

Module 3:Digital Electronics

Introduction

Quote of the day

"Any man who reads too much and uses his own brain too little falls into lazy habits of thinking".

— Albert Einstein

Digital Electronics : Binary Variables

- Binary variables take on one of two values.
- Recall that the two binary values have different names:
 - True/False
 - On/Off
 - Yes/No
 - High/Low
- We use 1 and 0 to denote the two values.
 - True=1 and False =0
 - On=1 and Off=0
 - Yes=1 and No =0
 - High=1 and Low=0
- These all termed as digital Logic

Logic Function

Consider the switches connected in parallel.

– Inputs:

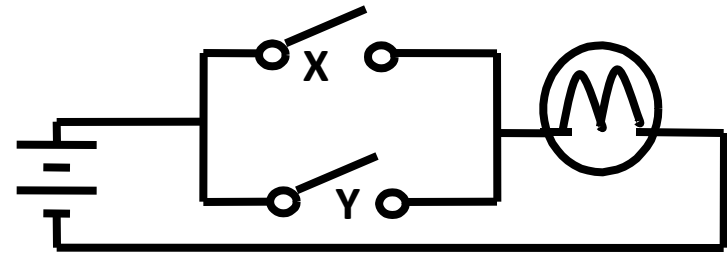
- logic 1 is switch closed
- logic 0 is switch open

– Outputs:

- logic 1 is light on
- logic 0 is light off.

- Operation: Lamp will glow if any switch **X OR Y** is closed.
- **Truth Table:** Tabular listing of Output for all possible combination of Inputs.

Switches in parallel => OR



Truth Table

| OR | | |
|----|---|-----|
| X | Y | X+Y |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

Logic Function contd...

Consider the switches connected in Series.

– Inputs:

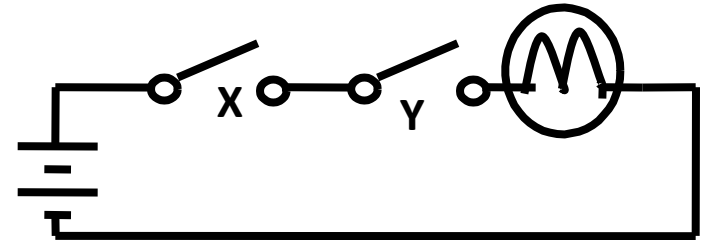
- logic 1 is switch closed
- logic 0 is switch open

– Outputs:

- logic 1 is light on
- logic 0 is light off.

- Operation: Lamp will glow if both switches **X AND Y** are closed.

Switches in series => AND



Truth Table

| AND | | |
|-----|---|-----|
| X | Y | X·Y |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

Logic Function contd...

- Normally closed switch

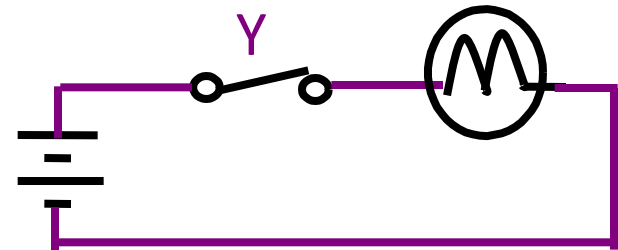
- NOT input:

- logic 1 is switch open
- logic 0 is switch closed

- Output:

- logic 1 is light on
- logic 0 is light off.

Normally-closed switch \Rightarrow NOT

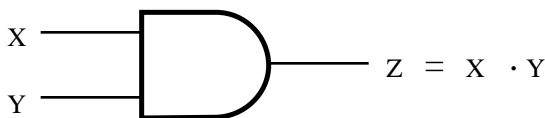


Truth Table

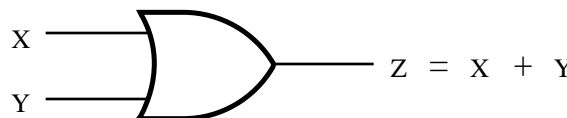
NOT

| Y | \bar{Y} |
|---|-----------|
| 0 | 1 |
| 1 | 0 |

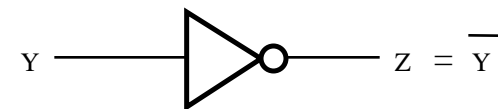
- Logical Symbols:



AND gate



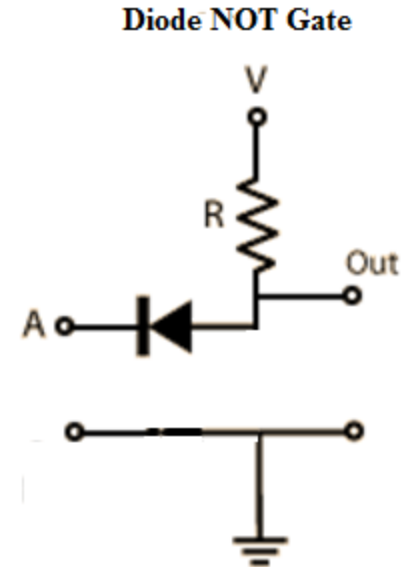
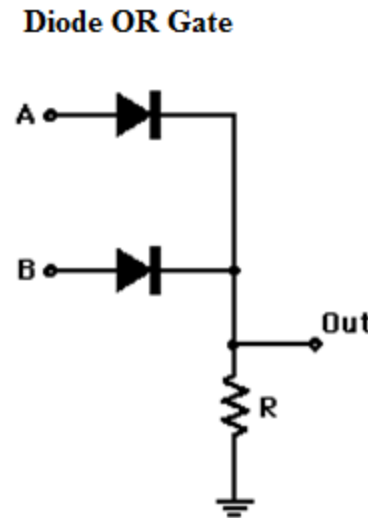
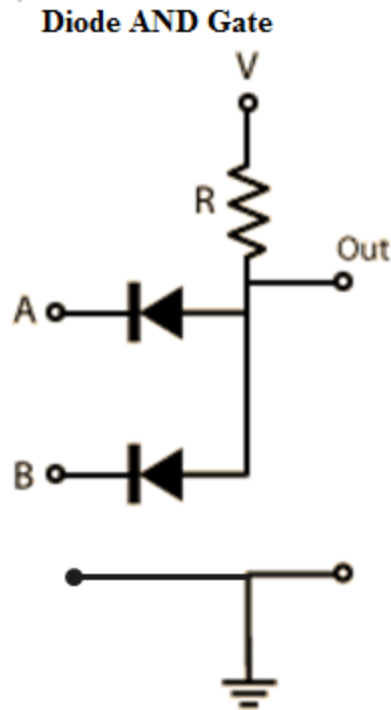
OR gate



NOT gate or inverter

Logic Function using Diodes

- These Mechanical switches can be replaced with Electronic switches like diodes, transistors etc. to achieve these operations.

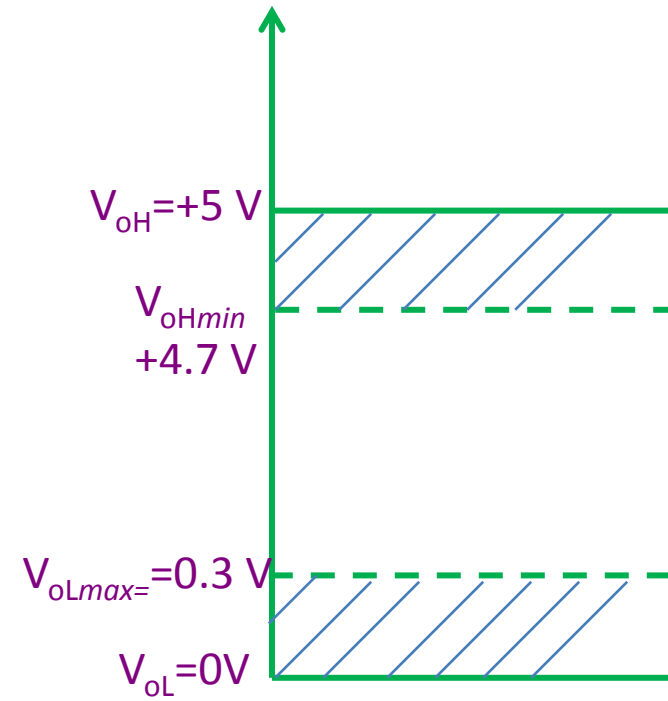


Logic Levels

- In Electronic switching circuits 0 and 1 are represented by voltage levels.
- For example
 - $+5V=1(\text{High})$ and $0V=0(\text{Low})$ Positive logic
 - $0V=1(\text{High})$ and $-5V=0(\text{Low})$ Negative logic
- There will be a margin of voltages for high or low levels
 - For example logic High (1)= 4.7 to 5 V
 - and Low (0)= 0 to 0.3 V for Positive logic

Logic Levels contd...

- Consider Logic High voltage is $V_{oH} = +5 \text{ V}$.
- Then Minimum high voltage for which Logic high is considered will be up to $V_{oHmin} = +4.7 \text{ V}$.
- If Logic Low=0v then maximum voltage level to be considered for logic low will be $V_{oLmax} = 0.3 \text{ V}$

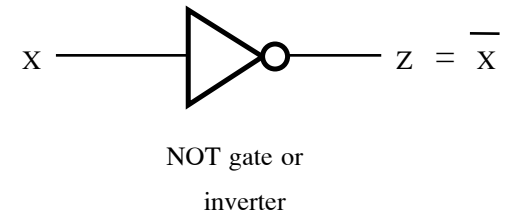
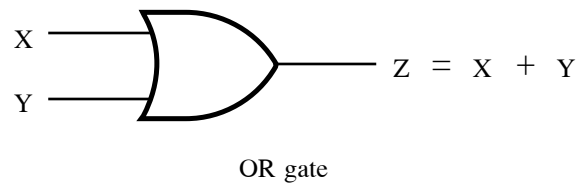
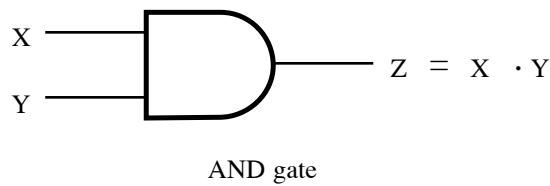


$$V_{oHmin} - V_{oLmax} = 4.7 - 0.3$$

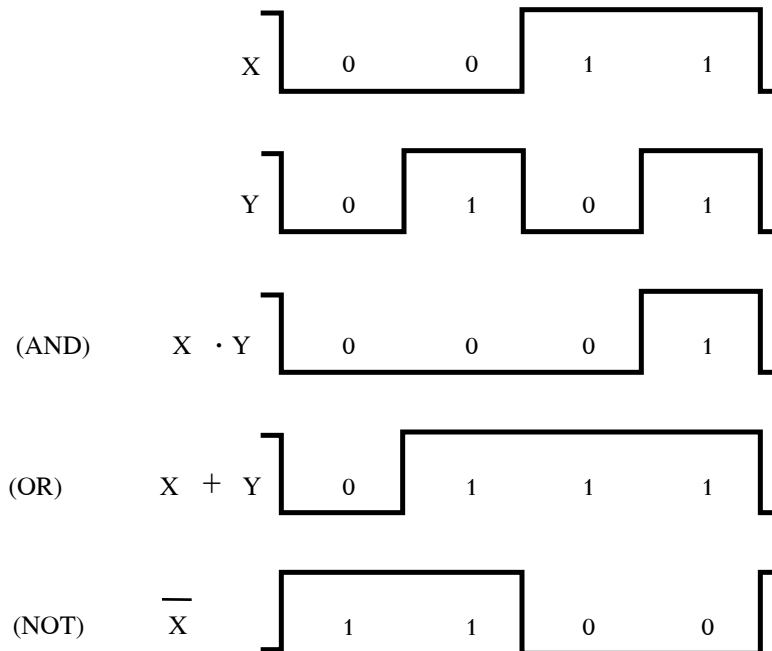
Forbidden region = 4.4 V

Logic Gate Symbols and Behavior

- Logic gates have special symbols:



- And waveform behavior in time as follows:



Assignment

- With the help of switching circuit, Input/output waveforms and truth table explain the operation of a NOT Gate, AND Gate and OR gate.
- Explain the construction of OR, AND and NOT Gates using Diodes.