



American International University – Bangladesh

Faculty of Engineering

Department of Electrical and Electronic Engineering

Course Name:	Microprocessor and Embedded Systems	Course Code:	
Semester:	2022-2023 Summer	Section:	F
Faculty Name:	Md Sajid Hossain		

Assignment No:	3 (individual submission consisting of 30 marks)
-----------------------	--

Student Name:	Rifat Hossain		
Student ID:	20-42461-1	Program Name:	CSE

[Sec: F]-Submission Link (MS forms): https://forms.office.com/r/zurGRhwBMW			
[Sec: Q]-Submission Link (MS forms): https://forms.microsoft.com/r/T6ZX6zhpFu			
Submission Date:	23/08/2023	Due Date:	EXAM DAY

Assessment Rubrics:

COs-POIs	Excellent [28-30]	Proficient [25-27]	Good [20-24]	Acceptable [10-19]	Unacceptable [1-9]	No Response [0]	Secured Marks
CO3 P.a.4.C.3	All the problems are solved correctly. The simulation processes are clearly described, and results are generated by combining all possible input patterns with appropriate outcomes. All necessary drawings and computations are shown.	All the problems are solved correctly. The simulation processes are clearly described, and results are generated by combining all possible input patterns with appropriate outcomes. A few necessary drawings and computations are missing.	All the problems are solved correctly. The simulation processes are not clearly described, and results are generated by combining all possible input patterns with appropriate outcomes. Some necessary drawings and computations are missing.	All the problems are not solved correctly. The simulation processes are not clearly described, and results are generated by combining several wrong input patterns with inappropriate outcomes. Some necessary drawings and computations are missing.	All the problems are not solved correctly. The simulation processes are not described, and results are generated by combining mostly wrong input patterns with inappropriate outcomes. Almost all the necessary drawings and computations are missing.	No responses at all	
Comments					Total marks (30)		

Questions:

1. Prepare a design of 2-bit ALU for the operations listed in Table 1 [10]

Table 1: For Questions 1 and 2 and 3

Binary Code	Function of selection variables					
	A	B	F with $C_{in} = 1$	F with $C_{in} = 0$	D	H
0 0 0	Input Data	Input Data	A+1	A, $C \leftarrow 0$	None	1's to the output Bus
0 0 1	R1	R1	A, $C \leftarrow 1$	A-1	R1	Shift Right with $I_R=0$
0 1 0	R2	R2	A+B'+1	A+B'	R2	-
0 1 1	R3	R3	A+B+1	A+B	R3	Circulate Left with Carry
1 0 0	R4	R4	A U B	A U B	R4	0's to the output Bus
1 0 1	R5	R5	A'	A'	R5	No Shift
1 1 0	R6	R6	A \cap B	A \cap B	R6	Circulate Right with Carry
1 1 1	R7	R7	A XOR B	A XOR B	R7	Shift Left with $I_L=0$

2. Design a 3-bit shifter circuit for the listed shift functions provided in Table 1. [5]

3. Develop the control words in binary and hexadecimal formats using the information provided in Table 1 for the following micro-operations: [10]

- | | |
|-------------------------------------|-----------------------------------|
| i. $R7 \leftarrow R3 + R4$ | ii. $R4 \leftarrow 3(R4 - 0)/3$ |
| iii. $R3 \leftarrow \text{SHL } R3$ | iv. $\text{Output} \leftarrow R5$ |
| v. $R5 \leftarrow R1$ | vi. $R2 \leftarrow 0$ |
| vii. $R6 \leftarrow \text{Input}$ | viii. $R6 \leftarrow R4 - R2$ |
| ix. $R2 \leftarrow \text{SHR } R5$ | x. $R3 \leftarrow \text{CRC } R7$ |

One example is shown as follows:

Micro-operation	A	B	D	F	C_{in}	H	In Hex
$R5 \leftarrow \text{CRC } (R3 + R4)$	011	100	101	011	0	110	72B6h

The necessary bits for the control word are presented in Table 2.

Table 1: 16-bit control word sequence

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A			B			D			F			C_{in}	H		

4. Show the flow chart for *counting the number of 1's* in register, R3, and storing the count in register R7. Assume that the starting address is 9. If register, R3 contains the data 10011011 then what would be the contents of register, R7 after this micro-operation is completed? [5]

(1) NO Question Answer

$\underline{S_2}$	$\underline{S_1}$	$\underline{S_0}$	$\underline{C_{in}}$	\underline{X}	\underline{Y}	\underline{Z}	\underline{F}
0	0	0	0	A	0	0	$A, C \leftarrow 0$
0	0	0	1	A	0	1	$A+1$
0	0	1	0	A	All 1s	0	$A-1$
0	0	1	1	A	All 1s	1	$A, C \leftarrow 1$
0	1	0	0	A	\bar{B}	0	$A+\bar{B}$
0	1	0	1	A	\bar{B}	1	$A+\bar{B}+1$
0	1	1	0	A	B	0	$A+B$
0	1	1	1	A	B	1	$A+B+1$
1	0	0	0	$A+B$	0	0	$A \cup B$
1	0	1	0	A	1	0	\bar{A}
1	1	0	0	$A+\bar{B}$	\bar{B}	0	$A \cap B$
1	1	1	0	A	B	0	$A \oplus B$

K-map for x

s_2	$s_1 s_0$	00	01	11	10
		0	1	3	2
0		A	A	A	A
1		A+B	A	A	A+B
		4	5	7	6

$$B S_2 \bar{S}_1 \bar{S}_0$$

$$\bar{B} S_2 S_1 \bar{S}_0$$

$$x = A + B S_2 \bar{S}_1 \bar{S}_0$$

$$+ \bar{B} S_2 S_1 \bar{S}_0$$

K-map for y

s_2	$s_1 s_0$	00	01	11	10
			1	3	2
0		0	A+B	B	\bar{B}
1		0	1	B	\bar{B}
			5	7	6

$$B S_0$$

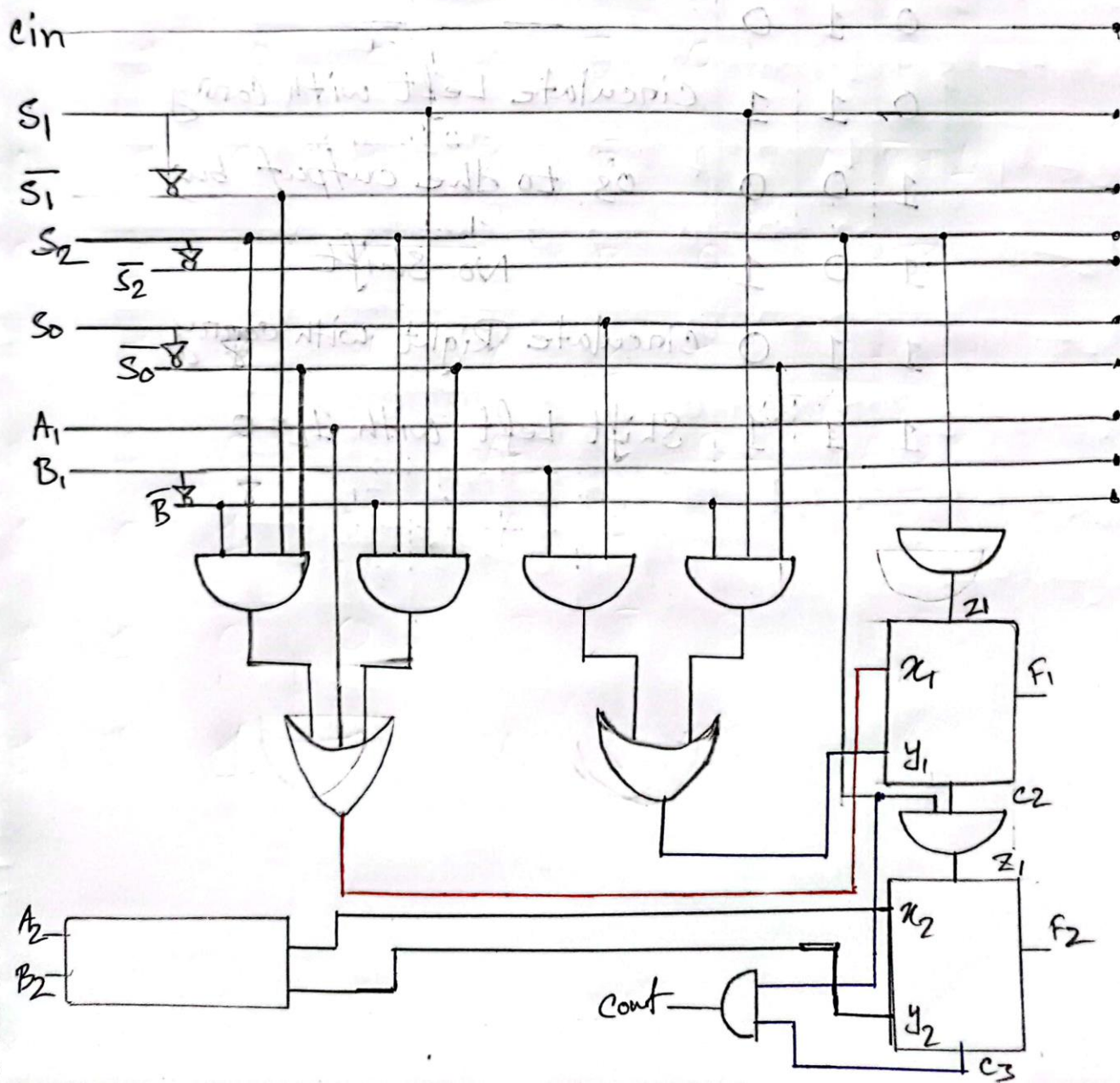
$$\bar{B} S_1 \bar{S}_0$$

$$y = B S_0 + \bar{B} S_1 \bar{S}_0$$

K-map for Z

$S_1 S_0$	00	01	11	10
0	cin	cin	cin	cin
1	0	0	0	0

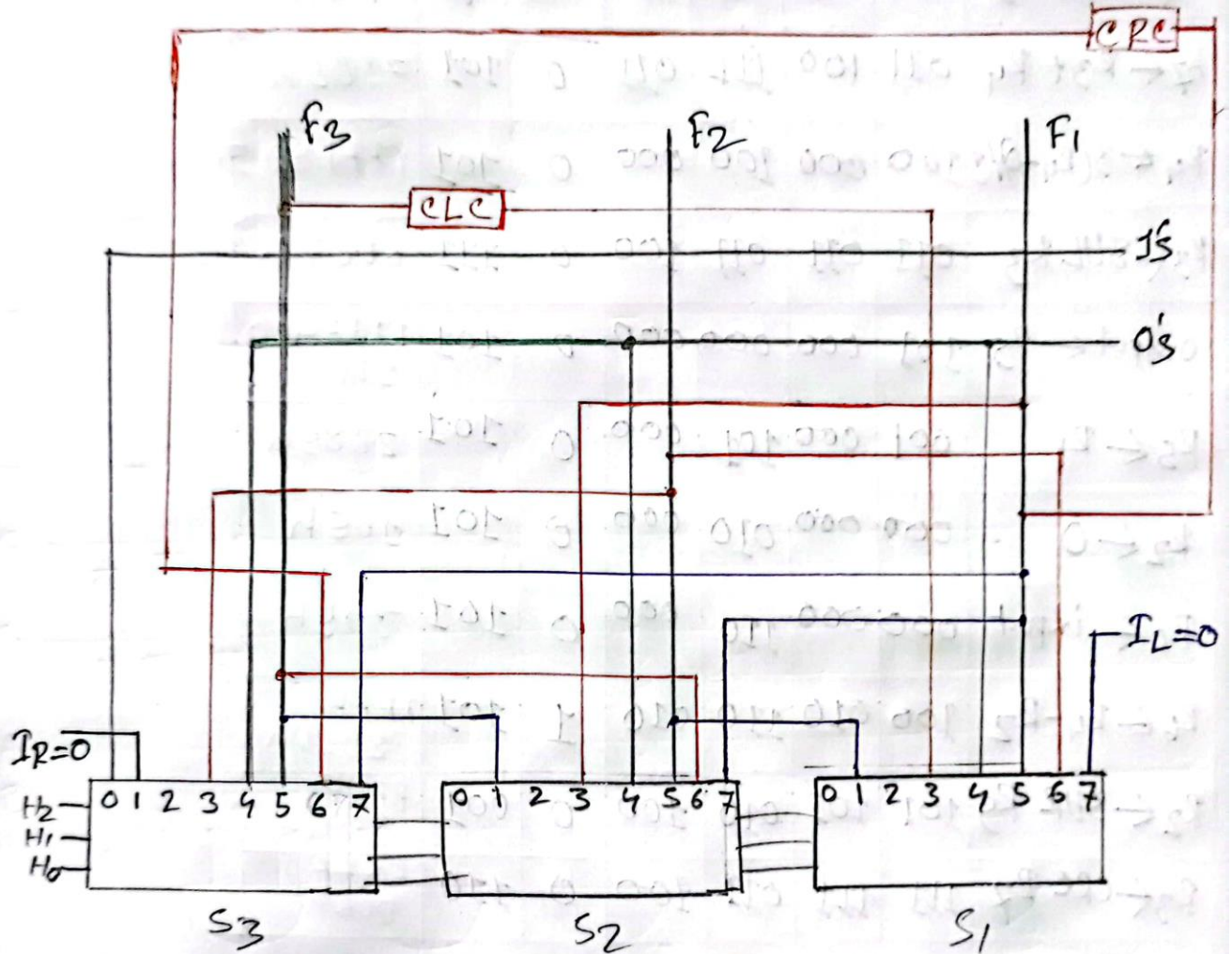
$$Z = cin S_2$$



(2) No Question Ans

3 bit shifter:

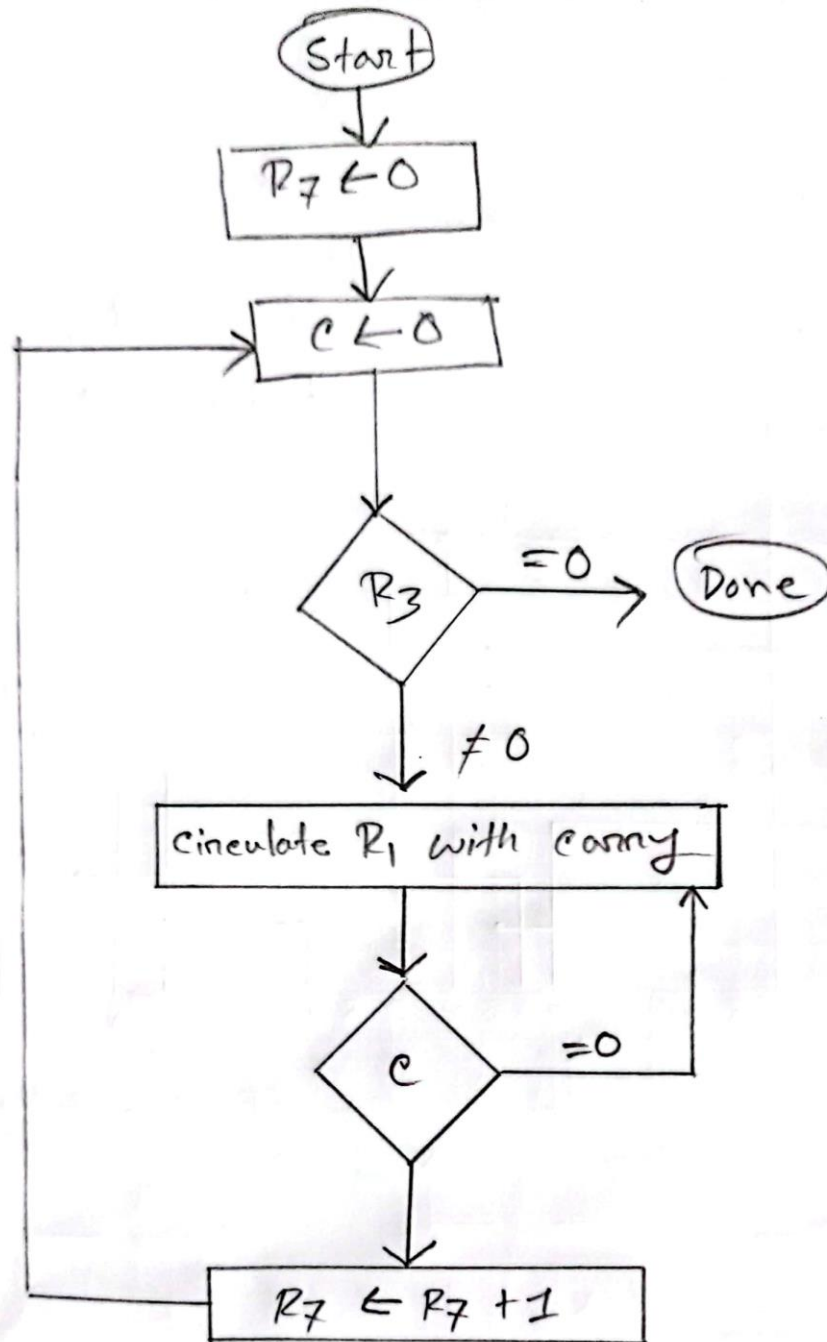
H_2	H_1	H_0	Function
0	0	0	1's to the output Bus
0	0	1	Shift Right with $I_R = 0$
0	1	0	— —
0	1	1	circulate Left with carry
1	0	0	0's to the output bus
1	0	1	No shift
1	1	0	circulate Right with carry
1	1	1	Shift Left with $I_L = 0$



3 NO Question Answer

Micro operations	A	B	D	F	cin	H	Hex
$R_7 \leftarrow R_3 + R_4$	011	100	111	011	0	101	73B5h
$R_4 \leftarrow S(R_4 - 0)/5$	100	000	100	000	0	101	FFFF8205h
$R_3 \leftarrow SHL R_3$	011	011	011	100	0	111	6DC7h
$Output \leftarrow R_5$	101	000	000	000	0	101	FFFFAC05h
$R_5 \leftarrow R_1$	001	000	101	000	0	101	2285h
$R_2 \leftarrow 0$	000	000	010	000	0	101	105h
$R_6 \leftarrow input$	000	000	110	000	0	101	305h
$R_6 \leftarrow R_4 - R_2$	100	010	110	010	1	101	FFFF8B2Dh
$R_2 \leftarrow SHR R_5$	101	101	010	100	0	001	FFFFB541h
$R_3 \leftarrow CRE R_7$	111	111	011	100	0	110	FFFFDc6h

4.



$$R_3 = 10011011$$

$$R_7 = \text{Binary of } 5 = 101$$