Paper 7, TDC Part-3
Chapter– 4, Combinational Logic Design
Lecture - 18

By:

Mayank Mausam

Assistant Professor (Guest Faculty)

Department of Electronics

L.S. College, BRA Bihar University,

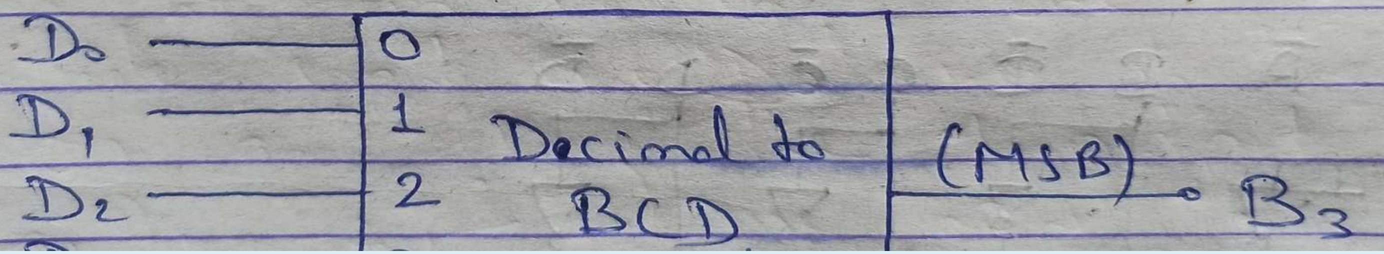
Muzaffarpur, Bihar

Combinational Logic Design

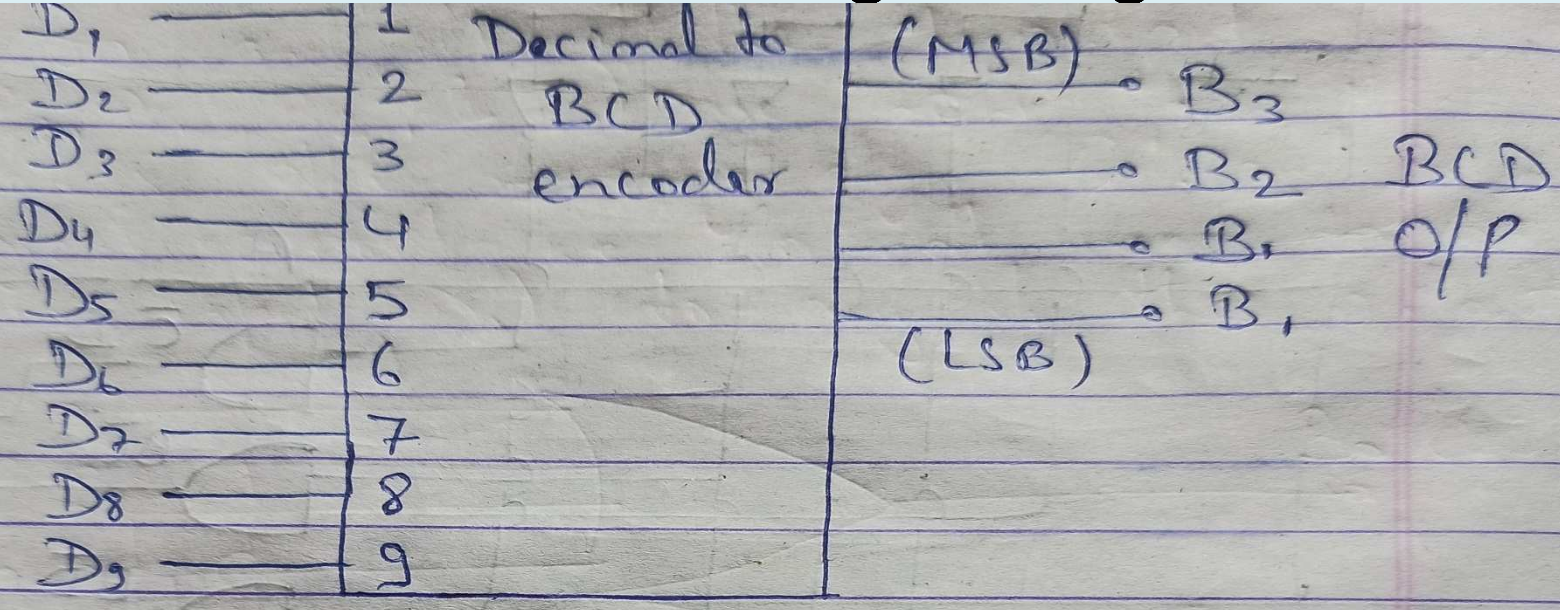
Encoder

An Encoder is a logic circuit which converts digits/symbols to a binary coded format. This process is known as encoding. It has n inputs and m outputs.

For, example a decimal-to-BCD encoder has 10 inputs and 4 outputs. Each input is for each decimal digit, and the 4 outputs corresponds to BCD code of each decimal digit.



Combinational Logic Design



Block diagram of Decimal-to-BCD encoder.

To draw the logical circuit of the ~~above~~ encoder given here we need to obtain logical expression for the output and the logical expression can be obtain from the truth table

Combinational Logic Design

So we will make truth table for Decimal to BCD Encoder.

Input	Output			
Decimal Digit	B_3	B_2	B_1	B_0
D_0	0	0	0	0
D_1	0	0	0	1
D_2	0	0	1	0
D_3	0	0	1	1
D_4	0	1	0	0
D_5	0	1	0	1
D_6	0	1	1	0
D_7	0	1	1	1
D_8	1	0	0	0
D_9	1	0	0	1

Truth table of Decimal-to-BCD Encoder

Combinational Logic Design

From the above truth we can now write the logical expression for the outputs,

$$B_0 = D_1 + D_3 + D_5 + D_7 + D_9$$

From the truth table we can observe that output line B_0 is "High (On)" for the input line D_1, D_3, D_5, D_7, D_9 so we ~~have~~ will ~~taken the~~ use 'OR' gate so that B_0 is On if either of D_1 or D_3 or D_5 or D_7 or D_9 is available at input line.

Combinational Logic Design

Similarly we can write the ~~the~~ logical expression for other output lines too,

$$B_1 = D_2 + D_3 + D_6 + D_7$$

$$B_2 = D_4 + D_5 + D_6 + D_7$$

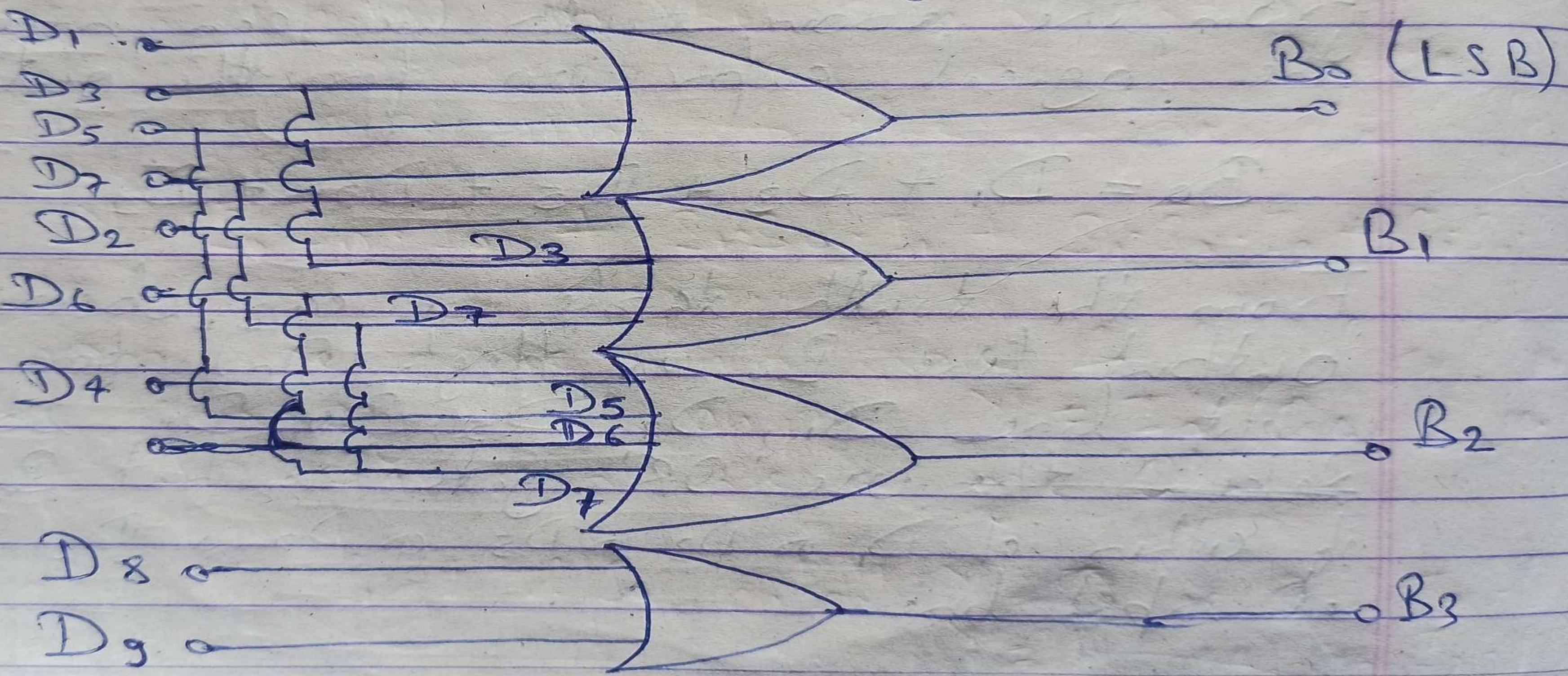
&

$$B_3 = D_8 + D_9$$

From the above expressions for 4 Outputs lines we can see that none of the expression include input line 'D_0' i.e. if the Encoder is on and all of the "4 output lines

Combinational Logic Design

(B_0, B_1, B_2, & B_3) are "Low" then that means the ~~binary~~ digit '0'. and so in logical circuit we do not need to connect this input (D_0) to any of the output.

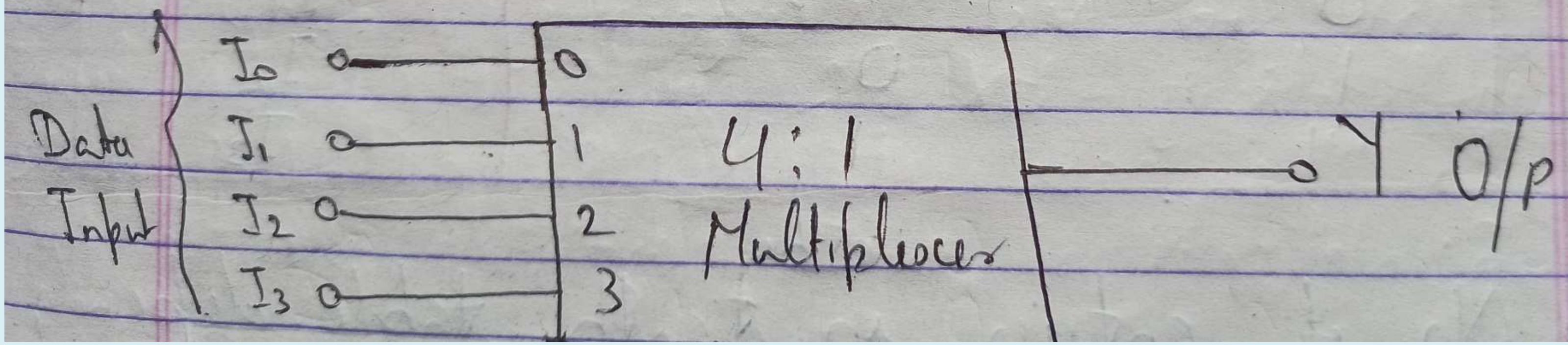


Implementation of Decimal to BCD encoder

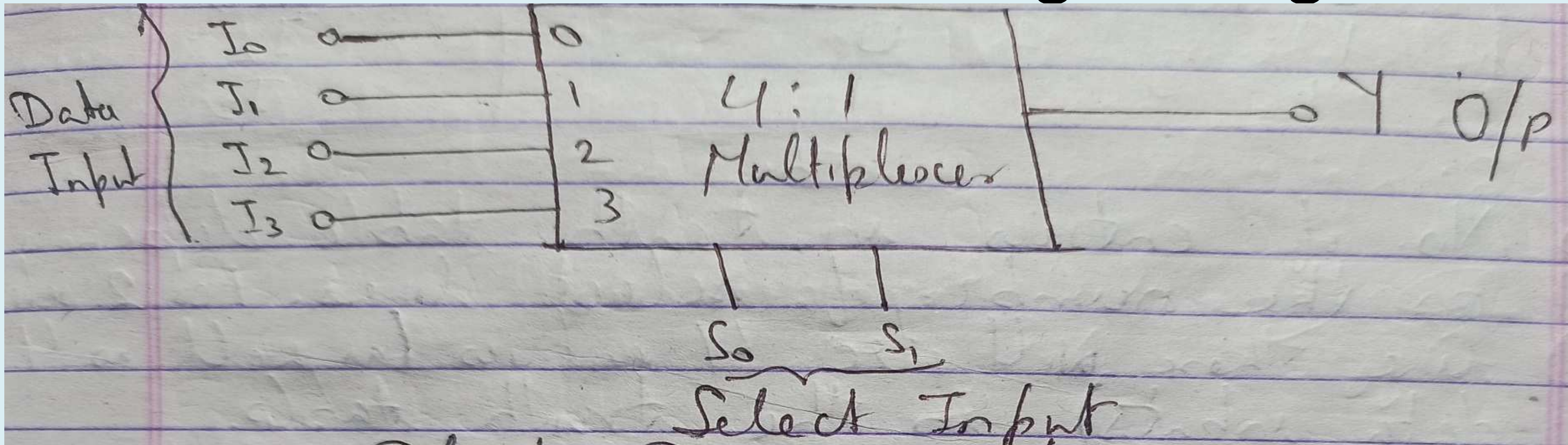
Combinational Logic Design

Multiplexer :→ The multiplexer is a logic circuit that allows one of the n data inputs at the output depending on the input condition on select line. A multiplexer has two types of input one is data input and other is select input and there is only one output line.

Figure below shows the block diagram of a 4:1 multiplexer



Combinational Logic Design



Block Diagram of a 4:1 multiplexer.

Depending on the no. of Data inputs there will be select line numbers.

For 2 Data Inputs → No. of Select line is 1
" 4 " " → " " " " is 2
" 8 " " → " " " " is 3
" 16 " " → " " " " " 4

and so on.

[illegible] ~~that~~ of A multiplexer will always having

Combinational Logic Design

single Output.

When a multiplexer is On, one of the data Inputs will appear at output depending on the value of select line. The truth table for a 4:1 multiplexer is given below

Select Input S_1	S_0	Output Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

Combinational Logic Design

So the No. of entries in truth table depends on the number of select lines. For 2 select line there will be 4 entries (as well as 4 data inputs) in the truth table.

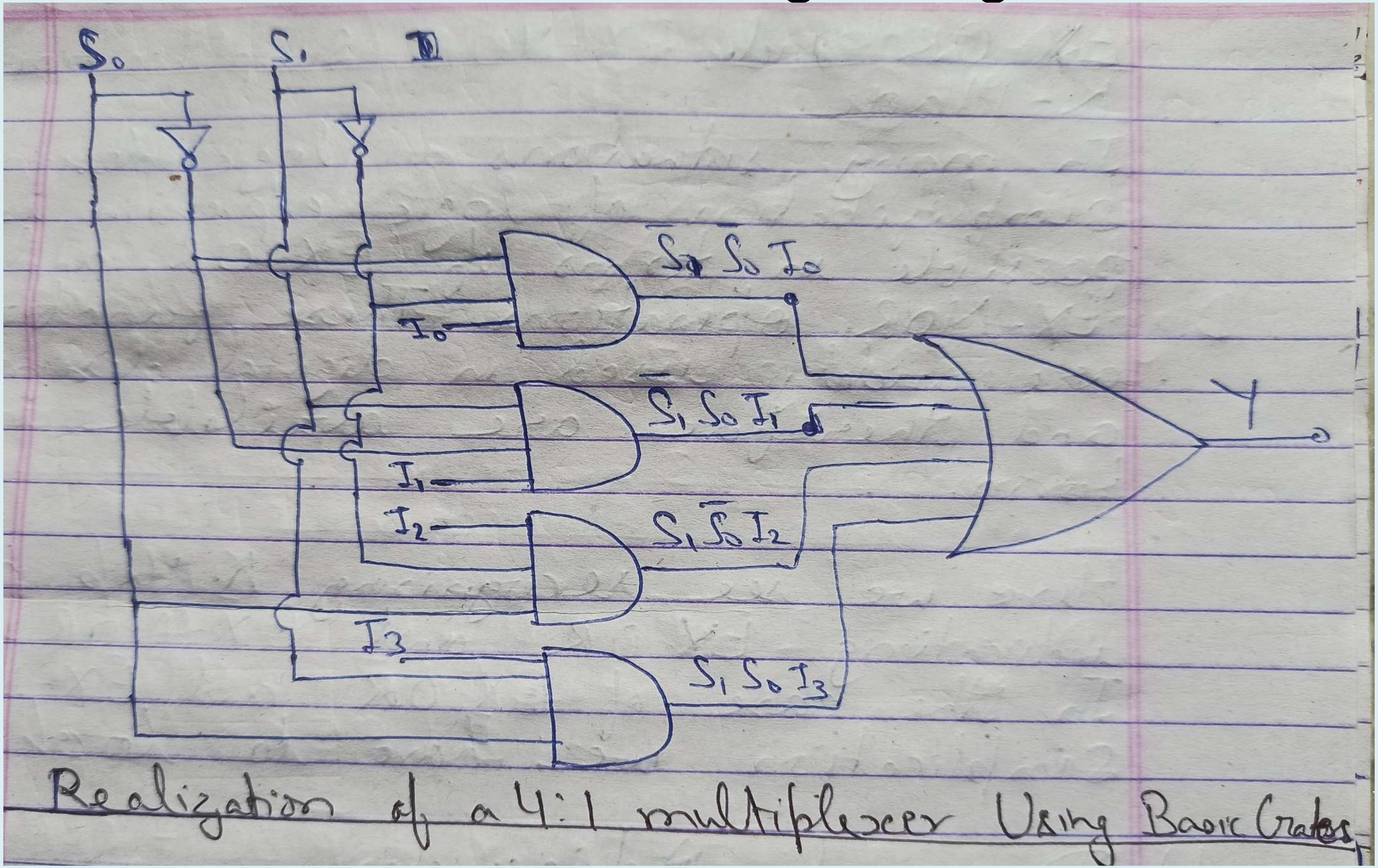
Logical expression for the output of 4:1 Multiplexer

$$Y = \bar{S_1} \cdot \bar{S_0} \cdot I_0 + \bar{S_1} \cdot S_0 \cdot I_1 + S_1 \cdot \bar{S_0} \cdot I_2 + S_1 \cdot S_0 \cdot I_3$$

From the above truth table & logical expression we can say that output $Y = I_0$ (0 or 1) i.e. if S_1 & S_0 both are at logic '0'.

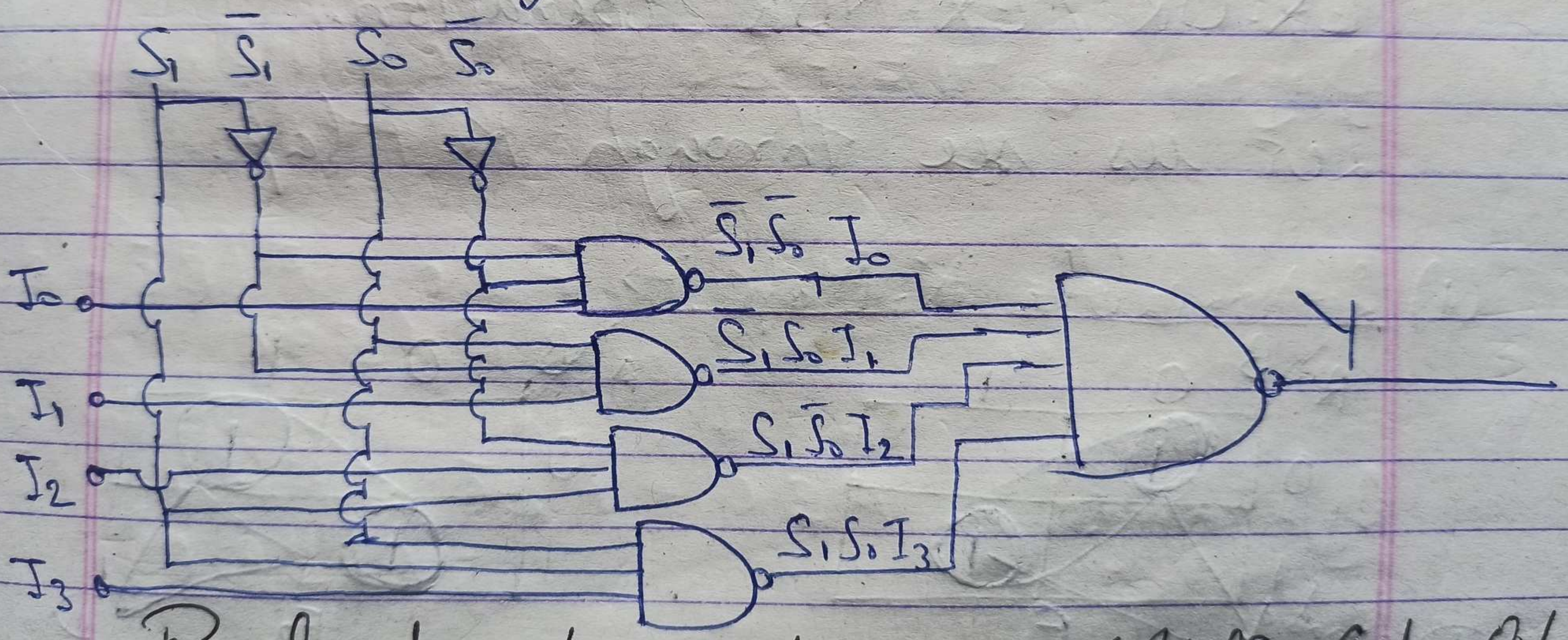
Similarly if $S_1 = 1$ & S_0 output $Y = 0$ i.e. 0 if $I_2 = 0$ or
$Y = 1$ i.e. if $I_2 = 1$

Combinational Logic Design



Combinational Logic Design

Since the o/p Y of multiplexer has obtained in SOP form so we can also implement the multiplexer logic circuit using NAND gates easily



Realization of 4:1 Mux using NAND Gates Only

Combinational Logic Design

Refer book- Modern Digital Electronics by RP Jain.

Thank You