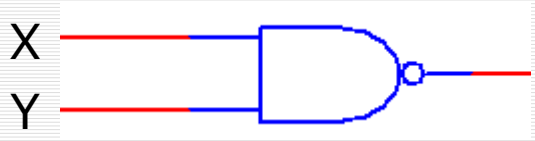
Universal Gates

- The gate can be used to replace an AND gate, an OR gate, or an INVERTER gate.
- 1. NAND Gate
- 2. NOR Gate

Universal Gate - NAND

- NAND is the contraction of AND & NOT gates.
- it has two or more inputs and only one output i.e. $Y = (A \cdot B)'$
- When all the inputs are HIGH, the output is LOW. If any one or both the inputs are LOW, then the output is HIGH.

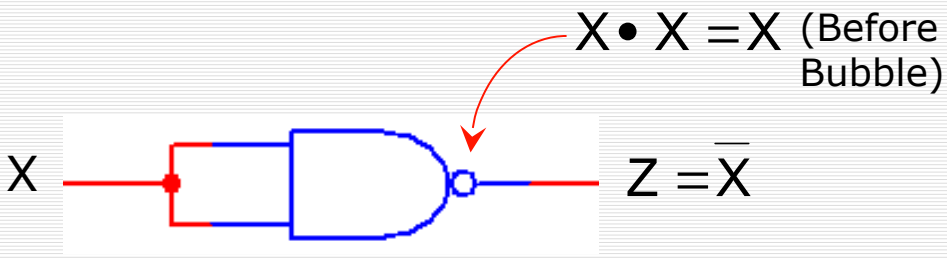
NAND Gate



$$Z = \overline{X\,Y} = \overline{X} + \overline{Y}$$

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

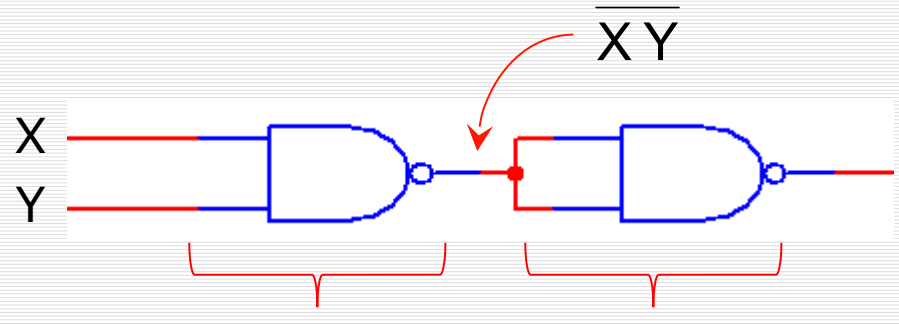
NAND Gate as an Inverter (NOT) Gate



X	Z
0	1
1	0

Equivalent to Inverter

NAND Gate as an AND Gate

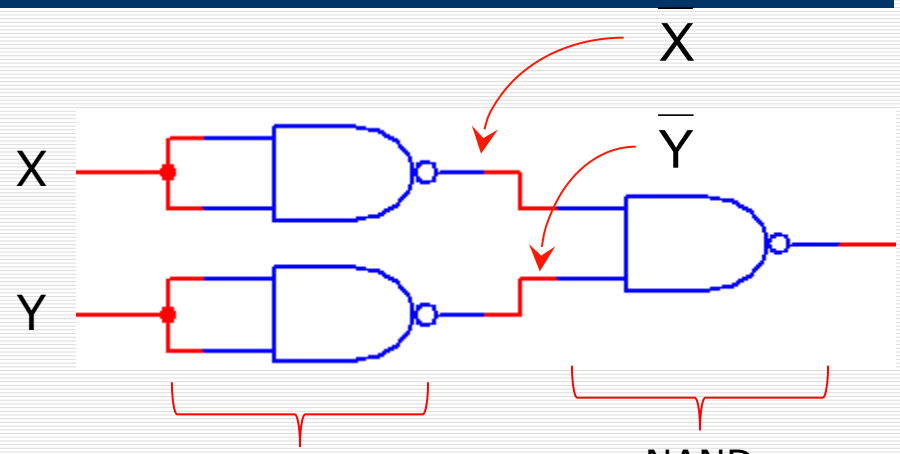


$$Z = \overline{\overline{X\,Y}} = X\,Y$$

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

Equivalent to AND Gate

NAND Gate as an OR Gate



$$Z = \overline{\overline{X}\,\overline{Y}} = \overline{\overline{X}} + \overline{\overline{Y}} = X + Y$$

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

Equivalent to OR Gate

Universal Gate - NOR

- NOR gate is the contraction of OR & NOT gates.
- NOR gate can be using to replace an AND gate, an OR gate or an INVERTER gate.

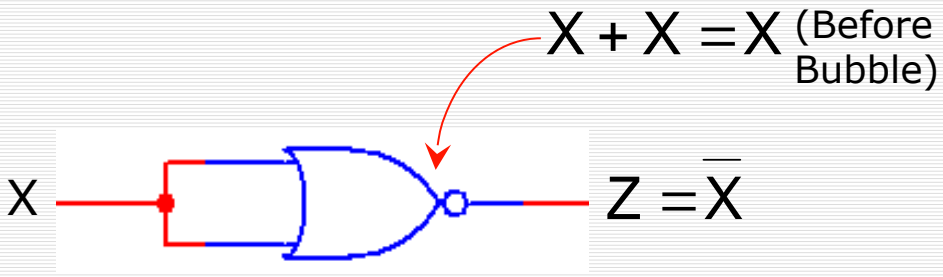
NOR Gate

X
Y

$$Z = \overline{X + Y} = \overline{X}\ \overline{Y}$$

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

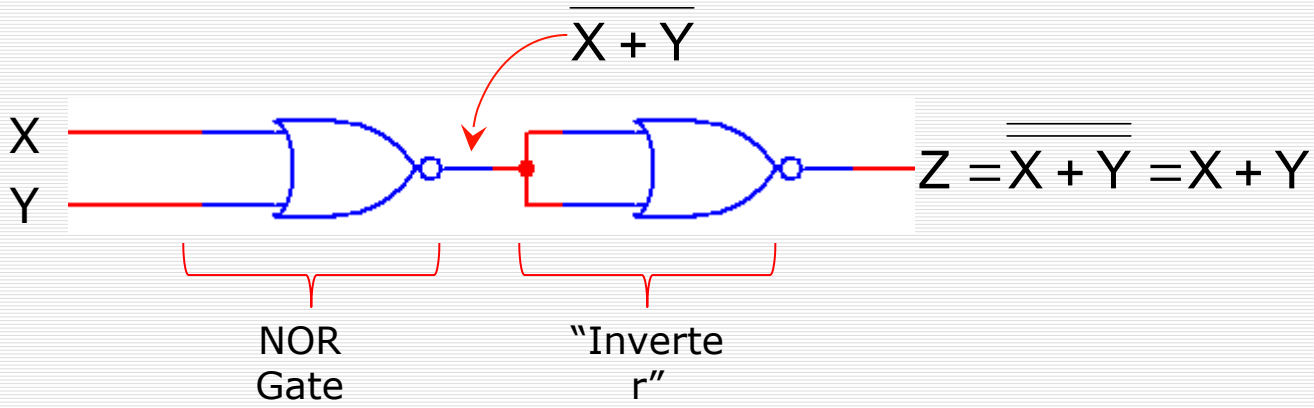
NOR Gate as an Inverter (NOT) Gate



X	Z
0	1
1	0

Equivalent to Inverter

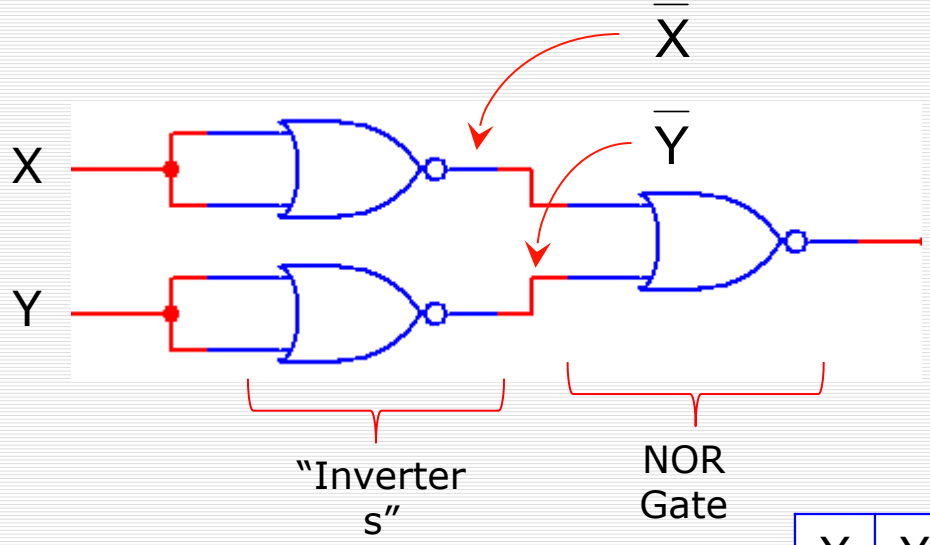
NOR Gate as an OR Gate



X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

Equivalent to OR Gate

NOR Gate as an AND Gate



$$Z = \overline{\overline{X} + \overline{Y}} = \overline{\overline{X}}\,\overline{\overline{Y}} = X\,Y$$

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

Equivalent to AND Gate