

CS2022 ASSIGNMENT 6 (Due Date: Oct 21, 2022)

Instructions: In this assignment, there are eight questions. The last three questions are multiple-choice questions. You have to answer all of them.

Question 1

Figure 1 shows a digital circuit with four full adders. For the left input of each full adder, it is always input with '0'. For the full adder associated with Z_0 , the right input is always '1'. The input $A = A_3A_2A_1A_0$ is restricted to $0XXX$, where X is either 0 or 1.

- What will be the output $Z = Z_4Z_3Z_2Z_1Z_0$ if $A = 0011$?
- What will be the output $Z = Z_4Z_3Z_2Z_1Z_0$ if $A = 0111$?
- What is the digital circuit used for?

Question 2

- In a processor, there must have a module called *control unit* or *instruction decode unit*. What is it used for?
- What is the difference between *instruction* and *microinstruction*?
- What is a microprogram?
- What factor determines the design of a microprogram?
- State three factors which determine the performance of a processor.

Question 3

- Each modern computer must have five necessary hardware components. What are they?
- State the reasons why RAM is needed in a computer system?
- State at least two differences between a CISC processor and a RISC processor.
- State two CISC processors which can be found in a computer or a cell phone.
- State two RISC processors which can be found in a computer or a cell phone.

Question 4

With reference to the 4-logic-gate processor architecture as shown in Figure 5 in the lecture note *Processor and Computer*, design the micro-instructions for the following logical operations. It is assumed that the value of A (resp. B) has already been stored in the register RA (resp. RB).

- $R1 = \neg A$.
- $R2 = \neg B$.
- $Z = (\neg A) \oplus (\neg B)$.
- $Z = A + ((\neg A) \oplus (\neg B))$.

Here \neg refers to NOT operation, \oplus refers to XOR operation and $+$ refers to OR operation. Your answers have to be conformed to the format as shown in Figure 4 in the lecture note *Processor and Computer*.

Question 4

With reference to the 4-logic-gate processor architecture as shown in Figure 5 in the lecture note *Processor and Computer*, design the micro-instructions for the following logical operations. It is assumed that the initial setting for RA and RB are 1 and 0. The contents of the other registers are set to '0'.

- $R1 = \neg A$.
- $R2 = \neg B$.
- $R3 = (\neg A) \oplus (\neg B)$.

Here \neg refers to NOT operation and \oplus refers to XOR operation.

What will be the contents of RA , RB , RZ , $R1$, $R2$, $R3$ and $R4$ after the above steps have been executed?

Question 5

With reference to the single-NAND-gate processor as shown in Figure 1 in *Processor and Computer (Supplementary)*, design the micro-instructions for the realization of the following instructions.

- NOT RA .
- AND RA RB .

Your answers have to be conformed to the format as shown in Figure 4 in the lecture note *Processor and Computer*. That is to say, you need to depict the control signals to be sent to the switches, the address bits A_1 and A_2 ; and the signal for R/W .

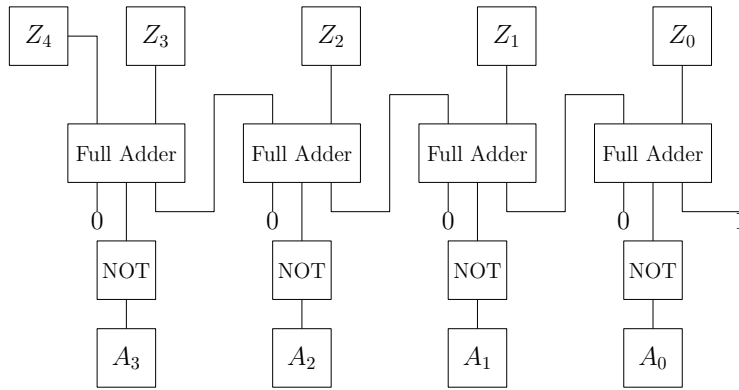


Figure 1: Digital circuit for Question 1.

Question 6

Refer to the artificial CPU and its commands, what will be the content of $M4$ if the following commands are executed?

```
DEF M1 1
DEF M2 2
DEF M3 5
```

```
MOV IA M1
IF IA == 0
    MOV IA M2
    MOV IA M2
    MOV IB M3
    ADD IA IB
    MOV M4 OUT
ELSE
    MOV IA M1
    MOV IA M1
    MOV IB M3
    MUL IA IB
    MOV M4 OUT
ENDIF
```

- (a) 2.
- (b) 7.
- (c) 5.
- (d) 0.
- (e) None of the above.

Question 7

What will be the content of $M4$ if the following program segment is executed?

```
DEF M1 16
DEF M2 22
DEF M3 10
MOV IA M1
MOV IB M2
CMP IA IB
CMP IA IB
```

```
MOV M4 OUT
MOV IA M2
MOV IB M3
CMP IA IB
CMP IA IB
MOV IA OUT
MOV IB M4
ADD IA IB
MOV M4 OUT
```

- (a) 28.
- (b) 30.
- (c) 32.
- (d) 34.
- (e) None of the above.

Question 8

Given that there are five memories $M1$, $M2$, $M3$, $M4$ and $M5$. Here is the program segment to instruct the circuit.

```
-----
MOV IA M1
MOV IB M2
MUL IA IB
MOV IA OUT
MOV IB M3
MUL IA IB
MOV IA OUT
MOV IB M4
SUB IA IB
MOV M5 OUT
-----
```

which of the following mathematical equation is identical to the operation of the following program segment?

- (a) $M5 = M4 - M1 \times M2 \times M3$.
- (b) $M5 = M4 - (M1 + M2) \times M3$

- (c) $M5 = M1 \times M2 \times M3 - M4$.
- (d) $M5 = (M1 + M2) \times M3 - M4$.
- (e) None of the above.