

Digital Systems

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IT131

Course Overview

Lecture 0



- Course Description:
- This course addresses the understanding and design of digital systems.
- The **subject** is also known by other names such as logic design, digital logic, digital design and switching circuits.
- Examples of digital systems: digital computers, control systems, data communication and many other systems that require electronic digital hardware

DIGITAL Systems

- Most of Digital Systems or devices consist of two integrated Components:
 - Hardware: which can be defined as a group of Electronic Circuits that execute the program instructions.
 - Software: which are used to control the hardware in order to execute the user commands.

WHAT IS DIGITAL?

- **Digital** describes any system based on discontinuous data or events.
- Computers are digital machines because at their most basic level they can distinguish between just two values, 0 and 1, or off and on.
- There is no simple way to represent all the values in between, such as 0.25.
- All data that a computer processes must be encoded digitally, as a series of zeroes and ones.



• Learning Outcomes:

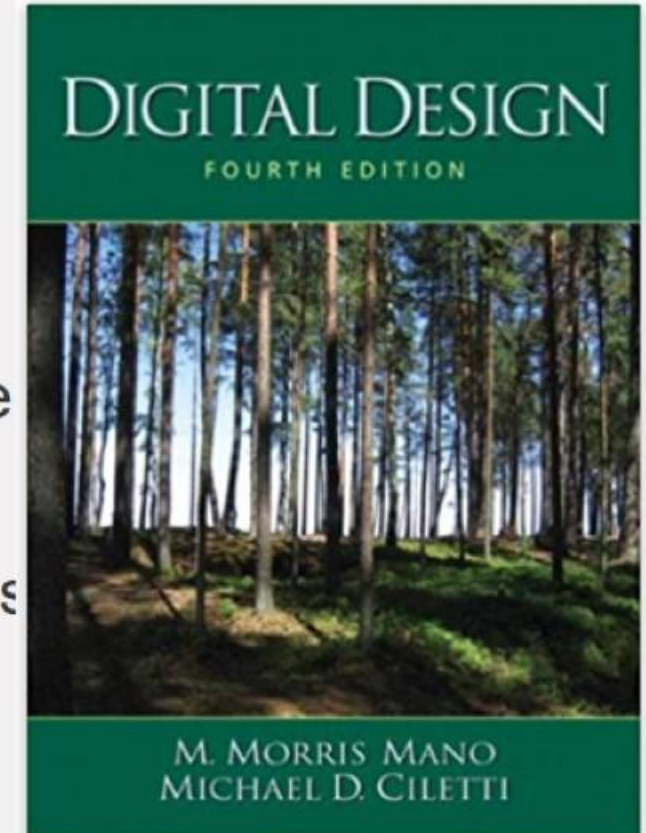
- Develop an understanding of different numbering systems and the concept behind
- Boolean algebra and the two valued logic.
- Optimize logic functions using any type of minimizing algorithms (Boolean algebra or Karnaugh map).
- Analyze any digital logic circuit either Combinational or Sequential.
- Design digital logic circuits (Define the problem, Determine inputs and outputs,
- Express the outputs as Boolean expressions and implement the outputs.
- Use simulation software for developing and testing digital logic circuits.

- Assessment Strategy

- The assessment strategy measures the student's understanding of digital systems and their design.
- The assessment is mainly implemented using Examinations to indicate student's progress in mastery of course content and it includes:
 - Weekly quizzes to measure the students understanding to the topics covered in that week.
 - An end-of-semester final examination to measure the student's mastery in understanding the knowledge and design skills gained through the whole course.

Course Overview

- **Credit Hours:** 4 credit hours
- **Required Textbook:**
 1. **M. Mano, M. D. Ciletti “Digital Design”, Prentice Hall.**
- Most of the material in these pages was originally taken from the 4th and 5th edition of this textbook.
- Lecture notes, power point slides (ppt-pdf) and videos and additional resources that are prepared by me.



- **CHAPTER 1**
- **Digital Systems and Binary Numbers**
- Digital Systems, Binary Numbers, Number-base Conversions, Octal and Hexadecimal Numbers, Complements, Signed Binary Numbers, Binary Codes, Binary Storage and Registers, Binary Logic

- **CHAPTER 2**
- **Boolean Algebra and Logic Gates**
- Introduction, Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Other Logic Operations, Digital Logic Gates, Integrated Circuits
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- What is the difference between the Boolean algebra and arithmetic algebra?
- The first obvious difference is that in Boolean algebra we have only (+) and (·) operators, but we do not have subtraction (-) or division (/) like in mathematics.
- The Second Difference, Boolean Algebra use Binary Values only which can be equal either 1 or 0 only, While the Arithmetic variables are numbers that consist of many decimal digits (1,2,3,4,...).

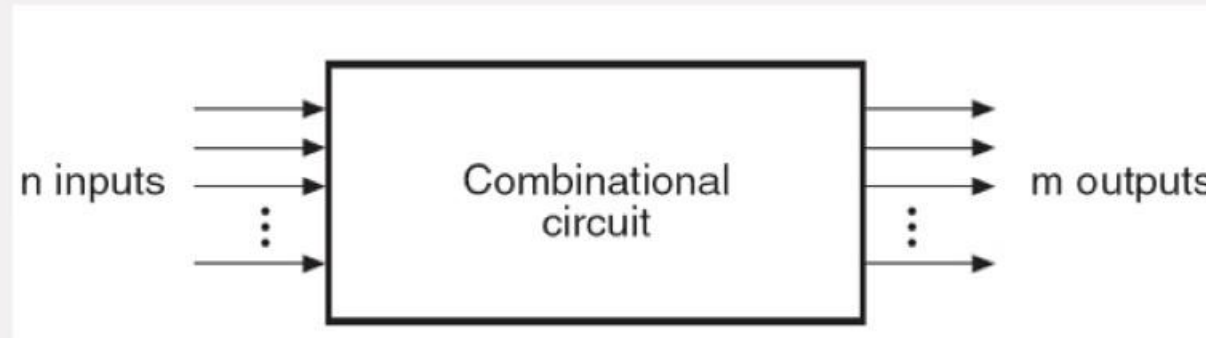
- Logic Gates
- There are three fundamental logical operations, from which all other functions, no matter how complex, can be derived. These Basic functions are named:
 - *AND*,
 - *OR*,
 - NOT (INVERTER).
- Each of these has a specific symbol and a clearly-defined behavior

- **CHAPTER 3**
- **Gate level Minimization**
- The Map Method, Two-variable map, Three-variable map, Four-Variable Map, Product of Sums Simplification, Don't-care Conditions, NAND and NOR Implementation, Other Two-Level Implementations, Exclusive-OR Function

- **Complexity** of a logic circuit is directly related to the algebraic expression.
- Simplification can be done using algebraic manipulation, but it has issues:
 - How to know succeeding steps in the manipulative process
 - Difficult to determine whether the simplest expression has been achieved.
- To obtain the simplest implementation for a given function, we will cover a graphical technique using Karnaugh maps (K-maps)

- **CHAPTER 4**
- **Combinational Logic**
- Introduction, Combination Circuits, Analysis Procedure, Design Procedure, Binary Adder-Subtractor, Decoders, Encoders, Multiplexers

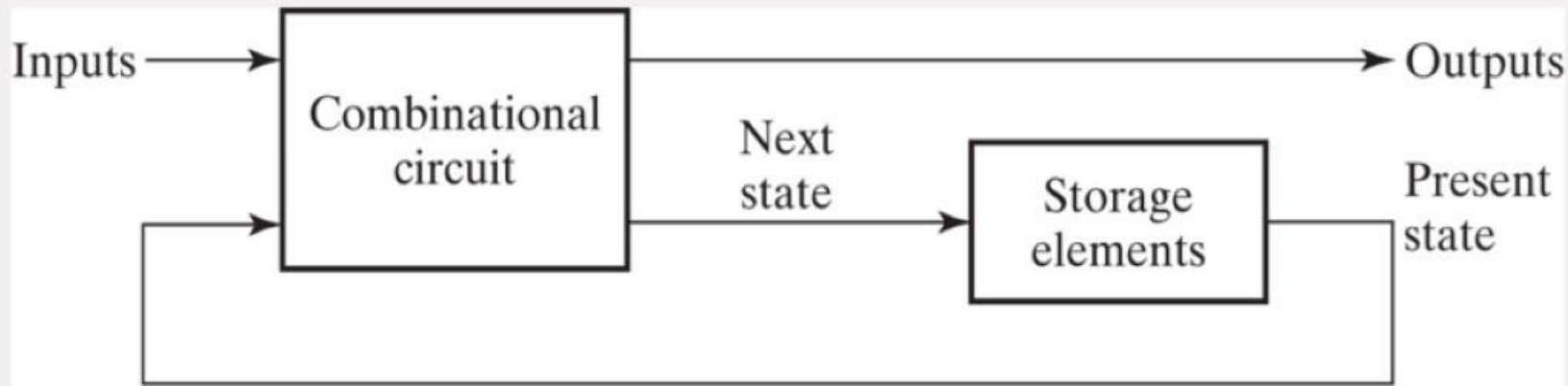
- A **combinational logic circuit** is a connected arrangement of:
 - A set of n Boolean inputs,
 - A set of m Boolean outputs, and
 - Logic gates and interconnections



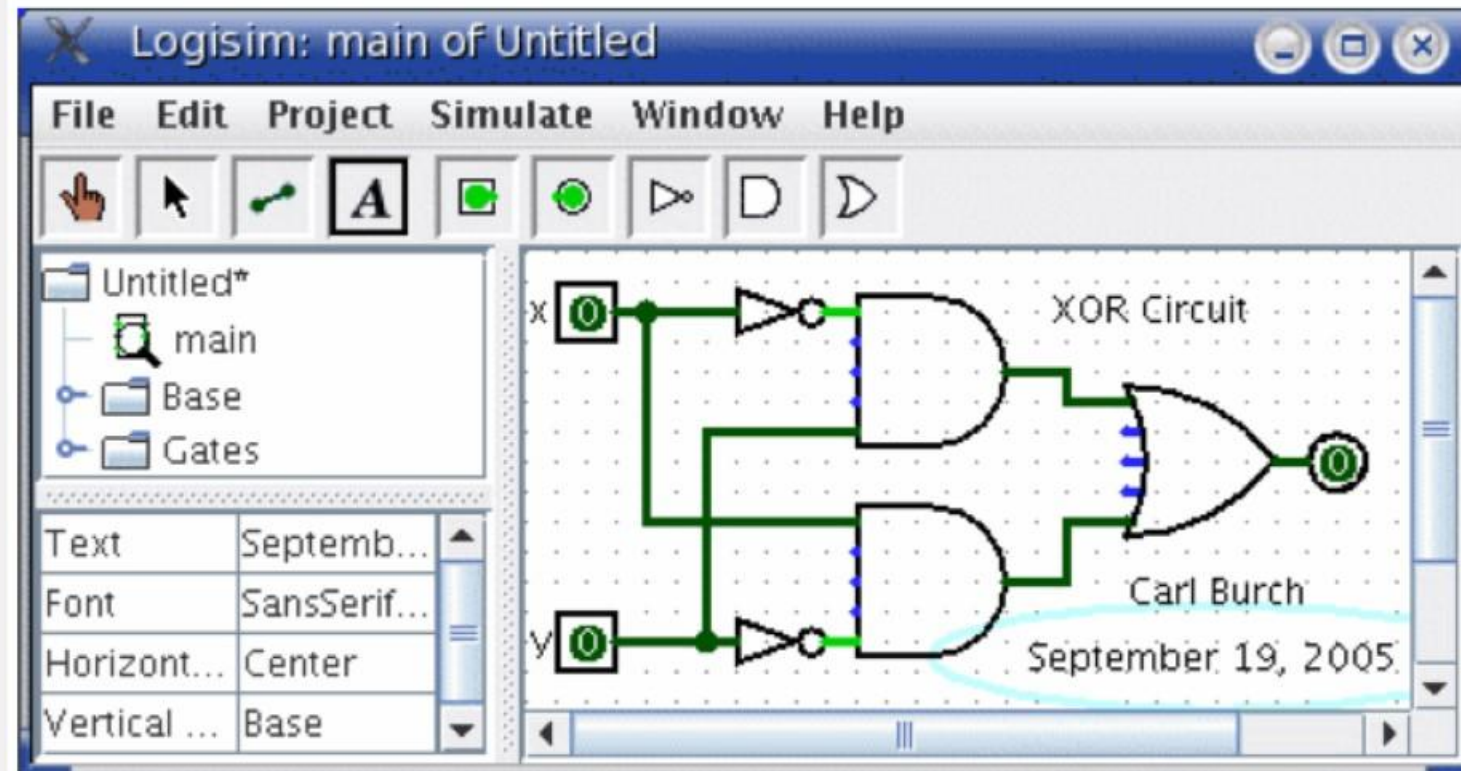
Block Diagram of Combinational Circuit

- **CHAPTER 5**
- **Synchronous Sequential Logic**
- Introduction, Sequential Circuits, Storage Element: Latches and Flip-Flops, Analysis of Clocked Sequential Circuits , Design Procedure

- A **sequential circuit** consists of a combinational circuit to which memory elements are connected to form a feedback path.



- **CHAPTER 6**
- **Hardware Simulation**
- Use simulation software such as Logisim, HDL for developing and testing digital logic circuits.





Thank You