DIGITAL DESIGN

COMPARATOR

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Q. What is a COMPARATOR?

A comparator is a combinational circuit which is used to compare the bits of two registers and return binary results.

For two inputs A and B, it returns the result of $A > B$, $A = B$ and $A < B$. Here, 0 stands for false and 1 for true.

1 BIT COMPARATOR

This type of comparator compares the two inputs, A and B which are of size 1 bit, and returns the result.

Truth Table:

A	B	(Y_1) A > B	(Y_2) A = B	(Y_3) A < B
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

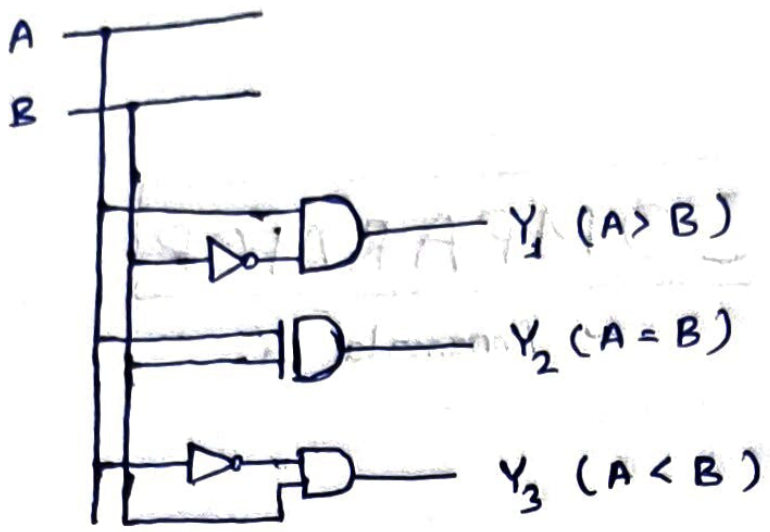
Based on the above truth table,

$$Y_1 = (A > B) = A\bar{B}$$

$$Y_2 = (A = B) = A'B' + AB = A \odot B \quad (\text{XAND})$$

$$Y_3 = (A < B) = \bar{A}B$$

The circuit for our comparator looks like this:



4 BIT COMPARATOR

Things get interesting here, because the inputs A and B are of size 4 bits. Comparators only compare 1 bit at a time and we have 4 bits. So, how do we do it?

Now, compare these numbers and say which is larger!

A = 1001

B = 1010

Here, B is larger than A. How? Simple! We compare each bit and progress. The logic is, we start with the MSB of both inputs and compare. We move to the next pair if they are equal, otherwise return the result. Try it out!

Truth Table:

A3 B3	A2 B2	A1 B1	A0 B0	A>B	A=B	A<B
A3 > B3	x	x	x	1	0	0
A3 < B3	x	x	x	0	0	1
A3 = B3	A2 > B2	x	x	1	0	0
A3 = B3	A2 < B2	x	x	0	0	1
A3 = B3	A2 = B2	A1 > B1	x	1	0	0
A3 = B3	A2 = B2	A1 < B1	x	0	0	1
A3 = B3	A2 = B2	A1 = B1	A0 > B0	1	0	0
A3 = B3	A2 = B2	A1 = B1	A0 < B0	0	0	1
A3 = B3	A2 = B2	A1 = B1	A0 = B0	0	1	0

n BIT COMPARATOR

The same can be done for inputs of any size n.

A_n	B_n	A_{n-1}	B_{n-1}	....	A_1	B_1	A_0	B_0	A>B	A=B	A<B
>	x			....	x		x		1	0	0
<	x			....	x		x		0	0	1
=	>			....	x		x		1	0	0
=	<			....	x		x		0	0	1
⋮	⋮			⋱	⋮		⋮		⋮	⋮	⋮
=	=			....	>		x		1	0	0
=	=			....	<		x		0	0	1
=	=			....	=		>		1	0	0
=	=			....	=		<		0	0	1
=	=			....	=		=		0	1	0

Things to try:

→ Draw a logic circuit diagram for a 4-bit comparator.

→ Explore NAND gate.

→ Design a logic circuit to find 2's complement of a number.