AOU
الجامعة العربية المفتوحة
Arab Open University
Faculty of Computer Studies

T103/TM103
Computer Organization and Architecture

Final Examination
Solution
Summer Semester 2022/2023

Date: ?? /??/2023

Number of Exam Pages: (including this cover sheet) **(7)**	**Time Allowed: (2) Hours**

Instructions:

- Total Marks: **100**
- This exam consists of **3** parts.
- **ALL questions** must be answered in the External Answer booklet.
- Be sure you write your **name and ID** on the External Answer booklet.
- **Programmable Calculators** are **not** allowed.

Part I: Choose the most correct answer (20 marks)

This part consists of **10 questions** carrying a **weight of two marks each**.
You should answer **ALL** the following:

1. A CPU component responsible for executing the instruction and placing the results in registers or memory:
   a) Bus.
   b) Register.
   c) Control Unit.
   d) Arithmetic Logic Unit.

2. A flip flop that is usually used to build registers is called:
   a) D Flip Flop.
   b) JK Flip Flop
   c) RS Flip Flop
   d) T Flip Flop.
3. If a carry-out of the leftmost bit (8^{th} bit) occurs in an addition of two signed numbers using 1's complement, then:
   a) It will be discarded.
   b) We have an erroneous result.
   c) It will be added to the sum.
   d) None of the above.

4. Which of the following is not a sequential circuit?
   a) Half Adder
   b) Counter
   c) Multiplexer
   d) Both a and c.

5. An immediate addressing mode means that:
   a) The value is implicitly stated in the instruction.
   b) The address of the operand is explicitly stated in the instruction.
   c) The address of the operand is to be found in the ALU.
   d) None of the above.
6. If we want to build a **32Kx32** word addressable RAM memory with only **4Kx4 RAM** chips, then we need:
   a) 8 different 4Kx4 RAM chips.
   b) 16 different 4Kx4 RAM chips.
   c) 32 different 4Kx4 RAM chips
   d) 64 different 4Kx4 RAM chips

7. Which of the following is a characteristic of EPROM?
   a) It is non-volatile.
   b) It can only be programmed once.
   c) Erasure is performed by applying an ultraviolet light.
   d) Both, a and c.

8. The unsigned 12-bit binary equivalent to the Hexadecimal number **E4** is:
   a) 111101000000
   b) 000011100100.
   c) 11100100
   d) 000011100010

9. Which of the following is non-volatile?
   a) SRAM
   b) Flash Memory
   c) DRAM
   d) All the above

10. The CPU component responsible for storing some data or intermediate results is the:
   a) RAM.
   b) Register.
   c) Control Unit.
   d) Arithmetic Logic Unit.

Part II: Short essay questions (30 marks)

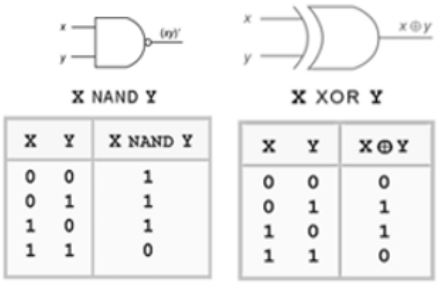
This part consists of five **questions** carrying a **WEIGHT OF 6 marks each**. You should attempt all questions.

Remark for questions in Part 2:

All the answers below for the questions are considered ideal answers to be considered in correction. However, the tutor should expect student's answers to be provided in different style and format. Kindly consider these answers and allow for partial marks to be awarded accordingly.

1. Draw the truth table and the corresponding gate of NAND and XOR.

Answer: (6 marks: 3 marks for each)



X NAND Y

X	Y	X NAND Y
0	0	1
0	1	1
1	0	1
1	1	0

X XOR Y

X	Y	X⊕Y
0	0	0
0	1	1
1	0	1
1	1	0

2. Using MARIE instruction set, find the equivalent assembly codes of the following binary instructions.
   a) **1001** 0110 **1111** 0000.
   b) **0010** 1000 **0100** 0000.

Answer: (6 marks: 3 marks for each instruction)
   a) Jump 6F0
   b) Store 840

3. Answer the following questions:
    a) In the computer architecture context, what are ports used for?
    b) What are the main three components of a typical bus?

Answer: (6 marks: 3 marks for each part)

a- Ports allow movement of data between a system and its external devices.
b- The three main components of typical bus are:
- **Data**
- **Control**
- **Address**

4. What do the following acronyms stand for: SRAM, USB, ROM?

Answer: (6 marks: 2 marks for each)

- SRAM: Static Random-Access Memory
- USB: Universal Serial Bus.
- ROM: Read Only Memory.

5. Given the below K-Map diagram, answer the following questions:
    a) Find the Sum of Product form of the Function F.
    b) Deduce the simplified form of the function F

	y'z'	y'z	yz	yz'
x'	0	1	1	1
x	0	0	1	1

Answer: (6 Marks: 3+3)

a- F= x'y'z + x'yz + x'yz' + xyz + xyz'
b- F_{simp} = y+ x'z (deduct 1 mark for any redundant term)

Part III: Numerical problems (50 marks)

This part consists of **four questions** carrying a weight of **50 marks**.
You should **answer all questions**.

1. Answer the following questions: **[12 marks]**

a) Find the values of (-72) and (+48) in 8-bits binary representation using **C1** representation.
b) Find the sum of (-72) and (+48) in 8-bits binary representation using **C1** representation.
c) What can you say about the result? Discuss.

Answer: (12 marks)

a) (6 marks)

-72 = 10110111(C1) **(3 marks)**

+48= 00110000(C1) **(3 marks)**

b) (**4 marks**: **3 marks** for the addition; **1 mark** for the final result)

```
   10110111
+  00110000
  ----------
  11100111c1
  ----------
```

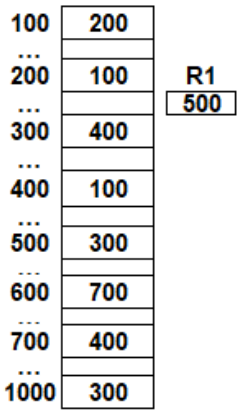
➔(-) 00011000 (which is -24)

c) The result is correct as (-24) is the sum of the two numbers. (**2 marks**)

2. Suppose we have the following code: **[12 marks]**

Load 500
Subt 200

Knowing that **AC=0** before executing the two instruction, and the memory and register R1 containing the values below, determine the actual value that will be found in the accumulator **AC** after executing each instruction in each mode, and fill in the table below:
Note that for each addressing mode the value of AC is initially 0.



Mode	Value in AC after Load 500	Value in AC after Subt 200
Immediate	500	300
Direct	300	200
Indirect	400	200
Indexed	300	-100

Answer: (12 marks: 1.5 marks for each correct answer)

Mode	Value in AC after Load 500	Value in AC after Subt 200
Immediate	500	300
Direct	300	300-M[200]=300-100=200
Indirect	400	200
Indexed	300	300-M[700]= 300-400=-100

3. Suppose that you have the following MARIE assembly code: **[12 marks]**

```
org 300
input
store x
input
store y
subt x
skipcond 800
jump Else
load x
add Three
jump End
Else, load y
End, output
halt
x, DEC 0
y, DEC 0
Three, DEC 3
```

a) What does the org 300 directive do?
b) When will the **jump Else** instruction be executed? Discuss.
c) What will be displayed after execution if the entered numbers are 6 and 8 respectively?
d) What is the value of x after executing the above program?

Answer: (12 marks: 3 marks for each part)

a) **Org 300 instructs the program to start at address 300.**
b) **Jump Else will be executed when (y-x)<=0 (or when AC<=0)**
c) **The output will be 9.**
d) **The value of x is 6.**

4. Assume that we have the following Direct Mapped Cache representation:

Direct Mapped (DM)

4	10	6
Tag	Block	Word

Answer the following questions based on the above data: **[14 marks]**

a- What is the size of the main memory (in power of 2)?
b- What is the number of blocks in the cache memory (in power of 2)?
c- How many blocks are there in the main memory (in power of 2)?

Hint: A power of two is a number of the form 2^n where n is an integer. For example: 2^3, 2^{20}, etc.

d- Draw the format of the memory address as seen by the cache, showing the fields as well as their sizes, for the **8-way set associative cache mapping.**
Hint: make use of the above DM scheme format.

Answer: (14 marks: 3+2+3+6)

a- The size of the main memory is 2^{20} (1 M) words. **(3 marks)**
b- The number of blocks in the cache memory is 2^{10} (1K) **(2 marks)**
c- The number of blocks in main memory= $2^{20}/ 2^6 = 2^{14}$ blocks **(3 marks)**
d- Each address has 20 bits, and there are 7 in the tag field, 7 in the set field and 6 in the word field. **(6 marks: 2 marks for each field)**

7	7	6

End of Questions