Digital Logic Gates

Last updated 10/8/24

These slides introduce digital logic gates

Digital Logic Gates

- Digital Logic
  - Defining signal as True or False

  - Logical
    - In the digital world we indicate T with a logical value 1
    - In the digital world we indicate F with the logical value 0

  - Physical
    - These are signals – voltages on a wire
    - 1 is defined as the positive voltage supply value (V_{DD})
      - 5V, 3.3V. 2.5V, …
    - 0 is defined as Gnd (0V)

Digital Logic Gates

- ## NOT – flips the value of the input
  - ### Logic Gate - Inverter

    - #### Circuit Symbol

      V_{DD}

      IN ─▷○─ OUT

      Gnd
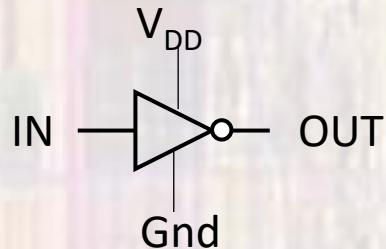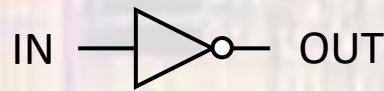
    - #### Logic Symbol

      IN ─▷○─ OUT

    - #### Truth Table (logic)

 | IN | OUT |
      |----|-----|
      | 0 | 1 |
      | 1 | 0 |

Always remember, 1 and 0 are abstractions
The actual values on the wires are V_{DD} and Gnd

Digital Logic Gates

- Buffer – replicates the value of the input
  - Logic Gate - Buffer

    - Circuit Symbol

      V_{DD}

      IN ──▷── OUT

      Gnd
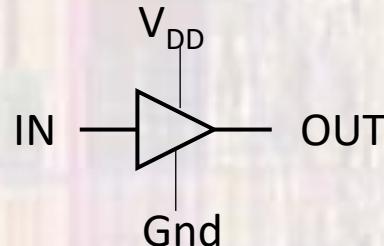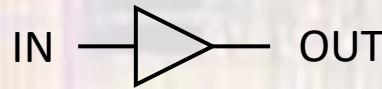
    - Logic Symbol

      IN ──▷── OUT

    - Truth Table (logic)

 | IN | OUT |
      |----|-----|
      | 0 | 0 |
      | 1 | 1 |

      Always remember, 1 and 0 are abstractions
      The actual values on the wires are V_{DD} and Gnd

# Digital Logic Gates

- OR – outputs 1(F) if either input is 1(T)
 - Logic Gate - OR

  - Circuit Symbol

V_{DD}

INA

INB

OUT

Gnd

  - Logic Symbol

INA

INB

OUT
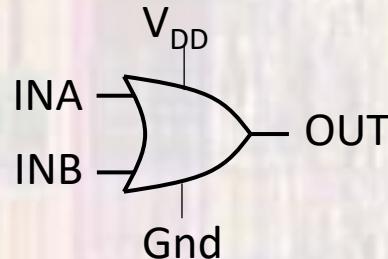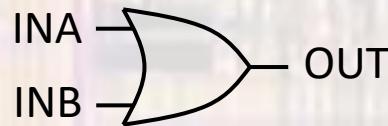
  - Truth Table (logic)

INB	INA	OUT
0	0	0
0	1	1
1	0	1
1	1	1

Digital Logic Gates

- NOR – outputs 0(F) if either input is 1(T)
  - Logic Gate - NOR

  - Circuit Symbol

    V_{DD}

    INA

    INB

    OUT

    Gnd

  - Logic Symbol

    INA

    INB

    OUT
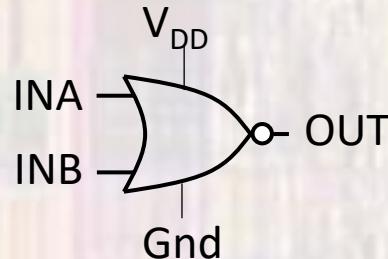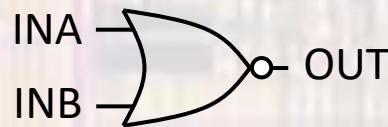
  - Truth Table (logic)

| INB	INA	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Digital Logic Gates

- AND – outputs 1(F) if both inputs are 1(T)
  - Logic Gate - NAND

    - Circuit Symbol

V_{DD}

INA
INB

OUT

Gnd

    - Logic Symbol

INA
INB

OUT
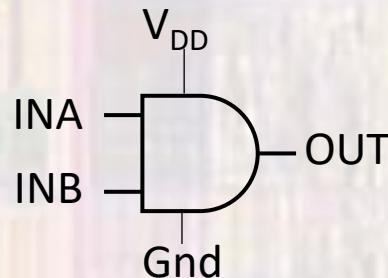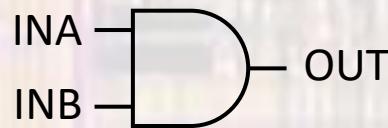
    - Truth Table (logic)

| INB	INA	OUT
0	0	0
0	1	0
1	0	0
1	1	1

Digital Logic Gates

- NAND – outputs 0(F) if both inputs are 1(T)
  - Logic Gate - NAND

    - Circuit Symbol

V_{DD}

INA

INB

OUT

Gnd

    - Logic Symbol

INA

INB

OUT
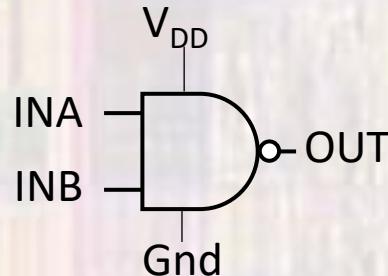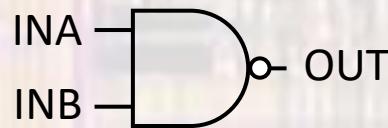
    - Truth Table (logic)

INB	INA	OUT
0	0	1
0	1	1
1	0	1
1	1	0

Digital Logic Gates

- XOR – outputs 1(T) if only 1 input is 1(T)
  - Logic Gate - XOR

  - Circuit Symbol

V_{DD}

INA

INB

OUT

Gnd

  - Logic Symbol

INA

INB

OUT
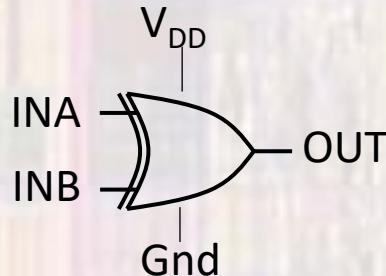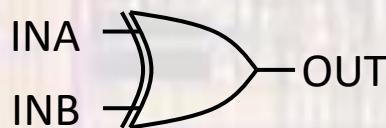
  - Truth Table (logic)

| INB	INA	OUT
0	0	0
0	1	1
1	0	1
1	1	0

Sometimes called the
In-equality Gate

Digital Logic Gates

- XNOR – outputs 0(F) if only 1 input is 1(T)
  - Logic Gate - XNOR

  - Circuit Symbol

V_{DD}

INA

INB

OUT

Gnd

  - Logic Symbol

INA

INB

OUT
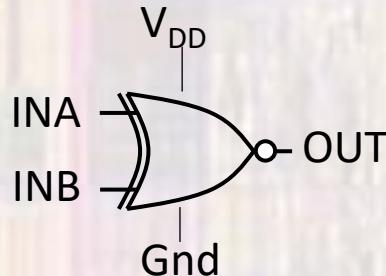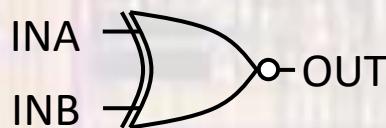
  - Truth Table (logic)

| INB	INA	OUT
0	0	1
0	1	0
1	0	0
1	1	1

Sometimes called the Equality Gate

Digital Logic Gates

- Multi-input gates

  - OR – outputs 1(T) if any inputs are 1(T)
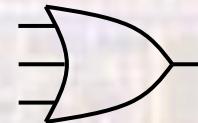
  - NOR – outputs 0(F) if any inputs are 1(T)
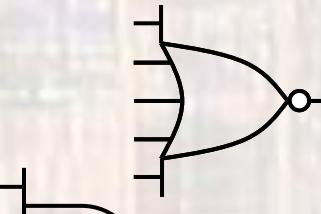
  - AND – outputs 1(T) if all inputs are 1(T)
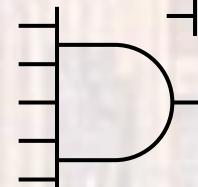
  - NAND – outputs 0(T) if all inputs are 1(T)
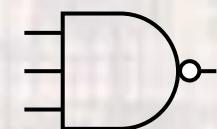
  - XOR – outputs 1(T) if an odd number of inputs are 1(T)
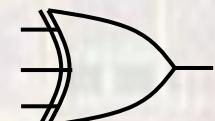
  - XNOR – outputs 0(T) if an odd number of inputs are 1(T)