Assignment No. 4

Title: Comparator

Problem Statement: Verify the truth table of one bit and two bit comparators using logic gates and comparator IC.

Hardware and Software Requirements:

Theory:

1) what is comparator?

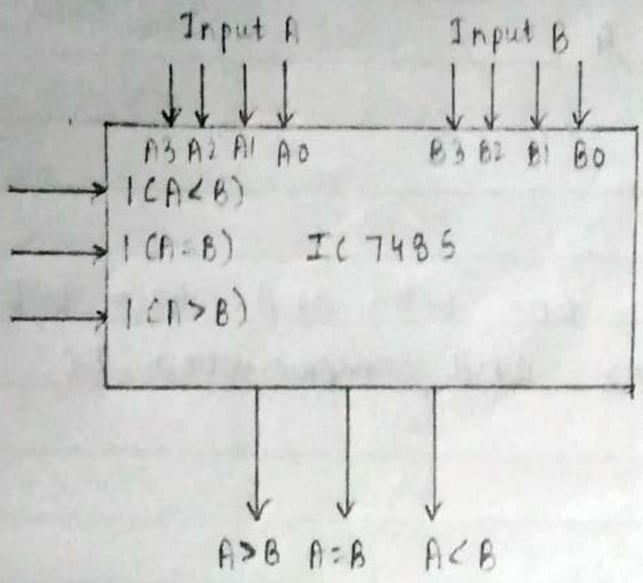
- A digital comparator or magnitude comparator is a hardware electronic device that takes two numbers as input in binary form and determines whether one number is greater than, less than or equal to the other number.
- Comparators are used in Central Processing Units (CPUs) and microcontrollers (MCUs).

2) IC-7485 Description

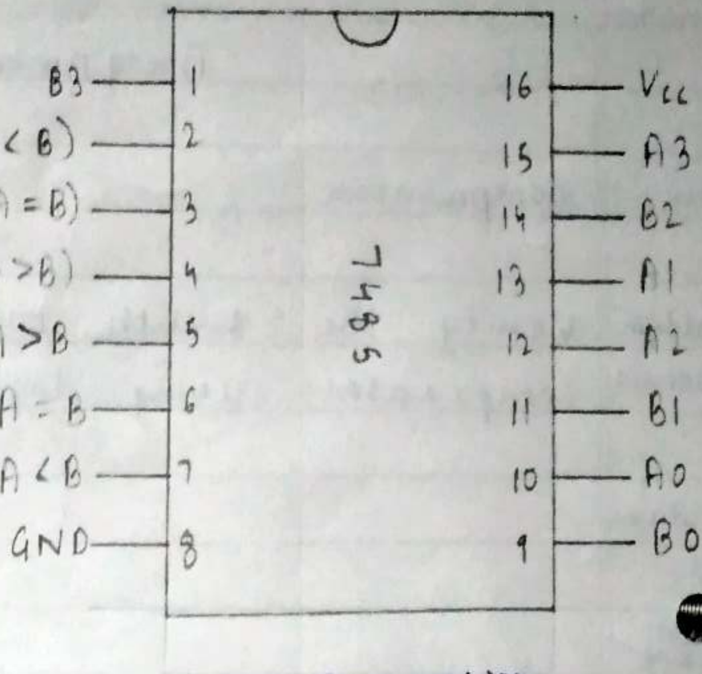
- ~~8-bit It is an 8-bit magnitude comparator.~~
- ~~It compares~~

i) 4-bit Magnitude comparator

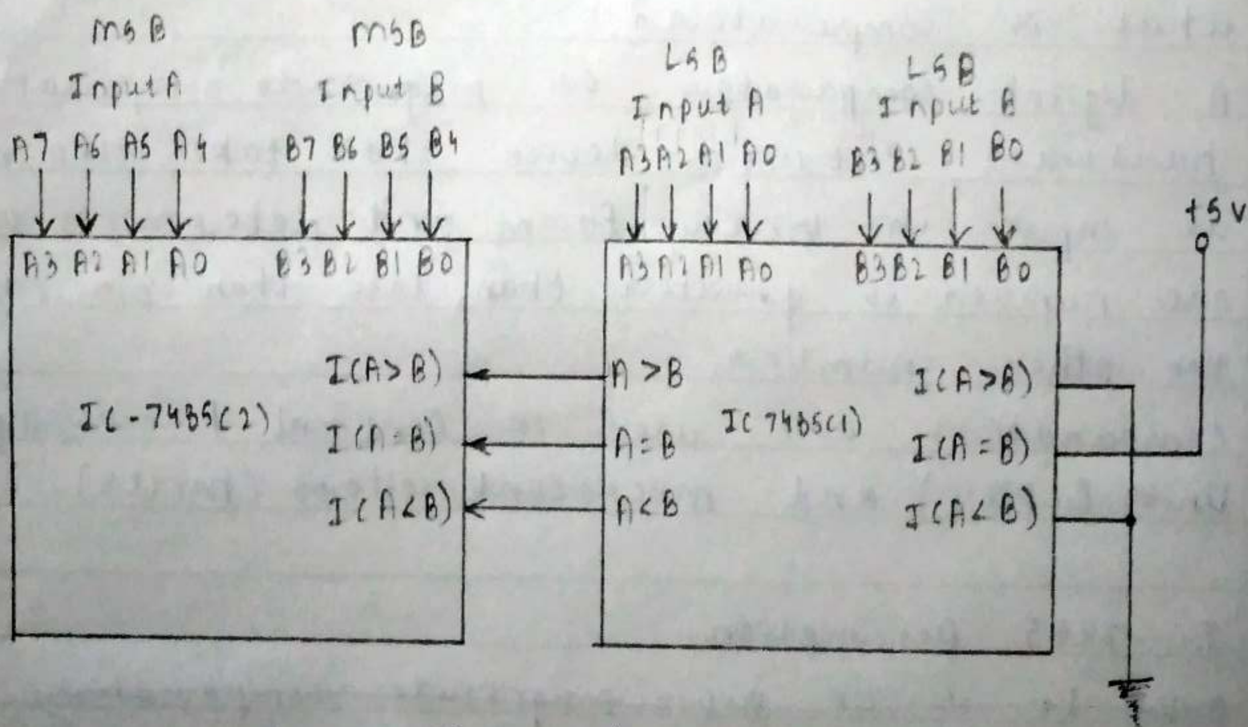
- The 4-bit comparator is mostly available in IC form and common type of this IC is 7485. This IC can be used to compare two 4-bit binary words by grounding I (A>B), I (A<B), I(A=B) connector



4-bit Magnitude Comparator



Pin description



8-bit Magnitude Comparator

inputs to V_{cc} terminal.

ii) 8-bit Magnitude Comparator

- An 8-bit comparator compares the two 8-bit numbers by cascading of two 4-bit comparators.
- The circuit connection of this comparator is shown below in which the lower order comparator A<B, A=B and A>B outputs are connected to the respective cascade inputs of the higher order comparator.

Design:

1. 1-bit comparator

- Truth table

A	B	A>B	A=B	A<B
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

- K-map:

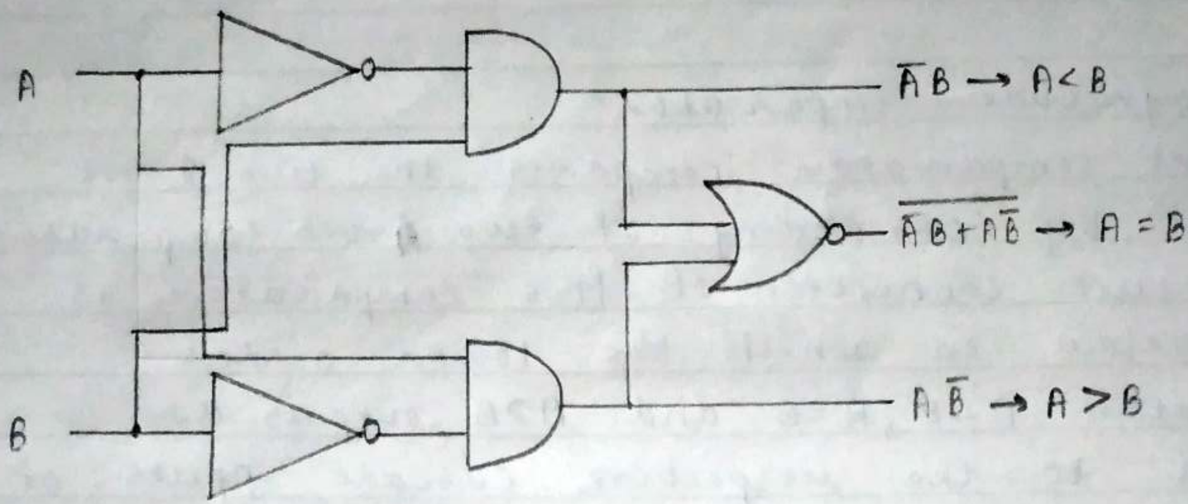
i) A>B

A>B

A \ B	$\bar{B}$	B
$\bar{A}$	0_{0}	0_{1}
A	1_{2}	0_{3}

$\therefore A>B = A\bar{B}$

→ Circuit diagram:



ii) $A = B$

$A=B$

$A \backslash B$	$\bar{B}$	B
$\bar{A}$	1 (0)	0 (1)
A	0 (2)	1 (3)

$$(A = B) = \bar{A}\bar{B} + AB$$
$$= \overline{\bar{A}B + A\bar{B}}$$

iii) $A < B$

$A<B$

$A \backslash B$	$\bar{B}$	B
$\bar{A}$	0 (0)	1 (1)
A	0 (2)	0 (3)

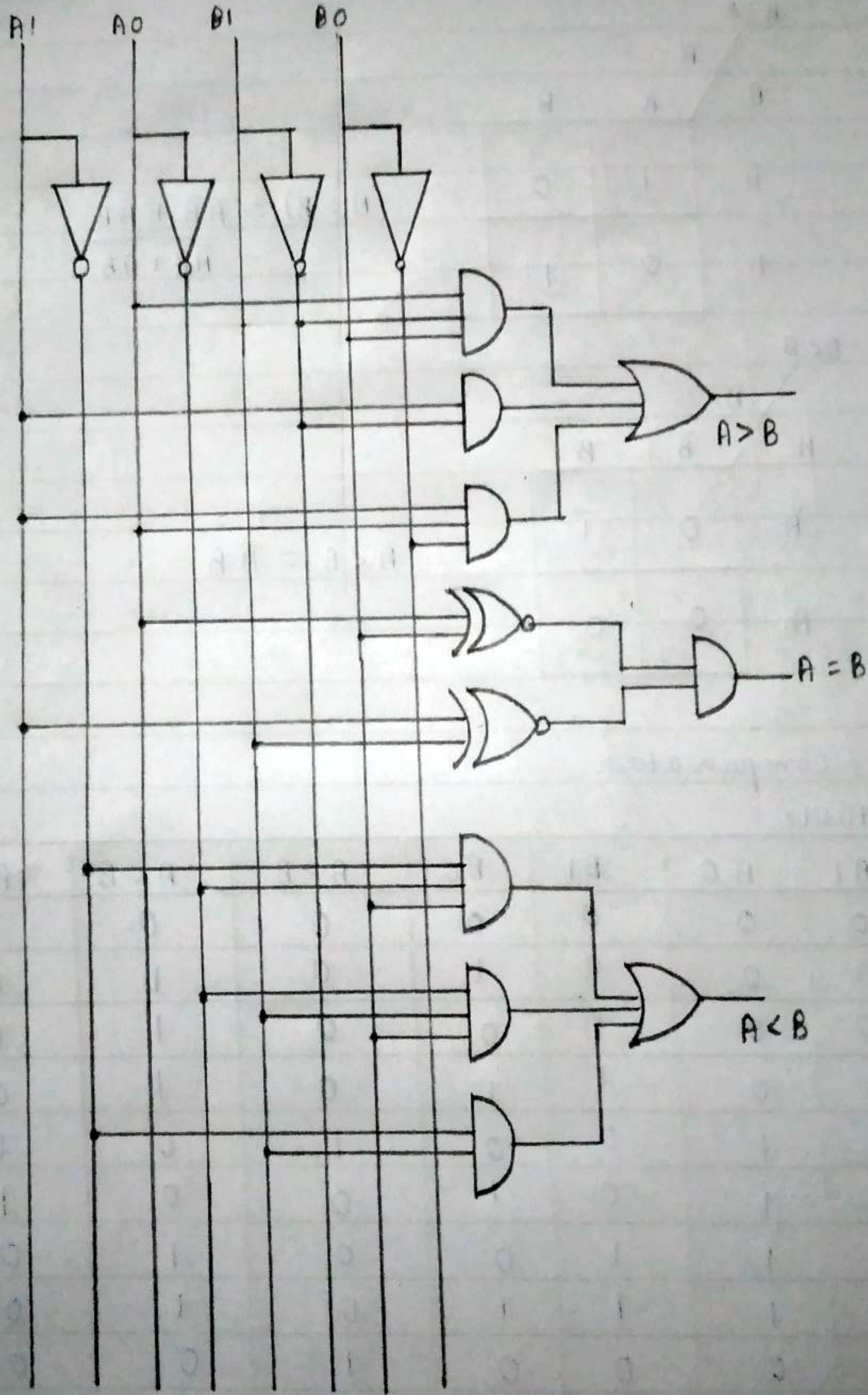
$$A < B = \bar{A}B$$

2. 2-bit comparator

- Truth Table

A1	A0	B1	B0	A > B	A < B	A = B
0	0	0	0	0	0	1
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	1	0	0
0	1	0	1	0	0	1
0	1	1	0	0	1	0
0	1	1	1	0	1	0
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	0	0	1
1	0	1	1	0	1	0
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	0	0	1

→ Circuit diagram :-



- K-map

i) $A > B$

$A>B$ — $B1B0$ / $A1A0$

$A1A0$ \ $B1B0$	$\overline{B1}\,\overline{B0}$	$\overline{B1}B0$	$B1B0$	$B1\overline{B0}$
$\overline{A1}\,\overline{A0}$	0_{0}	0_{1}	0_{3}	0_{2}
$\overline{A1}A0$	1_{4}	0_{5}	0_{7}	0_{6}
$A1A0$	1_{12}	1_{13}	0_{15}	1_{14}
$A1\overline{A0}$	1_{8}	1_{9}	0_{11}	0_{10}

$$A>B = A1\overline{B1} + A0\overline{B1}\,\overline{B0} + A1A0\overline{B0}$$

ii) $A = B$

$A=B$ — $B1B0$ / $A1A0$

$A1A0$ \ $B1B0$	$\overline{B1}\,\overline{B0}$	$\overline{B1}B0$	$B1B0$	$B1\overline{B0}$
$\overline{A1}\,\overline{A0}$	1_{0}	0_{1}	0_{3}	0_{2}
$\overline{A1}A0$	0_{4}	1_{5}	0_{7}	0_{6}
$A1A0$	0_{12}	0_{13}	1_{15}	0_{14}
$A1\overline{A0}$	0_{8}	0_{9}	0_{11}	1_{10}

$$(A=B) = \overline{A1}\,\overline{A0}\,\overline{B1}\,\overline{B0} + \overline{A1}A0\overline{B1}B0 + A1A0B1B0 + A1\overline{A0}B1\overline{B0}$$
$$= \overline{A0}\,\overline{B0}(\overline{A1}\,\overline{B1} + A1B1) + A0B0(\overline{A1}\,\overline{B1} + A1B1)$$
$$= (\overline{A1 \oplus B1})(\overline{A0 \oplus B0})$$
$$= (A1 \odot B1)(A0 \odot B0)$$

iii) $A < B$

$A<B$ — $B1B0$ / $A1A0$

$A1A0$ \ $B1B0$	$\overline{B1}\,\overline{B0}$	$\overline{B1}B0$	$B1B0$	$B1\overline{B0}$
$\overline{A1}\,\overline{A0}$	0_{0}	1_{1}	1_{3}	1_{2}
$\overline{A1}A0$	0_{4}	0_{5}	1_{7}	1_{6}
$A1A0$	0_{12}	0_{13}	0_{15}	0_{14}
$A1\overline{A0}$	0_{8}	0_{9}	1_{11}	0_{10}

$$A<B = \overline{A1}B1 + \overline{A1}\,\overline{A0}B0 + \overline{A0}B1B0$$

Conclusion: Verified ~~logic~~ truth table of one bit and two bit comparators using logic gates and comparator IC