ECE 3220
Digital Design with VHDL

Course Information

Lecture 1
Course Information

- **Course #**: ECE 3220
- **Course Name**: Digital Design with VHDL
- **Course Instructor**: Dr. Vida Vakilian
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**Course Objective:**
- To analyze and design combinational and sequential logic circuits.
- To write VHDL code to describe and synthesize both types of logic circuits.
Course Information

Textbooks

◆ Main book:

◆ Supplementary books:
1) Digital systems design using VHDL, Charles H. Roth, JR
2) Digital Electronics a Practical Approach with VHDL, 9\textsuperscript{th} edition, William Kleitz
Lab Information

- Labs performed weekly.
- In our Labs, we use Altera DE2 board
Homework

- Homework will be assigned on a weekly basis.
- Homework is due at the **beginning** of class on the date specified.
  - No late submissions accepted.
- You can discuss the homework problems with one another.
  - However, you must submit your own work.
  - Copying solutions is considered cheating.
- Homework is essential to the learning process!
Exams

- One midterm exam.
- Midterm and final exams are closed-book.
- No make-up exams.
  - In the case of an emergency, see me.
  - Notify me in advance (whenever possible) if a conflict or problem exists.
Grading

- The final grade will be calculated as follows:
  - Homework 10%
  - Lab 20%
  - Midterm 30%
  - Final Exam 40%
Digital Hardware Design
First Integrated Circuit (IC)

- In 1958, Jack Kilby made the first IC when he was working at Texas Instruments. He successfully interconnected several transistors, resistors and capacitors by hand on a single substrate.
First Integrated Circuit (IC)
First Microprocessor: Intel 4004

- In November 1971, Intel introduced the world's first single chip microprocessor, called “the Intel 4004”.

![Image of Intel 4004 microprocessor chip]
The development process begins with the definition of product specifications. The most obvious requirements are that the product must function properly.

- *Meet an expected level of performance*
- *Its cost should not exceed a given target*

In the case of large errors in testing, it is necessary to redesign the product and repeat all the steps.

When the prototype passes all the tests, then the product is deemed to be successfully designed and it can go into production.
Digital Hardware System

- A chip comprises a number of subcircuits, which are interconnected to build the complete circuit.

- Each of these subcircuits is a logic circuit, comprises a network of connected logic gates.

- Logic gates are built with transistors, implemented by fabricating various layers of material on a silicon chip.
Two design methodologies

**ASIC**
- Application Specific Integrated Circuit
- designed all the way from behavioral description to physical layout
- designs must be sent for expensive and time consuming fabrication in semiconductor foundry

**FPGA**
- Field Programmable Gate Array
- no physical layout design; design ends with a bitstream used to configure a device
- bought off the shelf and reconfigured by designers themselves
FPGA vs. ASIC

**ASICs**

- High performance
- Low power
- High cost

**FPGAs**

- Off-the-shelf
- Low development costs
- Short time to the market
- Reconfigurability
What is FPGA?

- Configurable Logic Blocks
- I/O Blocks
- Block RAMs
What is FPGA?
FPGA Design Process (1)

Specification / Pseudocode

On-paper hardware design
(Block diagram & ASM chart)

VHDL description (Your Source Files)

Functional simulation

Synthesis

Post-synthesis simulation
FPGA Design Process (2)

- Implementation
- Configuration
- Timing simulation
- On chip testing