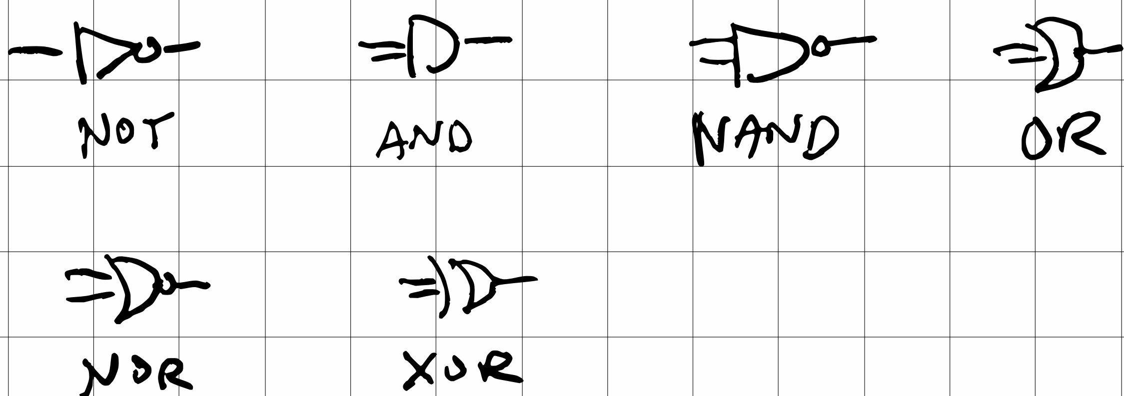
ME 133 lecture 12 12/15/2022

Last time:

- digital representations
  - binary
  - hexadecimal
- Combinational logic



- Truth tables
- Timing Diagrams

Today:

- Boolean Algebra
- Design Logic Networks

Fundamental Laws

OR	AND	NOT
$A + 0 = A$	$A \cdot 0 = 0$	$\overline{\overline{A}} = A$
$A + 1 = 1$	$A \cdot 1 = A$	
$A + A = A$	$A \cdot A = A$	
$A + \overline{A} = 1$	$A \cdot \overline{A} = 0$	

Commutative Laws

$$A + B = B + A$$
$$A \cdot B = B \cdot A$$

Associative Laws

$$(A + B) + C = A + (B + C)$$

$$(A \cdot B) \cdot C = A \cdot (B \cdot C)$$

Distributive laws

$$A \cdot (B + C) = (A \cdot B) + (A \cdot C)$$
$$A + (B \cdot C) = (A + B) \cdot (A + C)$$

De Morgan's law

$$\overline{A + B + C \cdots\cdots} = \bar{A} \cdot \bar{B} \cdot \bar{C} \cdots\cdots$$

$$\overline{A \cdot B \cdot C \cdots\cdots} = \bar{A} + \bar{B} + \bar{C} \cdots\cdots$$

Δ converting AND & OR to eachother.

$$A + B + C + \cdots = \overline{\bar{A} \cdot \bar{B} \cdot \bar{C} \cdots}$$

$$A \cdot B \cdot C \cdots\cdots = \overline{\bar{A} + \bar{B} + \bar{C}} \cdots\cdots$$

There are a more Identities
6.17 – 6.24 Ed. 4 ch. 6

Ex. $A + (\bar{A} \cdot B) = A + B$

A	$\bar{A}$	B	$\bar{A} \cdot B$	$A + (\bar{A} \cdot B)$	$A + B$
1	0	0	0	1	1
1	0	1	0	1	1
0	1	0	0	0	0
0	1	1	1	1	1

$$X = (A \cdot B \cdot C) + (B \cdot C) + (\bar{A} \cdot B)$$

① $A \cdot 1 = A$

$$= A \cdot (B \cdot C) + 1 \cdot (B \cdot C) + (\bar{A} \cdot B)$$

$$= \underbrace{(A + 1)}_{1} \cdot (B \cdot C) + (\bar{A} \cdot B)$$

$$\underbrace{1 \cdot (B \cdot C)}_{(B \cdot C)}$$

$$= (B \cdot C) + (\bar{A} \cdot B) = \boxed{B \cdot (C + \bar{A})}$$

Design Logic Network

Problem: Design a logic circuit for a home alarm system.

What we want:

1. Alarm to go off if the doors or windows are broken
2. Alarm to have motion detection
3. Alarm to be disabled when need

Assumptions:

1. we have sensors (binary) for window/doors & for motion

Define Possible States

1. Active state 1: alarm sounds only if the window or doors are detected.

2. Active state 2: window or doors or motion detection.

3. Disabled State: when occupants are home.

Boolean Variables

A: State of the doors & windows
B: state of motion in the house
Y: output to the alarm
CD: 2-bit code for possible operating state

$$CD = \begin{cases} 0\ 1 & \text{Alarm mode 1} \\ 1\ 0 & \text{Alarm mode 2} \\ 0\ 0 & \text{OFF} \end{cases}$$

Quasi logic Statement

Activate the alarm ($Y=1$)
if $A=1$ & alarm mode is 1 or 2
or activate alarm if A or B
if mode 2

Convert into Boolean expression

$$Y = A \cdot \underbrace{(\bar{C} \cdot D)} + (A+B) \cdot (\underbrace{C \cdot \bar{D}}_{\text{mode 2}})$$

C	D	$\bar{C} \cdot D$
0	1	1
1	0	0