0
- $7 \div 2 = 3$ the reminder is 1
- $3 \div 2 = 1$ the reminder is 1

For, the fraction part 0.78125, the binary equivalent is 0.11001.

- $0.78125 \times 2 = 1.5625$ the integer value is 1
- $0.5625 \times 2 = 1.125$ the integer value is 1
- $0.125 \text{ x } 2 = 0.25$ the integer value is 0
- $0.25 \times 2 = 0.5$ the integer value is 0
- $0.5 \times 2 = 1$ the integer value is 1

b. $298.79676 = (100101010.110010)_2$

For 298 the binary equivalent is 100101010.

- $298 \div 2 = 149$ the reminder is 0
- $149 \div 2 = 74$ the reminder is 1
- $74 \div 2 = 37$ the reminder is 0
- $37 \div 2 = 18$ the reminder is 1
- $18 \div 2 = 9$ the reminder is 0
- $9 \div 2 = 4$ the reminder is 1
- $4 \div 2 = 2$ the reminder is 0
- $2 \div 2 = 1$ the reminder is 0

For, the fraction part 0.79676, the binary equivalent is 0.110010.

- $0.79676 \times 2 = 1.59352$ the integer value is 1
- $0.59325 \times 2 = 1.18704$ the integer value is 1
- $0.18704 \times 2 = 0.37408$ the integer value is 0
- $0.37408 \times 2 = 0.74816$ the integer value is 0

- $0.74816 \times 2 = 1.49632$ the integer value is 1
- $0.49632 \times 2 = 0.99264$ the integer value is 0

3. Represent the following decimal numbers in binary using 8-bit signed magnitude, one's complement, and two's complement:

a. 75

- $75 \div 2 = 37$ the reminder is 1
- $37 \div 2 = 18$ the reminder is 1
- $18 \div 2 = 9$ the reminder is 0
- $9 \div 2 = 4$ the reminder is 1
- $4 \div 2 = 2$ the reminder is 0
- $2 \div 2 = 1$ the reminder is 0

- Decimal to 8 bit Signed-magnitude representation means if the given binary number is positive then place MSB bit is 0, if binary number is negative then place MSB bit is 1. And 75 is positive, and the binary representation of 75 is 01001011.

b. -106

- $106 \div 2 = 53$ the reminder is 0
- $53 \div 2 = 26$ the reminder is 1
- $26 \div 2 = 13$ the reminder is 0
- $13 \div 2 = 6$ the reminder is 1
- $6 \div 2 = 3$ the reminder is 0
- $3 \div 2 = 1$ the reminder is 1

- −106 is negative, and the binary representation of 106 is 1101010. So, MSB is 1.
- Decimal to binary 1's complement is: 0010101.
- Decimal to binary 2's complement is: we add 1 to the 1's complement. so, the 2's complement for −106 is 00010110.

c. 118

- $118 \div 2 = 59$ the reminder is 0
- $59 \div 2 = 29$ the reminder is 1
- $29 \div 2 = 14$ the reminder is 1
- $14 \div 2 = 7$ the reminder is 0

- $7 \div 2 = 3$ the reminder is 1
- $3 \div 2 = 1$ the reminder is 1

▪ Decimal to 8 bit Signed-magnitude representation means if the given binary number is positive then place MSB bit is 0, if binary number is negative then place MSB bit is 1. And 118 is positive, and the binary representation of 118 is 0110110.

d. -42

- $42 \div 2 = 21$ the reminder is 0
- $21 \div 2 = 10$ the reminder is 1
- $10 \div 2 = 5$ the reminder is 0
- $5 \div 2 = 2$ the reminder is 1
- $2 \div 2 = 1$ the reminder is 0

▪ −42 is negative, and the binary representation of 42 is 101010 So, MSB is 1.
▪ Decimal to binary 1’s complement is: 010101.
▪ Decimal to binary 2’s complement is: we add 1 to the 1’s complement. so, the 2’s complement for −42 is 00010110.

4. Using a “word” of 3 bits, list all of the possible signed binary numbers and their decimal equivalents that are representable in:

a. Signed magnitude

▪ In signed magnitude, the leftmost bit represents the sign of the number (0 for positive, 1 for negative), and the remaining bits represent the magnitude of the number.

For 3 bits, the possible combinations are:

- 000 (0)
- 001 (1)
- 010 (2)
- 011 (3)
- 100 (-0)
- 101 (-1)
- 110 (-2)
- 111 (-3)

b. One’s complement

- In one’s complement representation, negative numbers are obtained by complementing all the bits of the positive number.

- 000 (0)
- 001 (1)
- 010 (2)
- 011 (3)
- 100 (-3)
- 101 (-2)
- 110 (-1)
- 111 (0)

c. Two’s complement

- In two’s complement representation, negative numbers are obtained by taking the one’s complement of the positive number and then adding 1.

- 000 (0)
- 001 (1)
- 010 (2)
- 011 (3)
- 100 (-4)
- 101 (-3)
- 110 (-2)
- 111 (-1)

5. Perform the following binary multiplications:

a. 1100×101 = 11100

$$
\begin{array}{r}
1100 \\
\underline{\times 101} \\
1100 \\
0000\phantom{0} \\
\underline{+1100}\phantom{00} \\
11100\phantom{00}
\end{array}
$$

b. 10101×111 = 10010011

$$
\begin{array}{r}
10101 \\
\underline{\times 111} \\
10101
\end{array}
$$

```
  10101
+10101
10010011
```

6. Perform the following binary divisions:

a. 101101 ÷ 101 = 1001

```
     1001
101) 101101
     101
       0101
        101
          0
```

b. 1001010010 ÷ 1011 = 100

perform the binary division:

1001010010 (Dividend)

1011 (Divisor)

Step 1: Align the divisor with the leftmost digits of the dividend:

1001 010010

1011

Step 2: Perform division

| Quotient | Dividend | Divisor | Quotient Digit | Subtraction |
|---|---|---|---|---|
| | 1001 | 1011 | 0 | - |
| | 0 | 1011 | 1 | 0 |
| | Bring down 0 | 1011 | | |

Step 3: Multiply the divisor by the quotient digit (1), and subtract the result from the current dividend:

| Quotient | Dividend | Divisor | Quotient Digit | Subtraction |
|---|---|---|---|---|
| | 1001 | 1011 | 0 | - |

| | | | | |
|---|---|---|---|---|
| | 0<br>Bring down 0 | 1011<br>1011 | 1 | 0 |

Step 4: Bring down the next digit (0) from the dividend:

| Quotient | Dividend | Divisor | Quotient Digit | Subtraction |
|---|---|---|---|---|
| | 1001<br>0<br>Bring down 0 | 1011<br>1011<br>1011 | 0<br>1 | -<br>0 |

Since we have performed division until we have considered all digits in the dividend, the process is complete.

Therefore, the quotient is 100, and the remainder is 111. So, 1001010010 ÷ 1011 = 100 remainder 111.

7. Use the double-dabble method to convert $10212_3$ directly to decimal. (Hint: you have to change the multiplier.)

| Digit | Ternary (after shift) | Value |
|---|---|---|
| 1 | 0121 | 1 |
| 0 | 0000 | 0 |
| 2 | 0210 | 2 |
| 1 | 0121 | 1 |
| 2 | 0210 | 2 |

Converting the ternary number 012100210 to decimal:
Decimal = $(0\times3_8) + (1\times3_7) + (2\times3_6) + (1\times3_5) + (0\times3_4) + (0\times3_3) + (2\times3_2) + (1\times3_1) + (0\times3_0) = 0 + 2187 + 1458 + 243 + 0 + 0 + 18 + 3 + 0 = 3891$

8. Decode the following ASCII message, assuming 7-bit ASCII characters and no parity:

- 1001010 1001111 1001000 1001110 0100000 1000100 1000101

- 1001010: 74 → ASCII character: J
- 1001111: 79 → ASCII character: O
- 1001000: 72 → ASCII character: H
- 1001110: 78 → ASCII character: N

- 0100000: 32 → ASCII character: space
- 1000100: 68 → ASCII character: D
- 1000101: 69 → ASCII character: E

Therefore, the decoded ASCII message is "JOHN DE"

9. Compute the hamming distance of the following code:

a. 0011010010111100

b. 0001011010011110

We compare the two codes bit by bit and count the number of positions where they differ:

- 0011010010111100
- 0001011010011110

∧ ∧ ∧ ∧ ∧ ∧ ∧

the bits at positions 1, 4, 6, 9, 10, 11, and 15 differ between the two codes. So, the Hamming distance between the two codes is 7.