Unit - 1 - Register Transfer and Micro-Operations

1 Explain Register Transfer Language.

=> A Digital computer system is interconnection of digital modules.

A Digital modules is innterconection of some register and some control path.

Digital modules are & defined by the register and the operations that are performed on the data stored in them.

The Operation performed on store data in register is called Micro-Operation.

The sequence of Micro-operation performed on the store data in register.

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The Register Transfer Languge is the symbolic representation of notation used to specify the sequence of Micro-operation.

RTL is used to describe the sequence of micro-operation.

Micro-operation performed between two register, between memory and register or between two memory.

RTL is an algebric notation used to define machine level operation.

RTL is not executed by a computer.

Ex. Add 3 into Register R_2.

So, RTL defined as,

$$[R_2] \leftarrow [R_2] + 3$$

2 Explain the Register Transfer in detail with block Diagram and Timing Diagram.

=) Register Transfer stands for performed micro-operation on register and store result from same or another register.

This are the comman compute Register.

- MAR - Memory Address Register
Store the address for a memory unit.

- IR - Instruction Register -
Store the instruction to be executed.

- PC - Program Counter -
Store the next line instructio of the program.

- R_1 : Processor Register

- SR : Status Register -
Store the Flags data.

Ex. Information Transfer from Register R_1 to R_2.

$$R_2 \leftarrow R_1$$

Here, Information R_1, Transfer into register R_2.

R_1 is called source location and R_2 is called destination location.

Content of R_1 does not change but content of R_2 is over-written to content of R_1.

Content of R_2 is change.

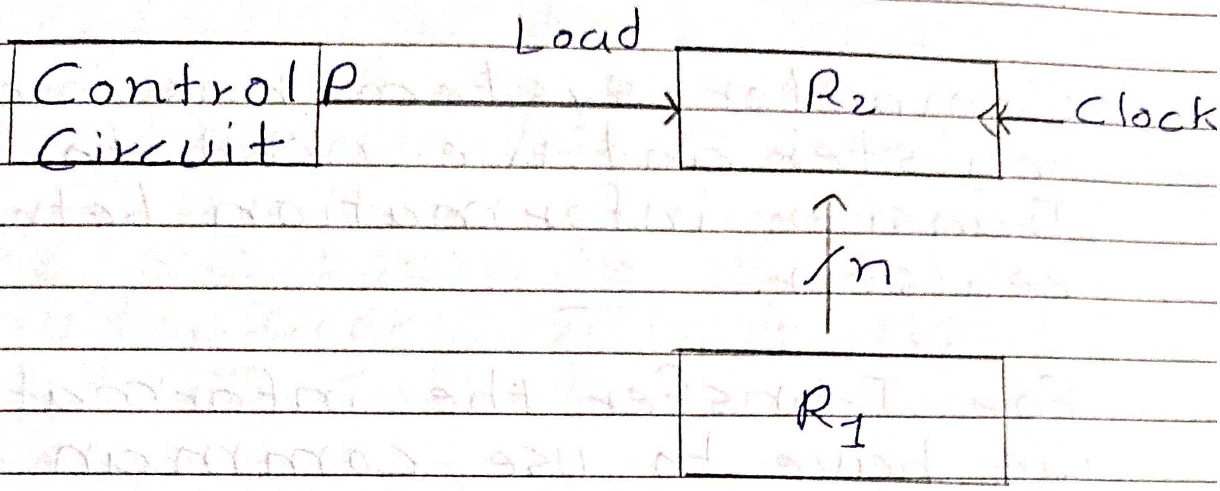
For Transfer the data from R_1 to R_2, we have to follow control condition.

$$P : R_2 \leftarrow R_1$$

Here, P is equal to 1 or 0.

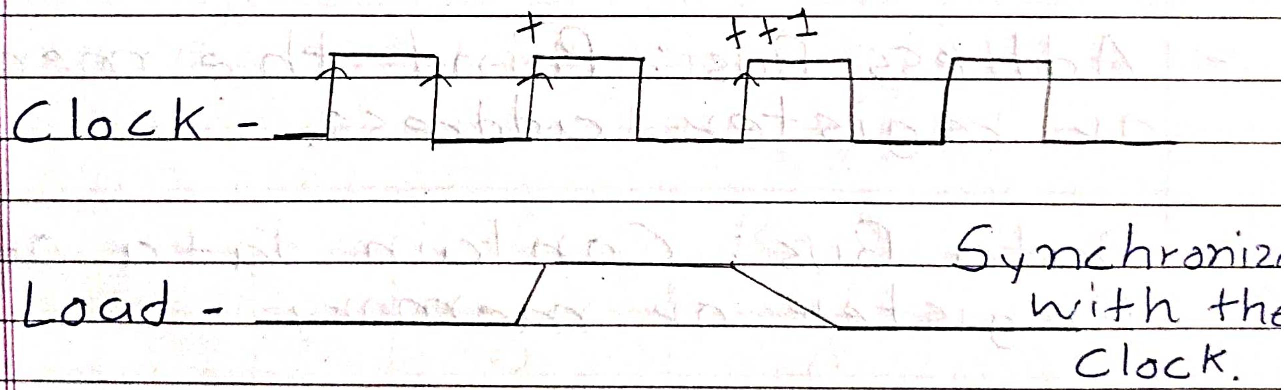
If P = 1, then Transfer data from R_1 to R_2

=> Block Diagram:



Here the n indecates the n-bit connect with R_1 and R_2 Register.

=> Timing Diagram:



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3 Design and explain a comman Bus System for four register

=> Computer system has many register and we need to Transfer information between register.

For Transfer the information we have to use comman Bus system.

For Transfer the different informatiom, comman System Bus contain different Buses.

- Address Bus : Point the memory or register address.

- Data Bus : Contain data of Register or memory.

- Control Bus : Contain control signal for performed the particular operation.

=> System Bus For Four Register.

For transfer the information using system bus for register we have to use Multiplexers.

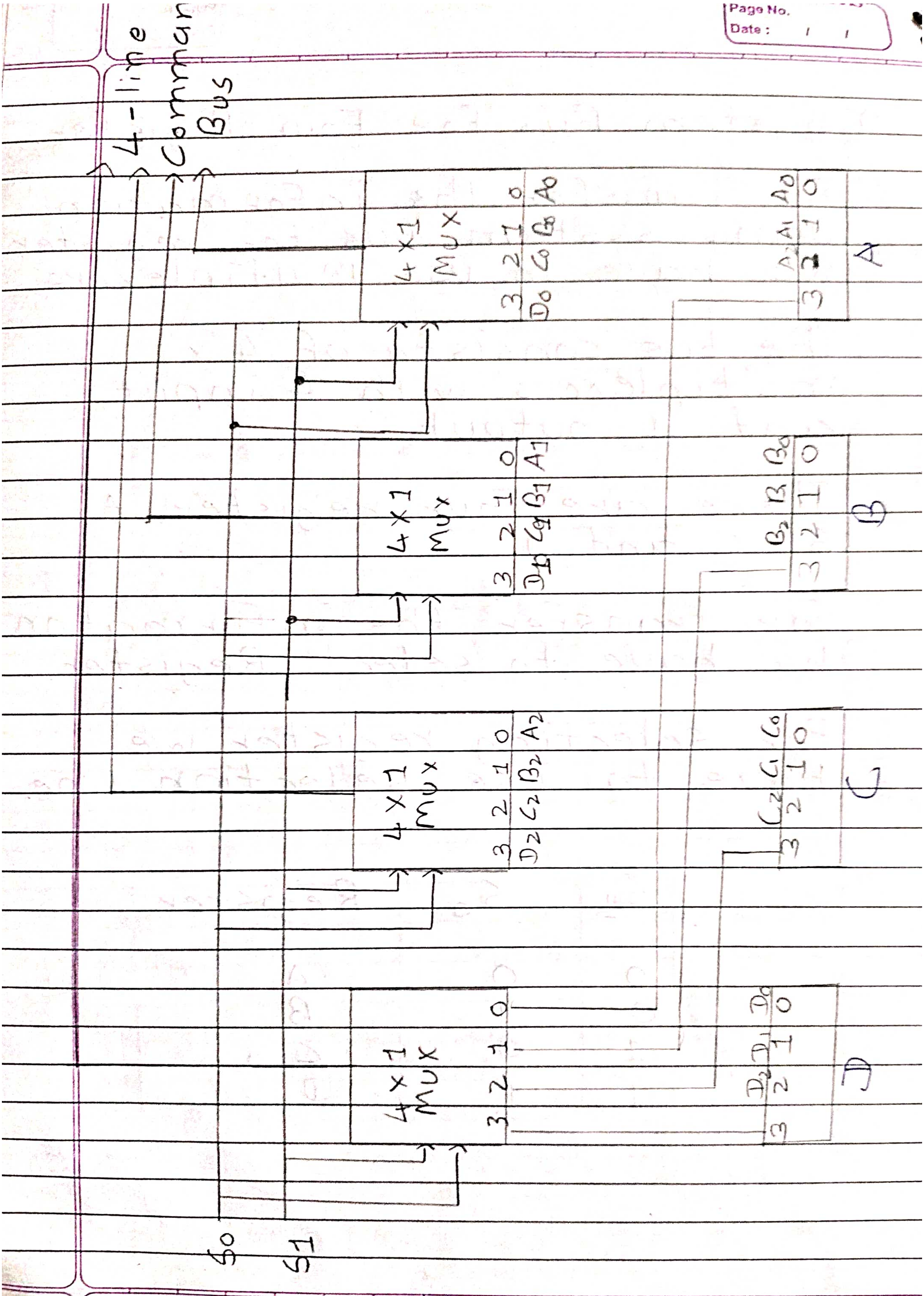
The bus consiste of 4 x 1 multiplexers with 4 input and 1 output.

There are Four register. A, B, C and D.

For transfer the information, we have to select Register.

For selecting register we have to use selection line.

S_1	S_0	Register
0	0	A
0	1	B
1	0	C
1	1	D


4-line
Common
Bus
4 x 1 MUX
4 x 1 MUX
4 x 1 MUX
4 x 1 MUX
S0
S1
A
B
C
D

4 Explain Memory Transfer.

The transfer of information from a memory is called Read Operation.

The transfer of new informatior and store in memory is called write operation.

A memory word is defined by M.

=) Read Operation:

Assume that the address of a memory unit stored in Address register AR. and the data register by DR.

DR ← M[AR]

Transfer of information into the data register from selected by the address register AR.

Here, Address register AR Transfer information in Data Register.

=> Write operation:

Assume that address of memory unit stored in Address registe AR and Process Register is R_1

$$R_1 \leftarrow M[AR]$$

Here, Address register AR information Transfer and overwrite from R_1 register.

R_1 register get new information using Address register.

5 Explain Arithmetic Micro-operation

Arithmetic Micro-operation deals with the operation performed on numeric data and stored in register.

This are the Basic Arithmetic Micro-operation.

(1) Addition: $R_3 \leftarrow R_1 + R_2$

Here, Register R_1 and Register

R_2 data Performed addition and stored in R_3 register.

② Subtraction : $R_3 \leftarrow R_1 - R_2$

Here, Register R_1 and R_2 Data Performed subtraction and stored in R_3 register.

③ 1's Complement : $R_1 \leftarrow R_1'$

Here, R_1 Register data performed complement operation and stored in R_1 register.

④ 2's Complement: $R_1 \leftarrow R_1' + 1$

Here, R_1 register data Performed complement operation and add with 1 and store in R_1 register.

⑤ Increment : $R_1 \leftarrow R_1 + 1$

Here, R_1 register data Performed addition with 1 and store in R_1 register.

⑥ Decrement Operation: $R_1 \leftarrow R_1 - 1$

Here, R_1 register Data perfomed subtraction with 1 and store in R_2 register.

6 Explain Binary Adder :

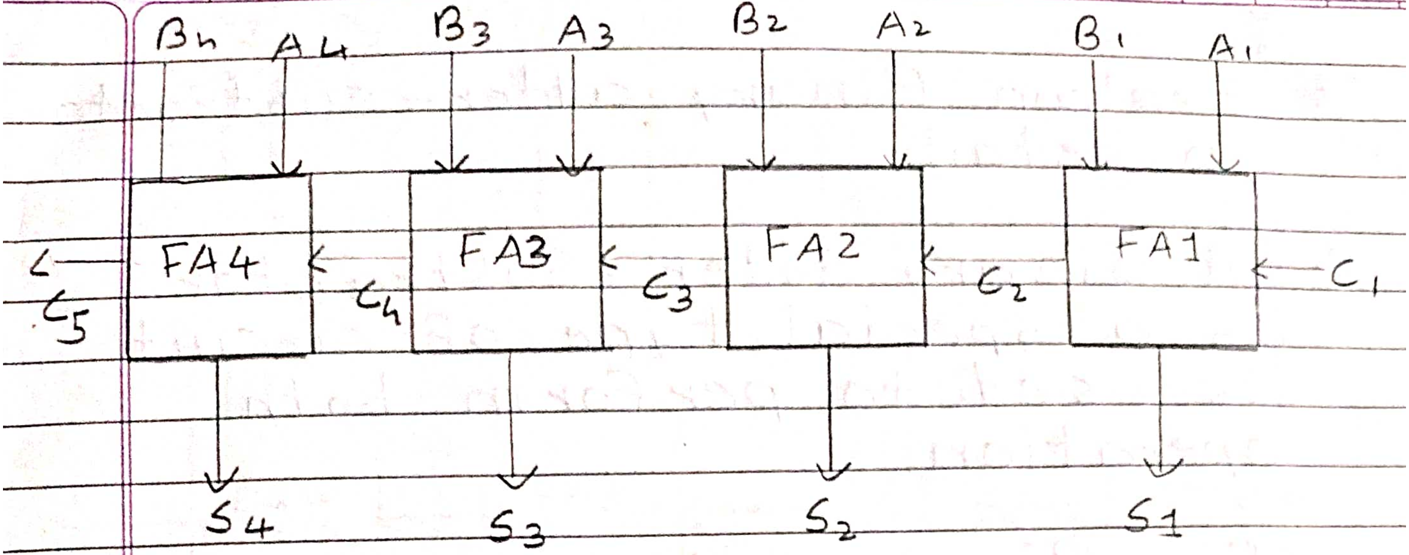
Binary adder is a digital circuit that produces the sum of two binary number.

In Binary adder, Full adders are connected in a chain.

First adder output carry is connected with each Full adder to the input carry of next adder.

n-bit binary adder requires a n-bit full adder to perform operation.

Binary adder performed the addition operation faster than single adder.



→ Advantages:

The Binary adder perform addition operation faster as compared to single adder.

→ Disadvantages:

The Binary adder, each Full adder has to wait for the carry which is generated by Previous full adder in chain.

→ Application:

Binary adder is use to finding the sum of two binary number.

7 Explain Binary adder-subtractor in detail.

=> A Binary Adder - Subtractor is a special type of circuit is used to perform both operation.

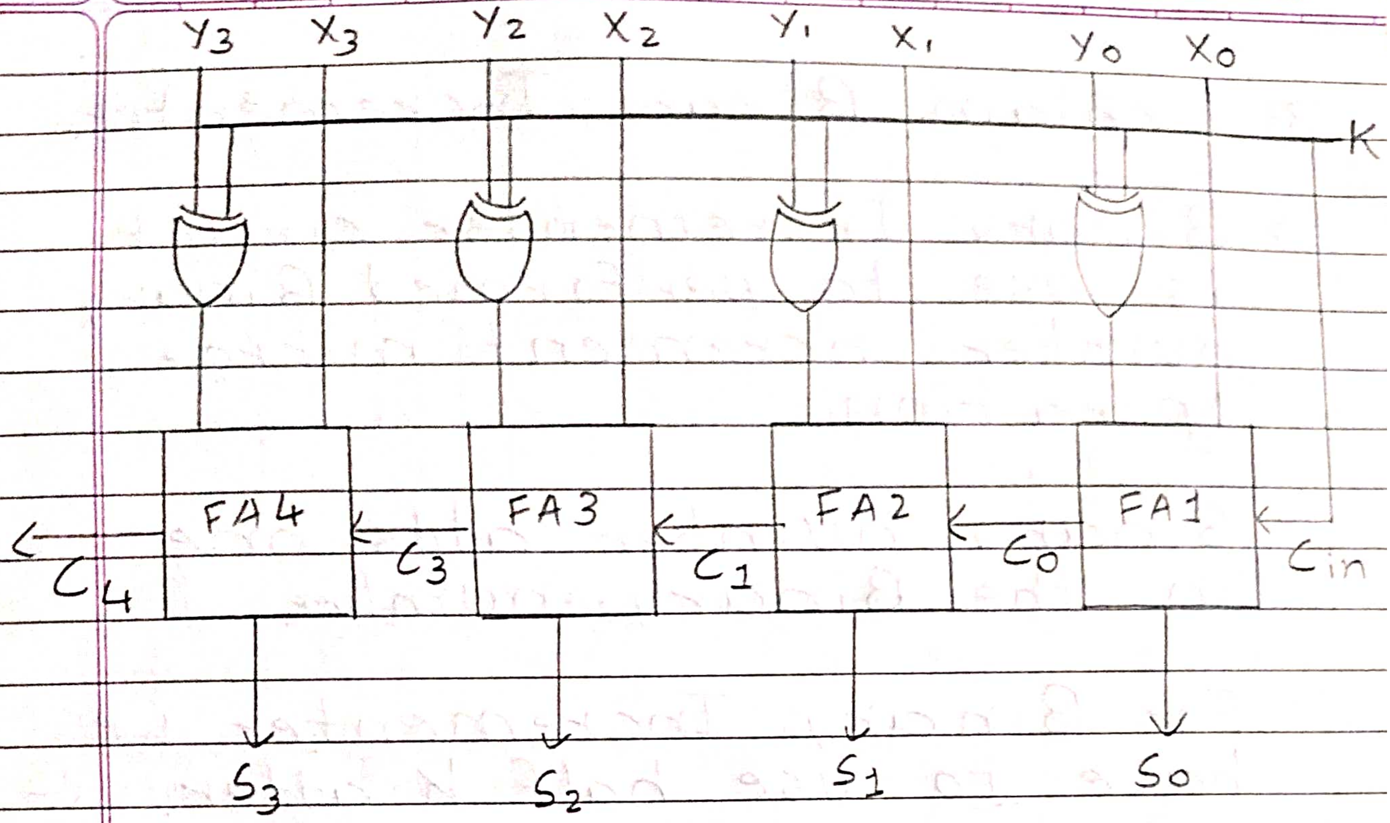
For Binary adder-subtractor required extra XOR gate in the circuit of full adder.

This circuit is control using the control signal.

The control line determines whether the operation addition or subtractor is performed.

If Control signal value is 0, So, this circuit is performed addition.

If control signal value is 1, So, this circuit is performed subtraction operation.



For n-bit Binary adder-subtractor we have to require n full adder and n XOR gate.

→ Advantages:

Using Binary Adder-Subtractor circuit we can performed addition and subtraction together.

→ Disadvantages:

For control the circuit we have to use control signle.

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8 Explain Binary Incrementer.

=> Binary Incrementer circuit is use to performed Binary number increment micro-operation.

Binary number adds one in the Binary number.

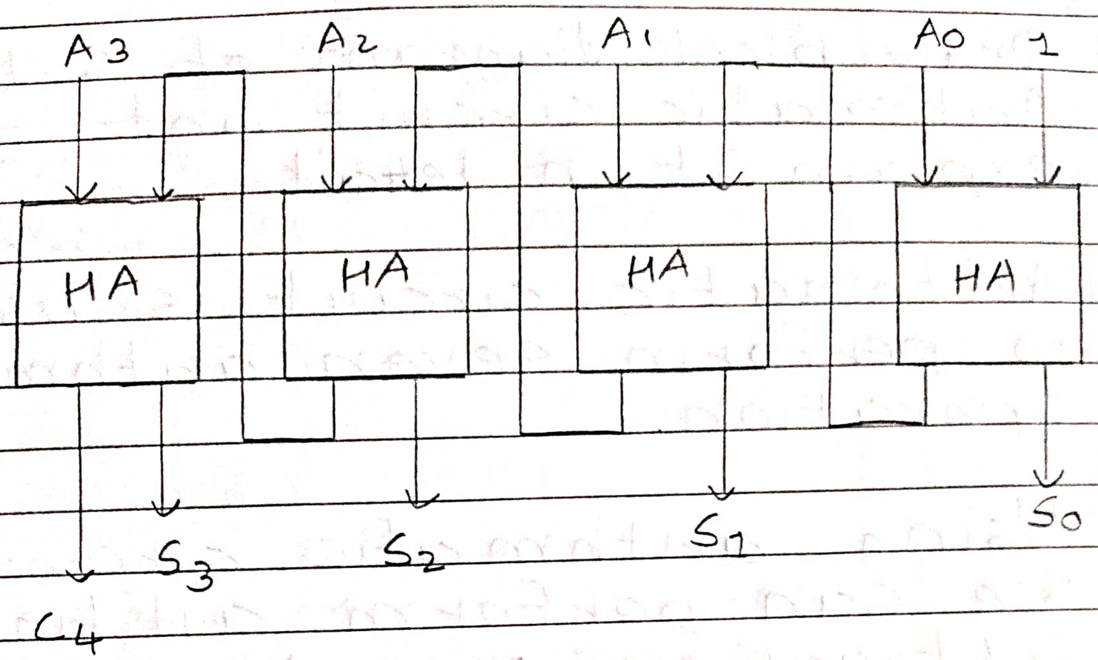
For Binary Incrementer we have to use half k adder.

For n-bit Binary Incrementer, we have to use n-bit half adder.

For Binary Incrementer, n half adder are connect with the chain.

The output carry from one half-adder is connected to one of the inputs of next half adder.

Using Binary Incrementer, we can increment any Binary number.



-> advantages:

Binary Incrementer, can performed any binary number incrementer.

-> Disadvantages:

Each Half adder, have to wait For previous carry of half adder circuit.

9 Draw Block diagram of 4-bit Arithmatic circuit and explain it in detail.

=> Arithmatic circuit is use to perform seven arithmatic operation.

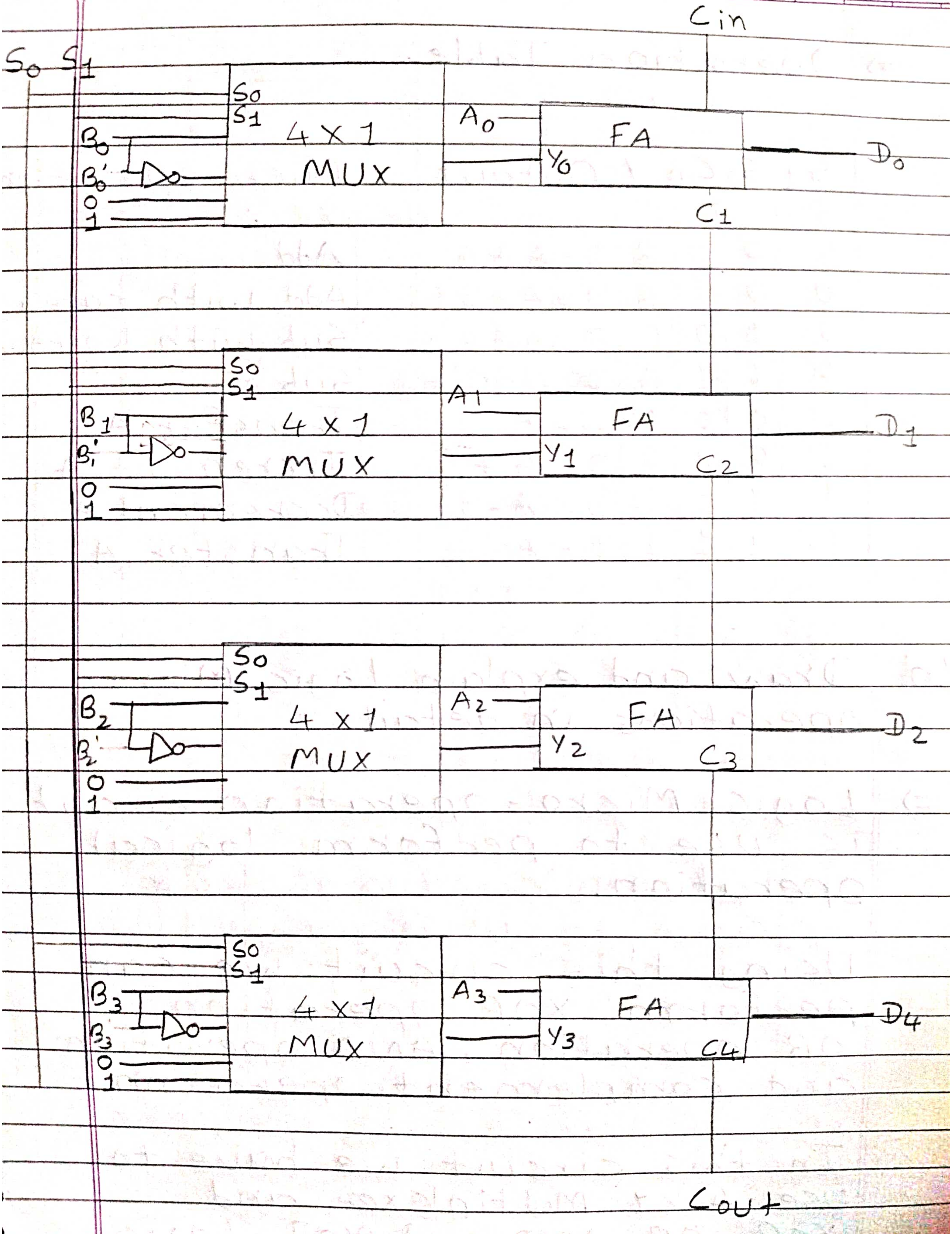
Using arithmatic circuit we can perform addition, subtraction operation.

For Arithmatic circuit we have to use Full adder and 4 x 1 Multiplexer.

For 4-Bit Arithmatic circuit we have to use 4 Full adder and 4, 4 x 1 Multiplexer.

The output of Full adder is calculated from the following arithmatic sum:

$$D = A + Y + C_{in}$$


Cin
S0 S1
S0
S1
4 X 1
MUX
B0
B0'
0
1
A0
Y0
FA
D0
C1
B1
B1'
A1
Y1
C2
D1
B2
B2'
A2
Y2
C3
D2
B3
B3'
A3
Y3
C4
D4
Cout

⇒ Operation Table:

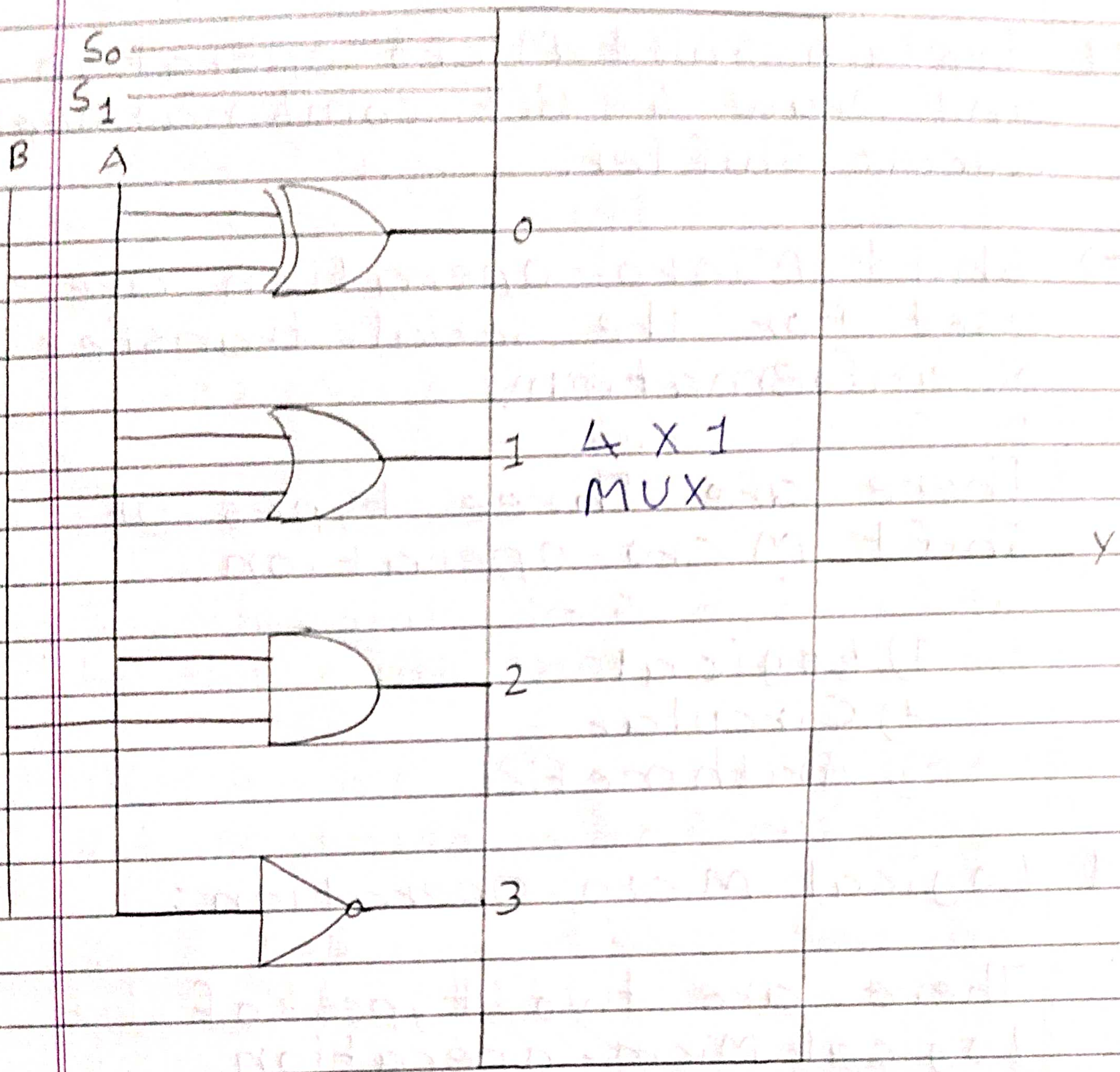
S_1	S_0	C_{in}	Y	Output	Micro-operation
0	0	0	B	D = A + B	Add
0	0	1	B	D = A + B + 1	Add with carry
0	1	0	B'	D = A + B'	Sub with borrow
0	1	1	B'	D = A + B' + 1	Sub
1	0	0	0	D = A	Transfer A
1	0	1	0	D = A + 1	Increment A
1	1	0	1	D = A - 1	Decrement A
1	1	1	1	D = A	Transfer A

10 Draw and explain Logic Micro-operations in detail.

⇒ Logic Micro-operation circuit is use to perform logical operation.

Using this circuit we can perform XOR operation, OR operation, AND operation and complement operation.

In this circuit we have to use 4 X 1 Multiplexer and XOR, OR, AND and NOT Logic Gates.



S_0	S_1	Output	Operation
0	0	$Y = A \oplus B$	XOR
0	1	$Y = A \vee B$	OR
1	0	$Y = A \wedge B$	AND
1	1	$Y = A'$	Complement

11 Explain Shift Micro-operation and Draw 4-Bit combinational circuit shifter.

=> Shift Micro-operation are used for the serial transfer of information.

There are Three types of shift Micro-operation.

1) Logical
2) Circular
3) Arithmetic.

1 Logical Micro-Operation:

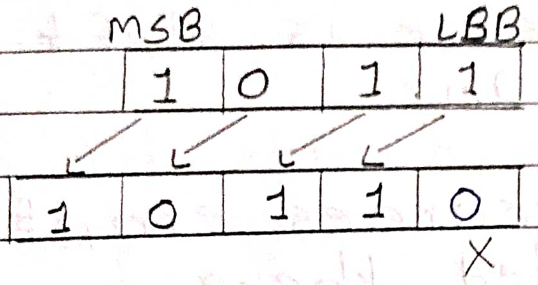
There are two types of Logical Micro-operation.

(i) Logical Left Shift
(ii) Logical Right shift.

(i) Logical Left shift:

In this shift, one position moves each bit to the left one by one.

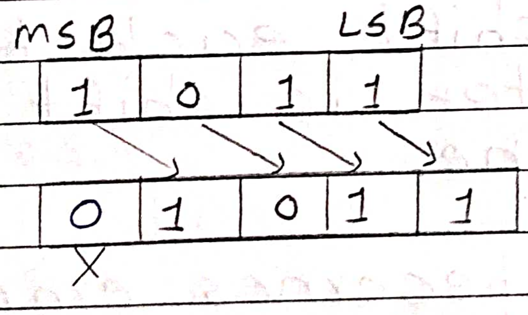
The empty Least significant bit is filled with zero.



(ii) Logical Right Shift:

In this shif, each bit moves to the right one by one. ~~and~~

The empty Most Significant bit is filled with zero.



2 Circular Micro-Operation:

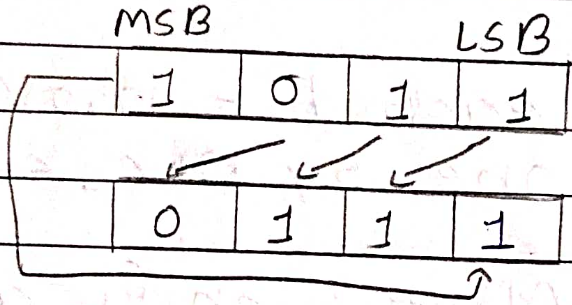
There are two types of circular Micro-operation.

(a) Circular Shift left
(b) Circular Right shift.

(a) Circular shift left:

In this shift, each bit in the register is shift left to one by one.

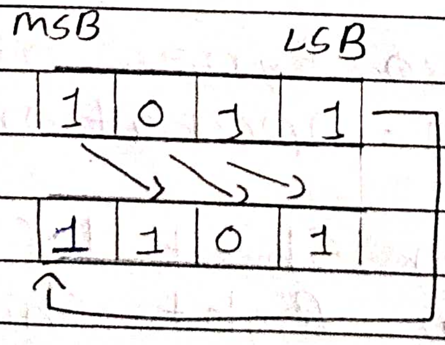
The LSB becomes empty so, MSB is filled there.



(b) Circular shift Right:

In this shift, each bit in the register is shift right one by one.

The MSB becomes empty so, LSB is filled there.



3 Arithmetic Shift:

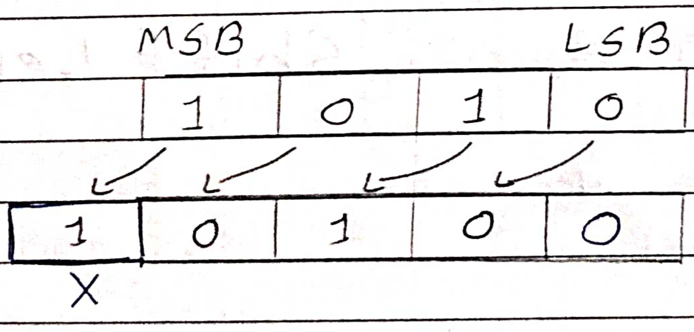
There are two types of Arithmetic shift.

(i) Arithmetic Left Shift
(ii) Arithmetic Right Shift.

(i) Arithmetic Left Shift:

In this shift, each bit is moved to the left side one by one.

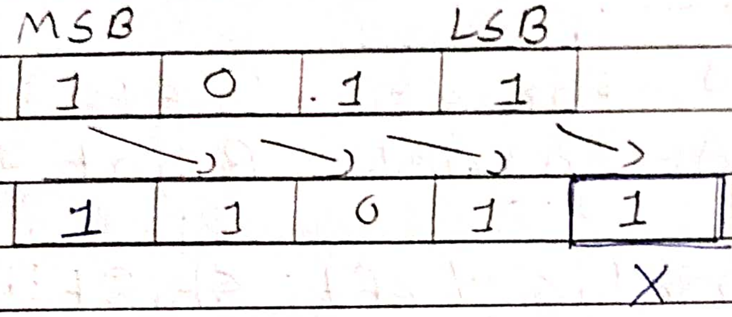
The empty LSB bit is filled with zero and MSB bit is rejected.



(ii) Arithmetic Right ~~left~~: Shift:

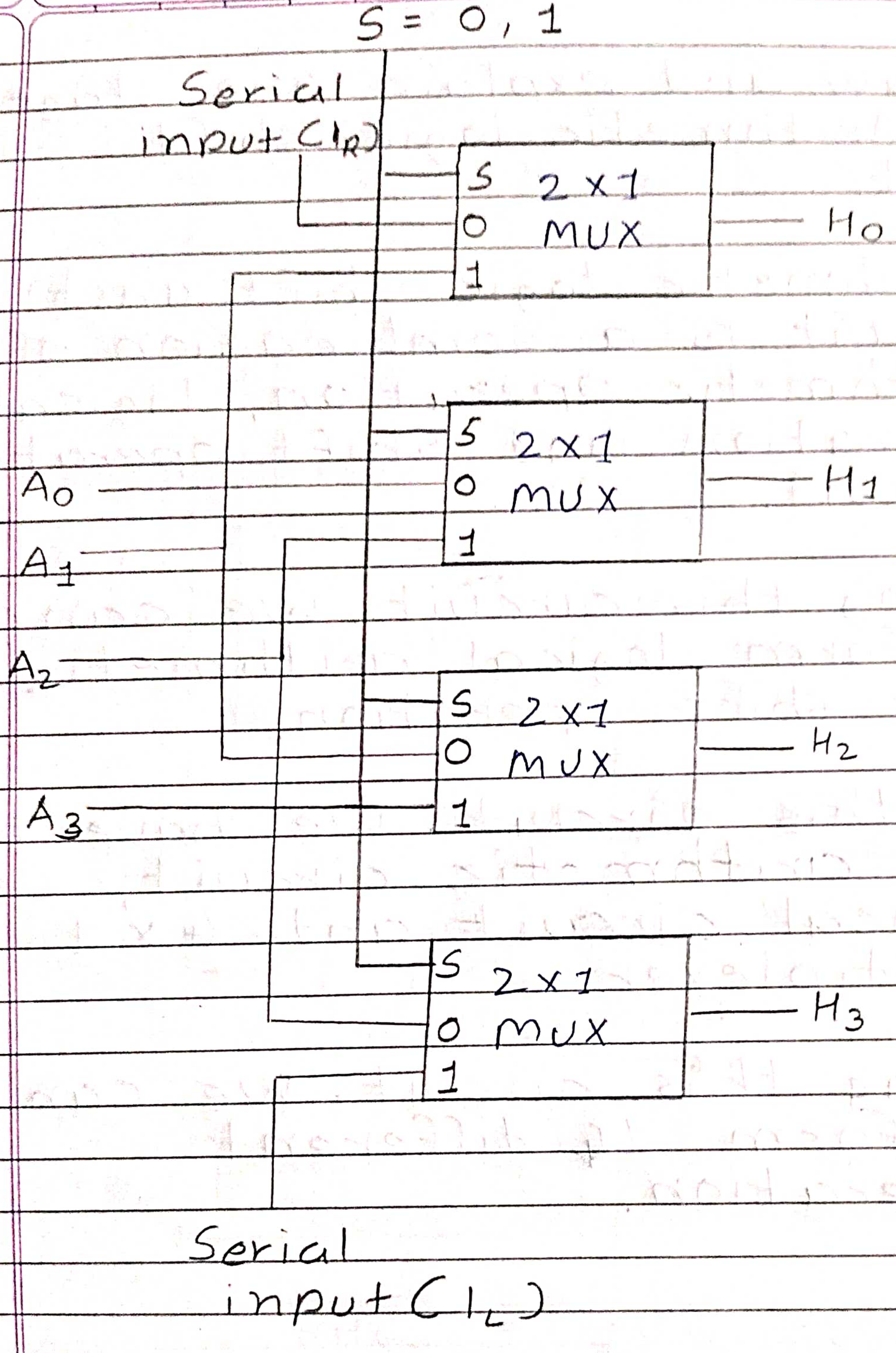
In ~~tis~~ this shift, each bit is moved to the right side one by one.

The LSB bit is rejected and empty MSB bit is filled with Previous MSB bit.



=> Shift Micro-operation Circuit:

S	H_0	H_1	H_2	H_3	
0	I_R	B_0	B_1	B_2	Shift Right
1	B_0	B_1	B_2	I_L	Shift Left.


S = 0, 1
Serial
input (I_R)
S
0
1
2 x 1
MUX
H0
A0
A1
A2
A3
H1
H2
H3
Serial
input (I_L)

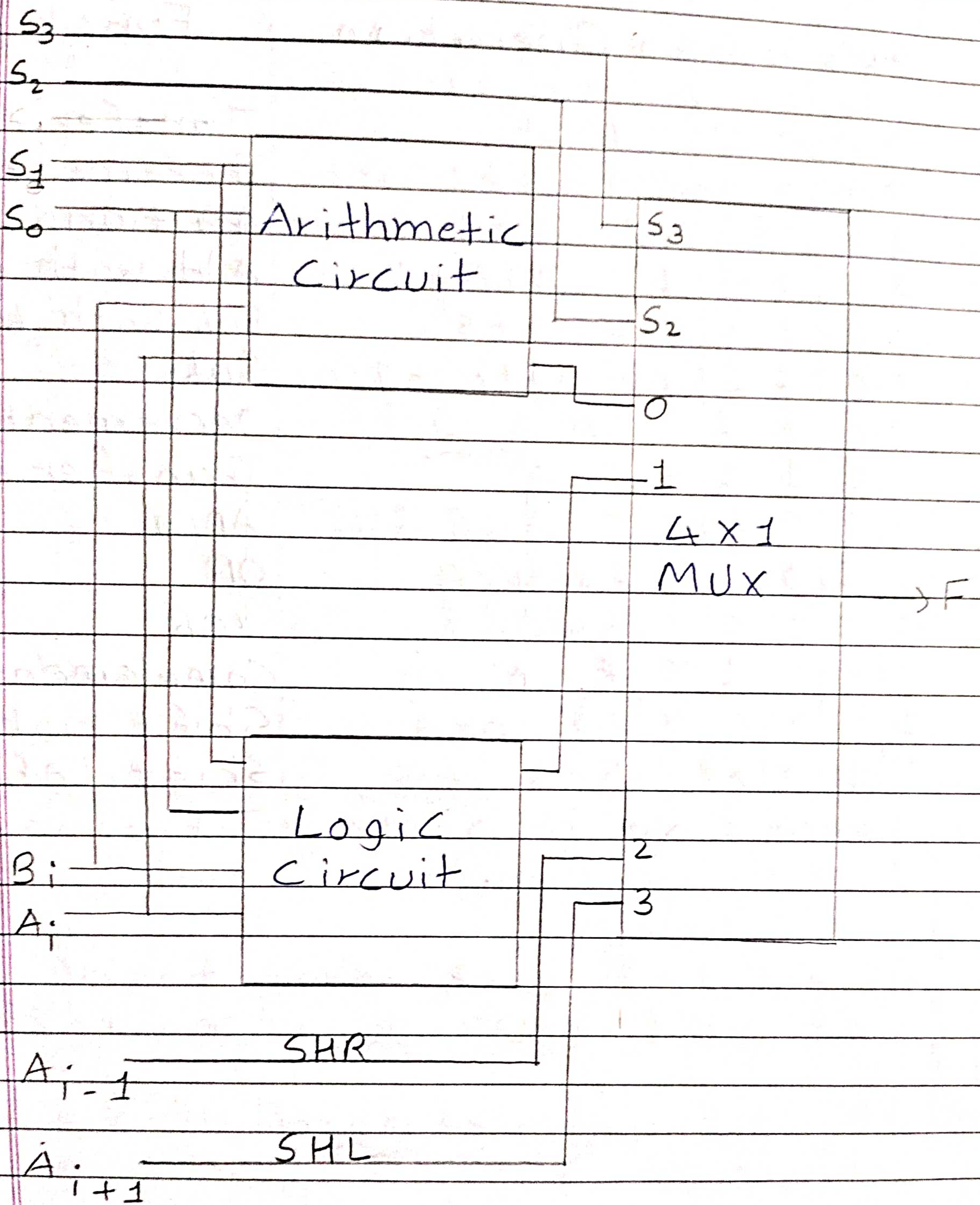
12 Draw and explain one stage of Arithmetic logic shift unit.

=> Arithmetic logic shift unit circuit is a combination of Arithmetic operation, logical operation and shift operation circuit.

Using this circuit, we can perform logical, arithmetic and shift operation.

In this circuit, we have to use arithmetic circuit, Logical circuit and 4 x 1 Multiplexer.

Using this circuit, we can perform 14 different operation.


S_3
S_2
S_1
S_0
Arithmetic Circuit
S_3
S_2
0
1
4 x 1 MUX
F
Logic Circuit
B_i
A_i
2
3
SHR
A_{i-1}
SHL
A_{i+1}

S_3	S_2	S_1	S_0	C_{in}	Operation	Function
0	0	0	0	0	$F = A$	Transfer A
0	0	0	0	1	$F = A + 1$	Increment A
0	0	0	1	0	$F = A + B$	Addition
0	0	0	1	1	$F = A + B + 1$	Add with carry
0	0	1	0	0	$F = A + B'$	Sub with borrow
0	0	1	0	1	$F = A + B' + 1$	Sub
0	0	1	1	0	$F = A - 1$	Decrement A
0	0	1	1	1	$F = A$	Transfer A
0	1	0	0	X	$F = A \wedge B$	AND
0	1	0	1	X	$F = A \vee B$	OR
0	1	1	0	X	$F = A \oplus B$	XOR
0	1	1	1	X	$F = A'$	Complement A
1	0	X	X	X	$F = \text{shr} A$	Shift right
1	1	X	X	X	$F = \text{shl} A$	Shift Left