# **NEC 304**

# STLD

Lecture 12

**Circuit Analysis Procedure** 

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#### **Overview**

#### ° Important concept – analyze digital circuits

- Given a circuit
  - Create a truth table
  - Create a minimized circuit

#### ° Approaches

- Boolean expression approach
- Truth table approach
- ° Leads to minimized hardware
- ° Provides insights on how to design hardware
  - Tie in with K-maps (next time)

## **The Problem**

- <sup>o</sup> How can we convert from a circuit drawing to an equation or truth table?
- ° Two approaches
  - ° Create intermediate equations
  - ° Create intermediate truth tables



## **Label Gate Outputs**

- 1. Label all gate outputs that are a function of input variables.
- 2. Label gates that are a function of input variables and previously labeled gates.
- 3. Repeat process until all outputs are labelled.



### **Approach 1: Create Intermediate Equations**

- Step 1: Create an equation for each gate output based on its input.
  - **R = ABC**
  - S = A + B
  - **T** = C'S
  - Out = R + T



### **Approach 1: Substitute in subexpressions**

- Step 2: Form a relationship based on input variables (A, B, C)
  - **R = ABC**
  - S = A + B
  - T = C'S = C'(A + B)
  - Out = R+T = ABC + C'(A+B)



#### **Approach 1: Substitute in subexpressions**

- □ Step 3: Expand equation to SOP final result
  - Out = ABC + C'(A+B) = ABC + AC' + BC'



### **Approach 2: Truth Table**

□ Step 1: Determine outputs for functions of input variables.



### **Approach 2: Truth Table**

Step 2: Determine outputs for functions of intermediate variables.



### **Approach 2: Truth Table**

**Step 3: Determine outputs for function.** 



#### **More Difficult Example**

□ Step 3: Note labels on interior nodes



Fig. 4-2 Logic Diagram for Analysis Example

# **More Difficult Example: Truth Table**

- Remember to determine intermediate variables starting from the inputs.
- When all inputs determined for a gate, determine output.
- The truth table can be reduced using K-maps.

#### Summary

#### <sup>°</sup> Important to be able to convert circuits into truth table and equation form

• WHY? ---- leads to minimized sum of product representation

#### ° Two approaches illustrated

- Approach 1: Create an equation with circuit output dependent on circuit inputs
- Approach 2: Create a truth table which shows relationship between circuit inputs and circuit outputs

#### $^{\circ}$ Both results can then be minimized using K-maps.

° Next time: develop a minimized SOP representation from a high level description