Assignment: 3.

Combinational Logic Circuit.

(1) Explain Half Adder in detail.

→ A Half Adder is a fundamental digital circuit used to perform the addition of two single-bit binary numbers.

→ It has two inputs, (A) & (B), and two outputs a which are sum (S) and carry (c).

- Sum (S) :- The bitwise sum of the inputs, which is equivalent to the result of an XOR operation betn (A) and (B).

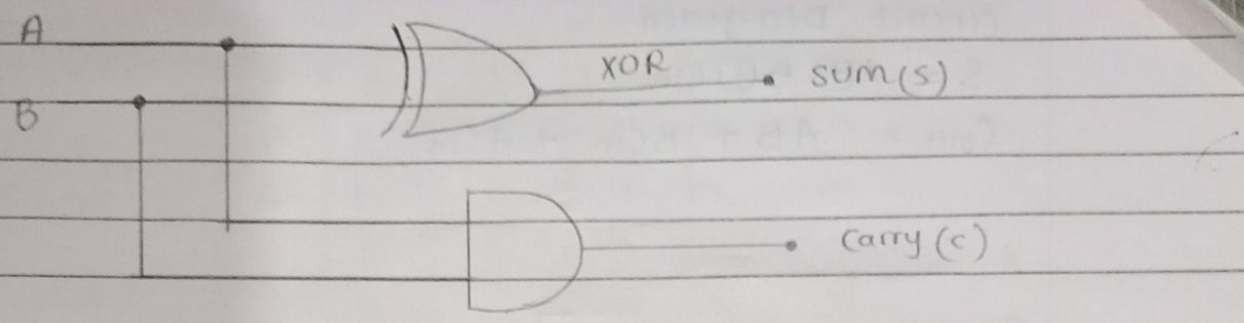
- Carry (C) :- The bitwise carry, which is the result of an AND operation between (A) and (B).

$S = A + B$

$C = A \cdot B$

Truth table :-

A	B	Sum(S)	Carry (C)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1



(2) Explain full Adder in detail.

→ A full Adder is a digital circuit that performs addition of binary numbers.

→ It adds three bits : two significant bits and one carry bit from a previous addition.

→ (S) = Sum bit

→ (C) = Carry out bit' which is the carry bit for the next addition.

→ (Cin) = Carry bit from the previous addition

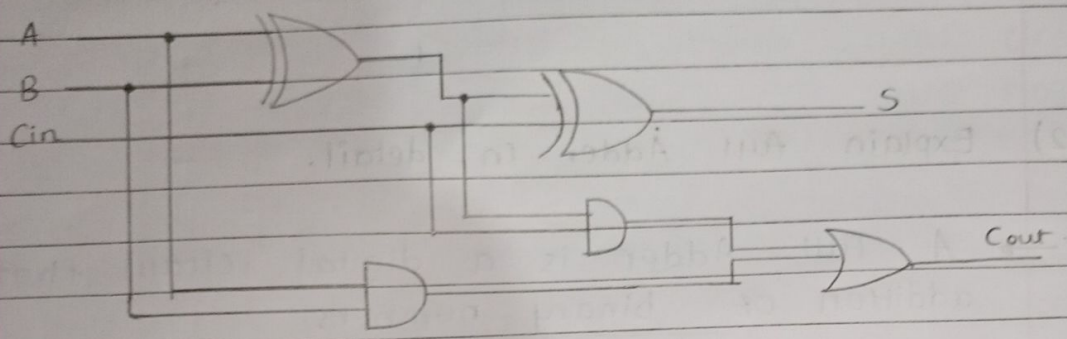
Truth table :-

A	B	(Cin)	S	(Cout)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Circuit Diagram :-

$S = A \oplus B \oplus Cin$

$C_{out} = AB + BCin + ACin$



(3) Explain Half Subtractor in detail.

→ A Half Subtractor is a combinational logic circuit designed to perform the subtraction ~~be~~ of two binary digits.

→ It takes two inputs and produces two outputs.

→ In output one is (D) difference and other is (B') Borrow.

→ Borrow indicates whether a '1' has been borrowed from the next higher bit.

(4)

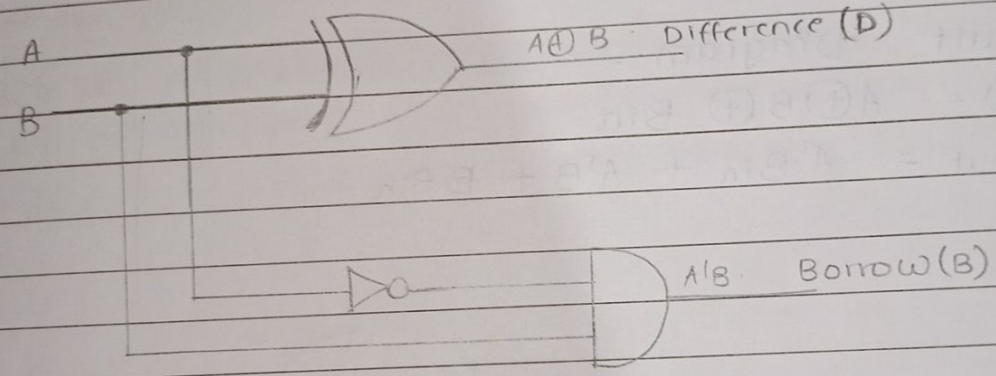
Truth table :-

A	B	(D)	(Bout)
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$D = A \oplus B$

$B = A'B$

Circuit : Diagram :-



(4) Explain full subtractor in detail.

→ A full subtractor is a combinational ~~etr~~ logic circuit used to perform the subtraction of three bits.

→ It takes (A), (B) and (Bin). as inputs.

→ And produces two outputs Difference (D) and (B) - Borrow out.

Truth Table :-

A	B	(Bin)	D	(Bout)
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

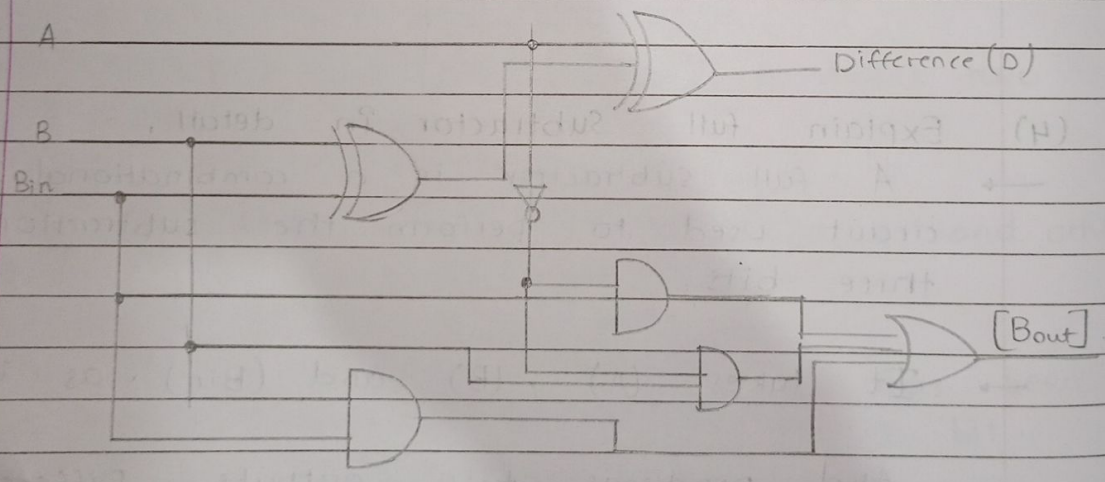
A \ B.Bin	B'B' 00	B'Bin 01	BBin 11	B.Bin' 10
A' 0		1	1	1
A 1			1	

$A'Bin + B.Bin + A.'B$

Circuit Diagram :-

$D = A \oplus B \oplus Bin$

$B_{out} = A'Bin + A'B + B.Bin$



(5) Explain BCD to Excess-3 code conversion.

→ BCD → Binary-Coded Decimal and Excess-3 are both binary encoding schemes used to represent decimal numbers.

→ First represent decimal digits (0-9) by a 4-bit binary number in BCD.

0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

→ Each decimal digit is represented by a 4-bit binary number that is the standard BCD code plus 3.

eg :- 3 in Excess-3 = 0011 + 0011

=

Convert each digit to BCD:-

4 in BCD = 0100

7 in BCD = 0111.

Now add 3 to each BCD digit;

4 = 0100 + 0011 = 0111 = (7)
7 = 0111 + 0011 = 1010 = (10).

∴ The excess -3 code for decimal no. 47 is 01111010.

(6) Short note on BCD adder.

→ A Binary - Coded decimal (BCD) adder is a digital circuit that performs arithmetic addition on numbers represented in BCD format.

→ BCD is a method of encoding decimal no. where each digit is represented by its own binary sequence.

→ Steps in a BCD Adder.

→ Add the BCD Digits : Perform a 4-bit binary addition on the two BCD Digits.

→ Check if the sum is greater than 9 or if there is a carry from the previous stage.

→ If the sum is greater than 9, add 6 to the sum to convert it back to a valid BCD digit.

eg :- 5 & 7 = 0101 + 0111 = 1100. (12)

Since 12 is greater than 9, add 6 (0110) to 1100
= 1100 + 0110 = 10010
= 10010 = (2) and 1 is carried to the next decimal place.

→ BCD adders are used in digital systems where decimal arithmetic is needed, such as in calculators, digital clocks etc.

(7) Draw circuit of 4-bit comparator and explain.

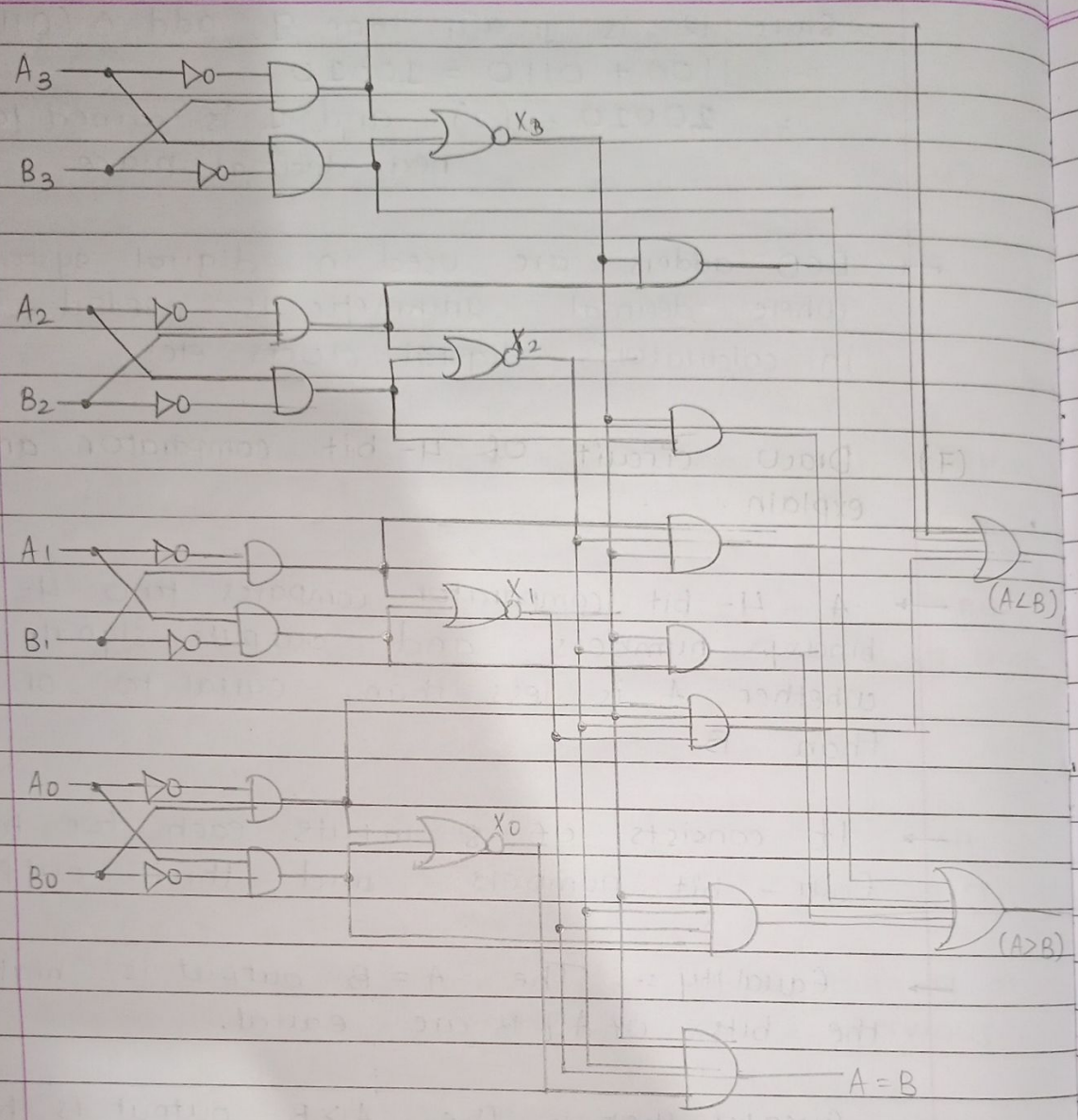
→ A 4-bit comparator compares two 4-bit binary numbers and outputs signals indicating whether A is less than, equal to, or greater than B.

→ It consists of 8 inputs each for two four-bit numbers and three outputs.

→ Equality :- The A = B output is high if all the bits of A & B are equal.

→ Greater than :- The A > B output is high if the MSB where A & B differ is 1 in A and 0 in B.

→ Less than : The A < B output is high if the MSB where A & B differ is 0 in A and 1 in B.


A3
B3
X3
A2
B2
X2
A1
B1
X1
A0
B0
X0
(A<B)
(A>B)
A = B

(8) Give comparisons between encoder and decoder.

Encoder	Decoder.
→ Converts input data into a different format or code.	→ Converts encoded data back to its original format
→ It compress data, tranform to diffn domain.	→ Decompress data, rettieve original information
→ Data compression, feature extraction, signal processing are Uses.	→ Data Decompression, signal reconstruction are Uses.
→ Original data are Input	→ Encoded or Compressed data are Input
→ Encoded or compressed data is produced in output	→ Original or reconstructed data are produced in O/P.
→ Direction of Operation is forward.	→ Direction of operation is backward.
→ eg:- Huffman encoder, audio / de Video codecs, neural network encoders	→ eg:- Huffman decoder, audio / video codecs, neural network decoders.

(9) Explain 4x1 line Multiplexer in detail.

→ A 4x1 Multiplexer (MUX) is a digital switch that selects one of four input signals and forwards it to single output line.

→ It operates using control signals to determine which input is connected to the output.

→ Input :- A 4x1 MUX has four data inputs, as A_0, A_1, A_2, A_3

→ It uses two control signals S_0 and S_1 to select which input to route to the output.

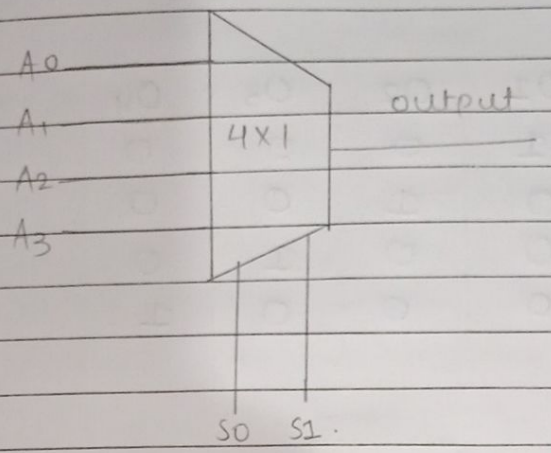
→ The values of S_0 and S_1 determine which of the four inputs is connected to the output.

(10)

→ If S_1 & S_0 = 00 output = A_0
→ If S_1 & S_0 = 01 output = A_1
→ If S_1 & S_0 = 10 output = A_2
→ If S_1 & S_0 = 11 output = A_3.

→ The main advantage of a multiplexer is its ability to handle multiple inputs with minimal hardware by using a selection mechanism.

Circuit :-



Truth table.

S_0	S_1	Y
0	0	A_0
0	1	A_1
1	0	A_2
1	1	A_3

(10) Draw a 2X4 line decoder and explain in detail

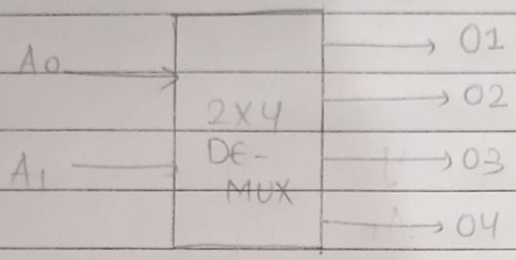
→ 2X4 Decoder have two Input lines and 4 output lines

→ lets say A_0 and A_1 is Input and in Output we get O1, O2, O3, O4.

↪

Truth table:-

A_0	A_1	O_1	O_2	O_3	O_4
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1.



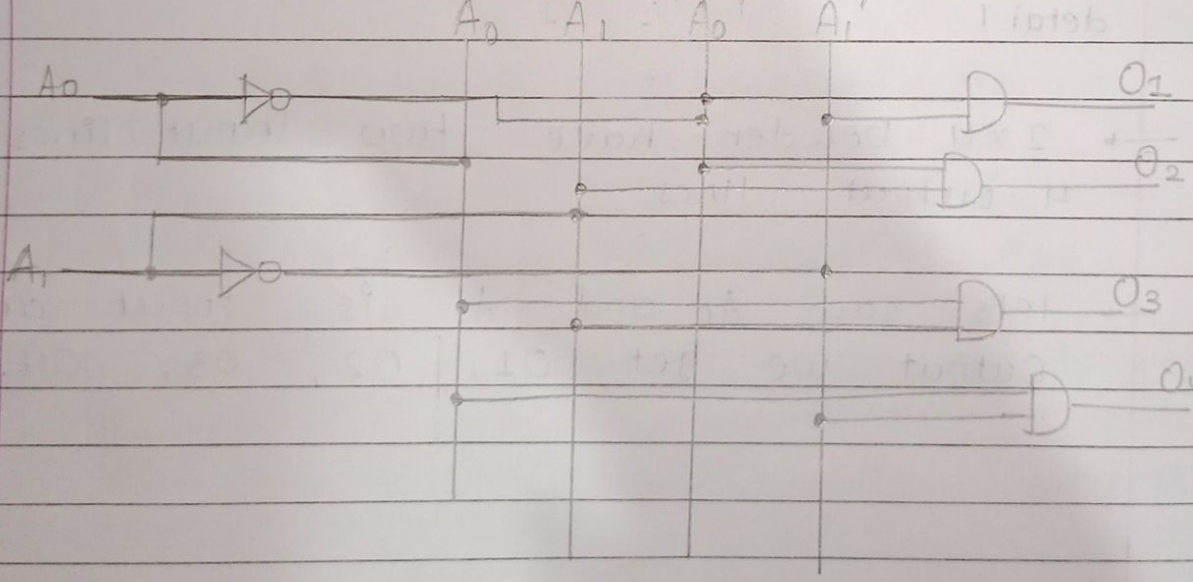
Circuit Diagram.

we have, $O_1 = A_0' A_1'$

$O_2 = A_0' A_1$

$O_3 = A_0 . A_1$

$O_4 = A_0 A_1'$



(11) Comparison between multiplexer and de-Multiplexer.

Multiplexer	De-Multiplexer.
→ Combines multiple input signals into a single output signal.	→ It Distributes a single input signal to multiple outputs.
→ Multiple Inputs, one output	→ One input, multiple outputs.
→ Uses control signals to select which input to send to the output.	→ Uses control signals to select which output the input will go to.
→ Selects one input from many and routes it to the output.	→ Routes the input signal to one of many outputs based on control signals.
→ Typically implemented using logic gates and flip-flops to select input	→ Typically implemented using logic gates and flip-flops to control output selection.
→ 4-X 1 MUX (4 inputs, 1 output)	→ 1 X 4 DE-MUX (1 input, 4 outputs).

(12) Explain Binary parallel adder.

→ A binary parallel adder is a digital circuit that adds two binary numbers simultaneously, producing a sum and a carry output for eat bit position.

→ A parallel adder uses multiple full adders connected in parallel to handle all bits of the binary no. at once.

→ for ex:- If we are adding two 4-bit numbers, you will use four full adders in parallel.

→ The first full adder processes the least significant bits (LSB) and the subsequent adders handle the higher-order bits.

→ The final carry-out from the last full adder is the carry-out of the entire addition oper^n.