Module 4

Basic Logic Design

9/13/2023

1 Logic Design

Logic gates are put together to create a circuit that performs an operation based on the inputs.

- If the open-door sensor is on AND the security is armed then sound the alarm.
- If launch sequences 1 AND 2 AND 3 are ready OR the principal sequence is ready AND the rocket is fueled, then launch the rocket

Basic logic design using logic gates is thus far known as `combinational logic design`. As soon as the input is changed, the output is changed, and there is no synchronization or clocking involved

combinational logic

Can have any number of inputs and outputs. These operations are defined by the logic circuits according to their design.

Tutorial of such

1. Use a truth table to first define the behaviour
2. How many outputs are needed
3. What combination of inputs will make the outputs `high` or `low`

Example

A porch lighting system uses a light sensor to detect if it is dark or light outside. It also contains a motion sensor to detect if someone walks in front of the sensor to turn on a porch light. Also attached to the system is a simple light switch which will turn on and off the porch light.

Operation

- If it's dark outside **and** somone crosses the motion sensor, the porch light will come on

- If it's light outside, the motion sensor will not turn on the porch light
- Regardless of if it's light or dark outside, the light switch will turn on the porch light

Inputs and Outputs

Inputs are:

- light sensor
- Motion sensor
- switch

Outputs are:

- Porch light

Create a truth table of the process

Minterm & Maxterm

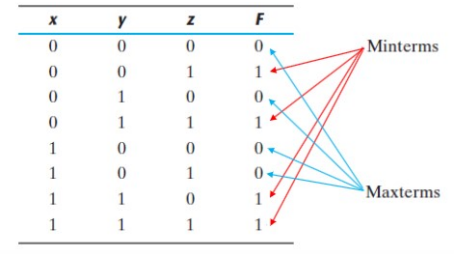
make Logically equivalent circuits with different implementations

- Minterm represents 1 on truth table output.

$$m_1 = x'y'z,\ m_3 = x'yz,\ m_6 = xyz',\ m_7 = xyz$$

- Maxterm represents 0 on truth table output.

$$m_0 = x + y_z,\ m_2 = x + y' + z,\ m_4 = x' + y + z,\ m_5 = x' + y + z'$$



x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Minterm or SOP

SOP:Sum Of Product:*Or all minterms together

$$F = x'y'z + x'yz + xyz' + xyz$$

$$F = m_1 m_3 m_6 m_7$$

This expression is a sum of products.

Maxterm or POS

POS: Product Of Sums:

$$F = (x + y + z) \cdot (x + y' + z) \cdot (x' + y + z) \cdot (x' + y + z')$$

$$F = M_0 M_2 m_4 m_5$$

*Expression if the product of the sums

Canonical Form

Representing the output of a truth table `using minterms and maxterms` is known as canonical form.