**Beijing-Dublin International College**

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## SEMESTER 2 FINAL EXAMINATION - (2017/2018)

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### School of Computer Science

# COMP2007J Principles of Computer Organisation

### Prof. Pádraig Cunningham
### Dr. Seán Russell*
### Dr Shen Wang*

## Time Allowed: 120 minutes

### Instructions for Candidates:

All questions carry equal marks.
Answer all questions.

**BJUT Student ID:**_____    **UCD Student ID:**_____

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I accept the punishment thereof.

**Honesty Pledge:**_____ **(Signature)**

### Instructions for Invigilators
Non-programmable calculators are permitted.
No rough-work paper is to be provided for candidates.

## Question 1:

a. Name and describe the four main structural components of a computer

**(6%)**

b. The processor instruction cycle is typically made up of two sub-cycles, name and describe them.

**(6%)**

c. Table 1 shows the contents of a computers memory. This computer has 5 bit memory addresses, a block size of 4 and 2 lines of cache that are allocated using **direct mapping**. Given this information, for each of the requested address state if it is a cache hit or miss and show the state of the cache after **each** request.

- 00110
- 10001
- 00100
- 01110
- 00111
- 10010

| Address | Data | Address | Data | Address | Data | Address | Data |
|---------|------|---------|------|---------|------|---------|------|
| 00000 | AA | 01000 | 0E | 10000 | BB | 11000 | 12 |
| 00001 | AB | 01001 | 0B | 10001 | BA | 11001 | 02 |
| 00010 | 0C | 01010 | 2C | 10010 | CE | 11010 | 5A |
| 00011 | 0D | 01011 | 20 | 10011 | 3A | 11011 | 16 |
| 00100 | 3E | 01100 | 30 | 10100 | 4A | 11100 | 1F |
| 00101 | 4F | 01101 | 41 | 10101 | 0A | 11101 | 1E |
| 00110 | 00 | 01110 | 01 | 10110 | 03 | 11110 | 14 |
| 00111 | 2F | 01111 | 21 | 10111 | 1A | 11111 | 11 |

Table 1: Memory Contents

**(13%)**

**(Question Total 25%)**

## Question 2:

a. Describe the main difference between bus and point-to-point based interconnection systems. Give one advantages and disadvantages of each.

**(6%)**

b. Describe the difference between direct and associative mapping of caches.

**(4%)**

c. Table 2 shows the initial state of a von Neumann computer. The available opcodes are:

| Address | Data |
|---------|------|
| 000 | 100A |
| 001 | 200B |
| 002 | 200C |
| 003 | 200D |
| 004 | 300E |
| 005 | 400F |
| 006 | 0000 |
| 007 | 200C |
| 008 | 200E |
| 009 | 300F |
| 00A | 0014 |
| 00B | 0010 |
| 00C | 0015 |
| 00D | 0030 |
| 00E | 004D |
| 00F | 0000 |
| ... | 0009 |

Table 2: Inital State of Computer

| Iteration | PC | AC | IR |
|-----------|------|------|------|
| 0 | 0000 | 0000 | 0000 |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |

Table 3: Answer Format

**0** : Jump to address (set value of program counter)

**1** : Load memory address into accumulator (AC)

**2** : Add the value in memory address to AC

**3** : Subtract the value in memory address from AC

**4** : Store value in AC to memory address

Show the state of the program counter (PC), accumulator (AC) and instruction register (IR) after each of the first 7 iterations of the program in a table similar to Table 3. This should be done in your answer book.

**(12%)**

d. After the program has completed, what value will be stored in memory location $000F$? What does the value mean or what calculation was performed?

**(3%)**

**(Question Total 25%)**

## Question 3:

a. To detect and correct errors occurred when writing or reading data to or from memory, SEC-DED Hamming Code is widely used. For simplicity, when a word length is 4 bits, we use Venn diagram. As shown in Figure 1, please generate check bits and overall parity bit when writing data into memory. Draw relevant diagrams in your answer book. As shown in Figure 2, when data is read from memory, state whether it has error(s). Correct it if necessary. Draw relevant diagrams in your answer book.
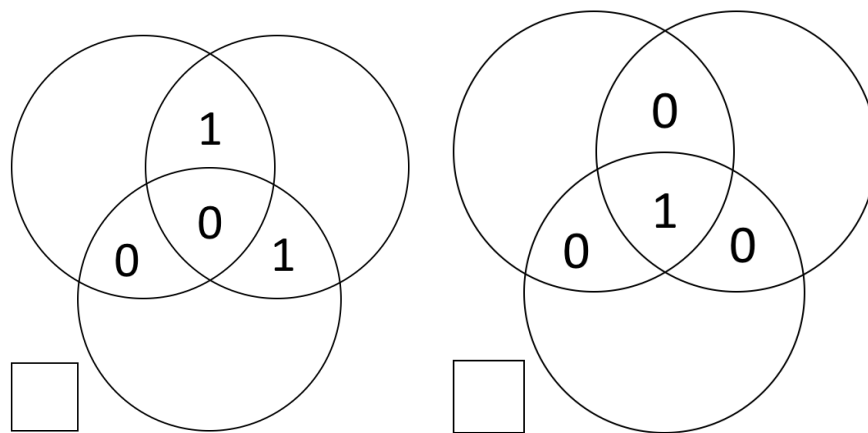
**(6%)**

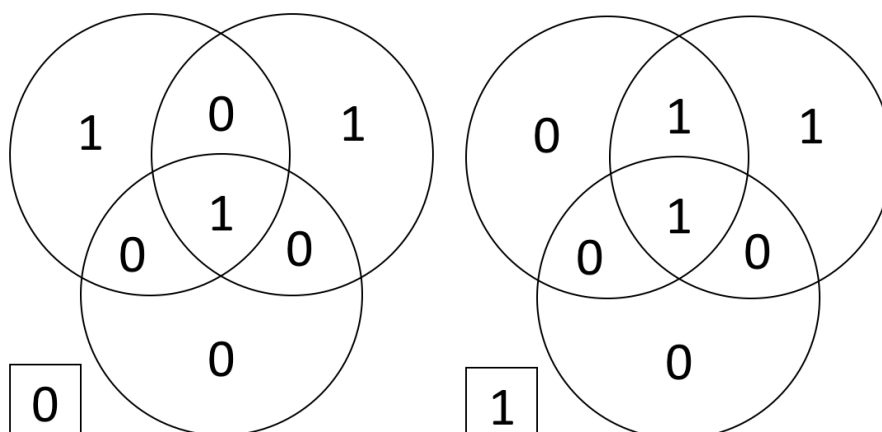Figure 1: Writing a word data into memory



Figure 2: Read a word data from memory

b. The following 2 words data is going to be stored in memory using SEC encoding:
$$1101110100101001.$$
Determine the Error Correction Code for each word and display the entire stored string.

**(3%)**

c. When reading from internal memory, the following values are read:
$$\text{a) } 1100000001101 \quad \text{b) } 1111111100111$$
These values are encoded using SEC-DED Hamming Code where the right-most bit is the overall parity bit. Please state what is the Error Correct Code in these read values and determine how many error(s) detected. Correct error if necessary.

**(6%)**

d. Describe what is meant by data striping in RAID? What is the difference between RAID 2-3 and RAID 4-6 in terms of data striping?

**(5%)**

e. Which RAID level uses reduced mode? What benefit it can bring? How does the reduced mode work?

**(5%)**

**(Question Total 25%)**

## Question 4:

a. Describe the reading/writing process using movable-head magnetic disk. You should use terms for magnetic disk components, and terms for the time spent at each main stage.

**(5%)**

b. Explain how to read data from optical disc. You should use terms for optical disc components, and explain when it is read as "0" or "1".

**(4%)**

c. Explain what is so called "solid state" for SSD. How flash memory can keep data when the power is off? What are the main advantages and disadvantages of magnetic tapes?

**(5%)**

d. Briefly describe the key characteristics of three main technologies for I/O operations: programmed I/O, interrupt-driven I/O, and DMA.

**(6%)**

e. Use one sentence to briefly describe each of five main functions of I/O module.

**(5%)**

**(Question Total 25%)**

**(Paper Total 100%)**