CS2026 ASSIGNMENT 7 (Due Date: April 24, 2026)

Instructions: You have to answer all of them. Put your answers in a MS WORD file, or other word processing file, and then submit the file to the course Gmail account.

Table for Question 1 to Question 5

The following table depicts the meaning of the notations in an equation performing logical operation.

Logical Operations	Descriptions
$\neg A$	NOT A
AB	AND A B
$A + B$	OR A B
$A \oplus B$	XOR A B

Question 1

Which of the following truth table is for the logical operation given below?

$$Z = (\neg A) \oplus (\neg B).$$

Hint: Fill in the following table and get your answer.

A	B	$\neg A$	$\neg B$	$(\neg A) \oplus (\neg B)$
0	0			
0	1			
1	0			
1	1			

Answer:

(a)

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	0

(b)

A	B	Z
0	0	1
0	1	0
1	0	1
1	1	1

(c)

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	1

(d)

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

(e) None of the above.

Question 2

Which of the following truth table is for the logical operation given below?

$$Z = A \oplus (\neg B).$$

Hint: Fill in the following table and get your answer.

A	B	$\neg B$	$A \oplus (\neg B)$
0	0		
0	1		
1	0		
1	1		

Answer:

(a)

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	1

(c)

A	B	Z
0	0	1
0	1	1
1	0	0
1	1	1

(d)

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

(e) None of the above.

Question 3

Which of the following truth table is for the logical operation given below?

$$Z = (A \oplus B) + B.$$

Hint: Fill in the following table and get your answer.

A	B	$A \oplus B$	$(A \oplus B) + B$
0	0		
0	1		
1	0		
1	1		

Answer:

(a)

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Z
0	0	1
0	1	0
1	0	1
1	1	1

(c)

A	B	Z
0	0	1
0	1	1
1	0	0
1	1	1

(d)

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

(e) None of the above.

Question 4

Which of the following truth table is for the logical operation given below?

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

Hint: Fill in the following table and get your answer.

A	B	$\neg A$	$A \oplus B$	$(\neg A) + (A \oplus B)$
0	0			
0	1			
1	0			
1	1			

Answer:

(a)

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Z
0	0	1
0	1	0
1	0	1
1	1	1

(c)

A	B	Z
0	0	1
0	1	1
1	0	0
1	1	1

(d)

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

(e) None of the above.

Question 5

Which of the following truth table is for the logical operation given below?

$$Z = AB + (\neg A)(\neg B).$$

Hint: Fill in the following table and get your answer. Owing to shorten the width of the table, we let $\bar{A}$ be $\neg A$ and $\bar{B}$ be $\neg B$.

A	B	AB	$\bar{A}$	$\bar{B}$	$\bar{A}\bar{B}$	$AB + \bar{A}\bar{B}$
0	0					
0	1					
1	0					
1	1					

Answer:

(a)

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

(b)

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	1

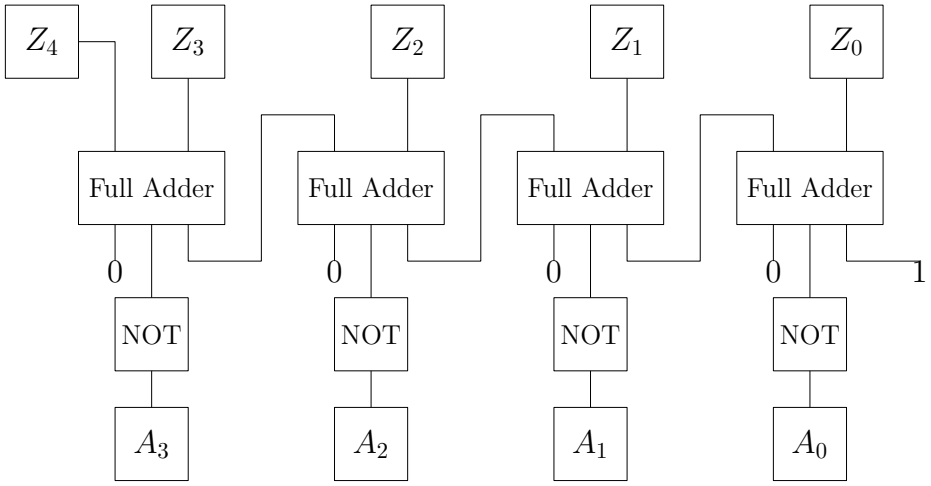
(c)

A	B	Z
0	0	1
0	1	1
1	0	0
1	1	1

(d)

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

(e) None of the above.



A	B	C_{in}	C_{out}	Z
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Figure 1: A logic circuit with four full adders. The rightmost input C_{in} of the rightmost full adder is always connected to logical '1'. The truth table for the full adder is given in the table. For each full adder, the inputs from left to right are A, B and C_{in}. The outputs from left to right are C_{out} and Z.

Question 6

Figure 1 shows a logic circuit with four full adders. If $A_3A_2A_1A_0 = 0101$, what is the output $Z_4Z_3Z_2Z_1Z_0$?

Answer:

(a) $Z_4Z_3Z_2Z_1Z_0 = 10100$.

(b) $Z_4Z_3Z_2Z_1Z_0 = 10110$.

(c) $Z_4Z_3Z_2Z_1Z_0 = 01010$.

(d) $Z_4Z_3Z_2Z_1Z_0 = 01011$.

(e) None of the above.

Question 7

With reference to the simple processor as shown in the Appendix, Figure 2, suppose that the registers are preset as $RA = 1$, $RB = 0$, $RZ = 0$, $R1 = R2 = R3 = R4 = 1$. What will be the contents of the registers RA and RB after the following micro-instructions (S1, S2, S3 and S4) have been executed?

S1: $S_1 = S_8 = 1$. The control signals to other connectors are set to 0. The signals to all two-way switches are set to 00.

S2: $S_{14} = 01$. $S_{12} = S_{15} = 10$. The control signals to all connectors are set to 0. The signals to other two-way switches are set to 00.

S3: $S_2 = S_5 = S_9 = 1$. The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

S4: $S_{12} = 10$. $S_{14} = 01$. $S_{16} = 10$. The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	1	0	0	1	1	1	1
S1							
S2							
S3							
S4							

Answer :

(a) $RA = 0, RB = 0$.

(b) $RA = 0, RB = 1$.

(c) $RA = 1, RB = 0$.

(d) $RA = 1, RB = 1$.

Question 8

With reference to the simple processor as shown in the Appendix, Figure 2, suppose that the registers are preset as $RA = 1$, $RB = 0$, $RZ = 0$, $R1 = R2 = R3 = R4 = 1$. What will be the contents of the registers $R1$ and $R2$ after the following micro-instructions (S1, S2, S3 and S4) have been executed?

S1: $S_1 = S_8 = 1$. The control signals to other connectors are set to 0. The signals to all two-way switches are set to 00.

S2: $S_{14} = 01$. $S_{12} = S_{15} = 10$. The control signals to all connectors are set to 0. The signals to other two-way switches are set to 00.

S3: $S_2 = S_5 = S_9 = 1$. The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

S4: $S_{12} = 10$. $S_{14} = 01$. $S_{16} = 10$. The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	1	0	0	1	1	1	1
S1							
S2							
S3							
S4							

Answer :

(a) $R1 = 0, R2 = 0$.

(b) $R1 = 0, R2 = 1$.

(c) $R1 = 1, R2 = 0$.

(d) $R1 = 1, R2 = 1$.

Question 9

With reference to the simple processor as shown in the Appendix, Figure 2, suppose that the registers are preset as $RA = 1$, $RB = 0$, $RZ = 0$, $R1 = R2 = R3 = R4 = 1$. What will be the contents of the registers $R3$ and $R4$ after the following micro-instructions (S1, S2, S3 and S4) have been executed?

S1: $S_1 = S_8 = 1$. The control signals to other connectors are set to 0. The signals to all two-way switches are set to 00.

S2: $S_{14} = 01$. $S_{12} = S_{15} = 10$. The control signals to all connectors are set to 0. The signals to other two-way switches are set to 00.

S3: $S_2 = S_5 = S_9 = 1$. The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

S4: $S_{12} = 10.\ S_{14} = 01.\ S_{16} = 10.$ The control signals to other connectors are set to 0. The signals to other two-way switches are set to 00.

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	1	0	0	1	1	1	1
S1							
S2							
S3							
S4							

Answer :

(a) $R3 = 0, R4 = 0.$

(b) $R3 = 0, R4 = 1.$

(c) $R3 = 1, R4 = 0.$

(d) $R3 = 1, R4 = 1.$

Question 10

With reference to the figure as shown in Figure 3, the initial conditions of the processor is set to be following.

$$S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = S_{14} = 00.$$
$$A1 = A2 = 0.\ R/W = 00.$$
$$R1 = R2 = R3 = R4 = 0.$$
$$RA = 1.\ RB = 0.\ RZ = 0.$$

What will be the content of RZ and $R1$ if the following micro-program has been executed?

S1: $S_1 = S_2 = S_3 = 1.\ S_{12} = S_{13} = S_{14} = 00.$ $A1 = A2 = 0.\ R/W = 00.$

S2: $S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = 10.\ S_{14} = 01.$ $A1 = A2 = 0.\ R/W = 00.$

S3: $S_1 = S_2 = S_3 = 1.\ S_{12} = S_{13} = S_{14} = 00.$ $A1 = A2 = 0.\ R/W = 00.$

S4: $S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = 00.\ S_{14} = 01.$ $A1 = A2 = 0.\ R/W = 10.$

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	1	0	0	0	0	0	0
S1							
S2							
S3							
S4							

Answer :

(a) $RZ = 0, R1 = 0.$

(b) $RZ = 0, R1 = 1.$

(c) $RZ = 1, R1 = 0.$

(d) $RZ = 1, R1 = 1.$

Question 11

With reference to the figure as shown in Figure 3, the initial conditions of the processor is set to be following.

$$S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = S_{14} = 00.$$
$$A1 = A2 = 0.\ R/W = 00.$$
$$R1 = R2 = R3 = R4 = 0.$$
$$RA = 0.\ RB = 1.\ RZ = 0.$$

What will be the content of $R1$ and $R2$ if the following micro-program has been executed?

S1: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 01.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 10.$

S2: $S_1 = S_2 = S_3 = 0.\ S_{12} = 01.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S3: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S4: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 0.\ A2 = 1.\ R/W = 10.$

S5: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 01.$

S6: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S7: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 10.\ S_{14} = 01.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S8: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 1.\ R/W = 01.$

S9: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S10: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 1.\ A2 = 0.\ R/W = 10.$

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	1	0	0	0	0	0	0
S1							
S2							
S3							
S4							
S5							
S6							
S7							
S8							
S9							
S10							

Answer :

(a) $R1 = 0, R2 = 0.$

(b) $R1 = 0, R2 = 1.$

(c) $R1 = 1, R2 = 0.$

(d) $R1 = 1, R2 = 1.$

Question 12

With reference to the figure as shown in Figure 3, the initial conditions of the processor is set to be following.

$$S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = S_{14} = 00.$$

$$A1 = A2 = 0.\ R/W = 00.$$

$$R1 = R2 = R3 = R4 = 0.$$

$$RA = 0.\ RB = 1.\ RZ = 0.$$

What will be the content of $R1$ and $R2$ if the following micro-program has been executed?

S1: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 01.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 10.$

S2: $S_1 = S_2 = S_3 = 0.\ S_{12} = 01.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S3: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S4: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S5: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 0.\ A2 = 1.\ R/W = 10.$

S6: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 01.$

S7: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S8: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S9: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 10.\ S_{14} = 01.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S10: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 1.\ R/W = 01.$

S11: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S12: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 1.\ A2 = 0.\ R/W = 10.$

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	0	1	0	0	0	0	0
S1							
S2							
S3							
S4							
S5							
S6							
S7							
S8							
S9							
S10							
S11							
S12							

Answer :

(a) $R1 = 0, R2 = 0.$

(b) $R1 = 0, R2 = 1.$

(c) $R1 = 1, R2 = 0.$

(d) $R1 = 1, R2 = 1.$

Question 13

With reference to the figure as shown in Figure 3, the initial conditions of the processor is set to be following.

$$S_1 = S_2 = S_3 = 0.\ S_{12} = S_{13} = S_{14} = 00.$$

$$A1 = A2 = 0.\ R/W = 00.$$

$$R1 = R2 = R3 = R4 = 0.$$

$$RA = 0.\ RB = 1.\ RZ = 0.$$

What will be the content of RA and RB if the following micro-program has been executed?

S1: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 01.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 10.$

S2: $S_1 = S_2 = S_3 = 0.\ S_{12} = 01.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S3: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S4: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S5: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 0.\ A2 = 1.\ R/W = 10.$

S6: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 10.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 01.$

S7: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S8: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S9: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 10.\ S_{14} = 01.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S10: $S_1 = S_2 = S_3 = 0.\ S_{12} = 10.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 1.\ R/W = 01.$

S11: $S_1 = S_2 = S_3 = 1.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 00.\ A1 = 0.\ A2 = 0.\ R/W = 00.$

S12: $S_1 = S_2 = S_3 = 0.\ S_{12} = 00.\ S_{13} = 00.\ S_{14} = 01.\ A1 = 1.\ A2 = 0.\ R/W = 10.$

Hint: Fill in the following table to get your answer.

	R_A	R_B	R_Z	R_1	R_2	R_3	R_4
Initial	0	1	0	0	0	0	0
S1							
S2							
S3							
S4							
S5							
S6							
S7							
S8							
S9							
S10							
S11							
S12							

Answer :

(a) $RA = 0, RB = 0$.

(b) $RA = 0, RB = 1$.

(c) $RA = 1, RB = 0$.

(d) $RA = 1, RB = 1$.

Question 14

Suppose an integer is represented in the following 8-bit sign-magnitude fix-point format.

$$\text{Number} = sx_{n-1} \cdots x_1 x_0$$

Here,

$$s = \begin{cases} 0 & \text{if the number is positive,} \\ 1 & \text{if the number is negative.} \end{cases}$$

The number in decimal is given by

$$\text{Number} = (-1)^s \sum_{i=0}^{n-1} x_i 2^i.$$

What is the minimum number that can be represented by this format?

Answer:

(a) 2^7.

(b) $2^7 - 1$.

(c) 0.

(d) $1 - 2^7$.

(e) None of the above.

Question 15

Suppose an integer is represented in the following 8-bit sign-magnitude fix-point format.

$$\text{Number} = sx_{n-1} \cdots x_1 x_0$$

Here,

$$s = \begin{cases} 0 & \text{if the number is positive,} \\ 1 & \text{if the number is negative.} \end{cases}$$

The number in decimal is given by

$$\text{Number} = (-1)^s \sum_{i=0}^{n-1} x_i 2^i.$$

What is the maximum number that can be represented by this format?

Answer:

(a) 2^7.

(b) $2^7 - 1$.

(c) 0.

(d) $1 - 2^7$.

(e) None of the above.

Question 16

Suppose an integer is represented in the following 8-bit sign-magnitude fix-point format.

$$\text{Number} = sx_{n-1} \cdots x_1 x_0$$

Here,

$$s = \begin{cases} 0 & \text{if the number is positive,} \\ 1 & \text{if the number is negative.} \end{cases}$$

The number in decimal is given by

$$\text{Number} = (-1)^s \sum_{i=0}^{n-1} x_i 2^i.$$

The range of a number format is defined as the difference between the maximum number and the minimum number that can be represented. What is the range of this number format? [Note: -0 is ignored.]

Answer:

(a) 2^7.

(b) $2^7 - 1$.

(c) 2^8.

(d) $2^8 - 1$.

(e) None of the above.

Question 17

For a number represented by $(n + m + 1)$-bit sign-magnitude fixed point format, the binary number has one sign-bit s, n bits for integral part and m bits for the fractional part.

$$\text{Number} = sx_{n-1} \cdots x_1 x_0 y_1 y_2 \cdots y_m.$$

The value of the above binary number in decimal form can be obtained as follows :

$$\text{Number} = (-1)^s \left(\sum_{i=0}^{n} x_i 2^i + \sum_{j=1}^{m} y_j 2^{-j} \right).$$

That is to say,

$$s = \begin{cases} 0 & \text{if the number is positive,} \\ 1 & \text{if the number is negative.} \end{cases}$$

Now, there are three different sign-magnitude fixed point number presentation formats.

(i) 8-bit sign-magnitude format.

`sxxxyyyy`

(ii) 8-bit sign-magnitude format.

`sxxxxyyy`

(iii) 8-bit sign-magnitude format.

`sxxxxxyy`

The range of a number format is defined as the difference between the maximum number and the minimum number that can be represented. In term of the range, from the longest to the shortest, which of the following is the correct order?

Answer:

(a) (i) > (ii) > (iii).

(b) (i) > (iii) > (ii).

(c) (ii) > (i) > (iii).

(d) (iii) > (ii) > (i).

(e) None of the above.

Question 18

For a number represented by $(n + m + 1)$-bit sign-magnitude fixed point format, the binary number has one sign-bit s, n bits for integral part and m bits for the fractional part.

$$\text{Number} = sx_{n-1} \cdots x_1 x_0 y_1 y_2 \cdots y_m.$$

The value of the above binary number in decimal form can be obtained as follows :

$$\text{Number} = (-1)^s \left(\sum_{i=0}^{n} x_i 2^i + \sum_{j=1}^{m} y_j 2^{-j} \right).$$

That is to say,

$$s = \begin{cases} 0 & \text{if the number is positive,} \\ 1 & \text{if the number is negative.} \end{cases}$$

Now, there are three different sign-magnitude fixed point number presentation formats.

(i) 8-bit sign-magnitude format.

`sxxxyyyy`

(ii) 8-bit sign-magnitude format.

`sxxxxyyy`

(iii) 8-bit sign-magnitude format.

`sxxxxxyy`

The precision of a number format is defined as the difference between two consecutive numbers that can be represented. If the difference is smaller, the precision is higher. In term of the precision, from the highest to the lowest, which of the following is the correct order?

Answer:

(a) (i) > (ii) > (iii).

(b) (i) > (iii) > (ii).

(c) (ii) > (i) > (iii).

(d) (iii) > (ii) > (i).

(e) None of the above.

APPENDIX

In this appendix, you will find the architectures of (A) the processor with 4 logic gates and (B) the processor with one logic gate.

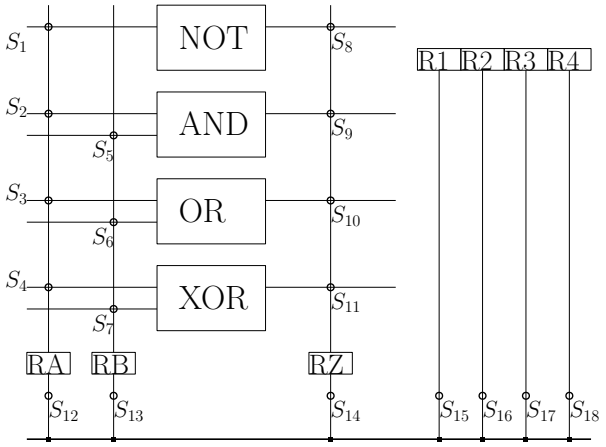
A. Processor with 4 Logic Gates

A simple processor, with a sector of four logic gates and a sector of four registers, shown in Figure 2. Each register is associated with a two-way switch. The signals to be fed to the switch and the corresponding actions are depicted in the following table.

S_i	Action
00	Disconnect.
01	Read from register.
10	Write to register.

For each connector, its control signal is either '0' (for disconnection) and '1' (for connection).

$$\text{Connection} = \begin{cases} \text{Connect} & \text{if } S_i = 1, \\ \text{Disconnect} & \text{if } S_i = 0. \end{cases}$$



Two-Way Switches: Disconnected (00); Down (01), Up (10).

$(S_{12}, S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18})$

Connectors: Disconnected (0), Connected (1).

$(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11})$

Figure 2: A processor with four logic gates. Switches S_1 to S_{11} are simple switches (i.e. connectors). S_{12} to S_{18} are two-way switches.

B. Processor with a NAND Gate

Figure 3 shows a simple processor with single NAND gate inside. Switches S_1, S_2 and S_3 are simple switches (i.e. connectors). S_{12}, S_{13} and S_{14} are two-way switches. The signals sending to $A1$, $A2$ and R/W together with the corresponding actions are depicted in the following table.

$A1$	$A2$	R/W	Action
0	0	01	Read data from $R1$
0	1	01	Read data from $R2$
1	0	01	Read data from $R3$
1	1	01	Read data from $R4$
0	0	10	Write data to $R1$
0	1	10	Write data to $R2$
1	0	10	Write data to $R3$
1	1	10	Write data to $R4$
x	x	00	Disconnection

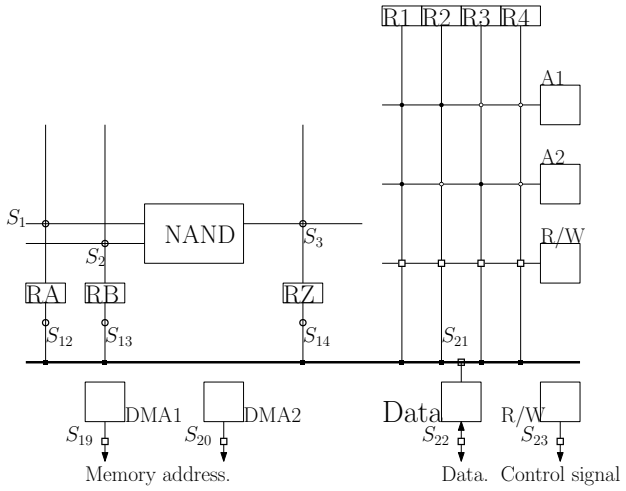


Figure 3: A processor with single NAND gate.