

Fundamentals of Digital System Design

ECE 3700, CPSC 3700

- Instructor: Priyank Kalla (kalla@ece.utah.edu)
- 4 Credits
- Tu, Thu 12:25 - 1:45pm, EMCB 101
- Office Hours: Wed: 11am-12pm, Thu: 2-3pm, or by appointment
- Office: MEB 4512
- TA hours: To be announced
- Textbook: Fundamentals of Digital Logic with Verilog Design
 - Authors: Stephen Brown and Zvonko Vranesic

Agenda for Today

- Introduction to the course
- Course Organization
- Course Syllabus Overview
- Requirements, Responsibilities, grading policy, etc.
- Introduction to the course via an example
- Discussions....

Course Description

- What is this course all about?
 - DIGITAL
 - LOGIC
 - DESIGN
 - VERILOG
- Putting it all together.....

Digital Design Realization Process

- Design Specifications (usually in English)
- Design Conceptualization (Mathematical modeling)
- Design Analyses: Performance, Costs, Reliability
- Design Descriptions - VHDL, Verilog, SystemC, ...
- Circuit realization: Synthesis, Custom Design
- Design Testing: Errors, Physical Defects and Failures
- Marketing.....
- Hefty Paychecks (if the economy is alright)

Tentative Course Syllabus

- Theory of Digital Design
 - Why digital design?
 - How to think digital?
 - Theory: Boolean algebra, set theory, relations & functions
- Overview of implementation technology
- Combinational Logic Design: Conceptualization + Optimization + Implementation
- Digital Arithmetic: Adders, Multipliers, Comparators, Selectors
- Sequential Logic Design
- All of the above through a Computer-Aided Design Perspective

Course Organization

- http://www.ece.utah.edu/~kalla/index_3700.html
- Course Materials: Textbook + Lecture slides
- Homework Assignments
- Laboratory Design Experiments and Projects
- Two Mid-Term Exams and One Comprehensive Final
- Grading Policy:
 - Mid-Term Exams: 15% each
 - Final Exam: 30%
 - Homeworks: 15%
 - Laboratory Experiments and Projects: 25%
- Pre-requisites: Don't worry about it....

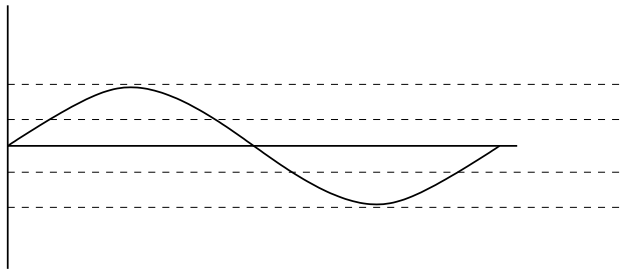
Your Responsibilities

- Please attend all the lectures
- Review lecture notes every week
- Be prompt in returning homeworks and lab reports
- Absolutely no cheating!
 - Discuss assignments w/ your colleagues....
 - Solve homeworks yourselves...
 - Don't pass someone else's hardware as yours
 - Don't copy Verilog Code
- Don't hesitate to contact me or TAs.

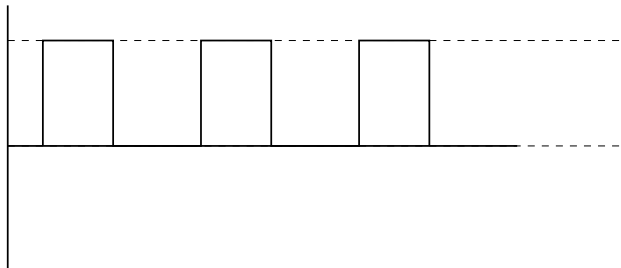
What are the Labs all about?

- Solve homework problems on paper
- Describe the design using Computer-Aided Design Tools
- Analyze the design using Computer-Aided Design Tools
- Laboratory Kits will be provided to you
- Contain: Chips, Wires, I/O Devices, Softwares...
- Build your design, show that it works & feel proud.
- TAs will assist you in the lab
- Labs from 2nd (3rd?) week - compulsory attendance! (1 credit)
- TAs: Will finalize by the next lecture...

Let's Begin Thinking Digital

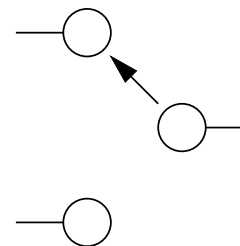


Analog Signal
 $Y = \text{Continuous Function (X)}$
Signal can have infinite values



Digital Signal
 $Y = \text{Discrete Function (X)}$
Signal can have ONLY 2 values: 0 or 1

Binary Variable: 2 values (0 or 1)
Boolean Values: False or True
Electrical Signal: 0Volts or 5Volts
Model as a switch...



Digital Design Example

- Design an Alarm System for a Car
- Specs: (When ignition is ON) AND (Door is OPEN) =; Alarm is ON!
- Ignition is either ON or OFF
- Ignition Circuit: 5 Volt signal or 0 Volts.
- Ignition is a Binary variable: Value 1 or Value 0.
- Ignition ON: Logically a TRUE Value. Ignition OFF: FALSE!
- Door is either OPEN or LOCKED. 0 or 1; TRUE or FALSE.
- Alarm is also Binary: Alarm is ON or OFF.
- This is a digital system.....

Digital Design & Implementation Issues

- Design should be correct & meet the specs
- It should be cost effective....
- Costs: Area, Power dissipation, Man-hours required to develop it...
- It should be reliable: Should run for a long time
- Should be easy to extend/upgrade
- Should be marketable: Speed?
- The above requirements pose the following constraints:

Digital Design & Implementation Issues

- Area, Speed (delay), power, time-to-develop
- Minimize area: Optimize Logic (minimize logic equations)
- Maximize Speed: This is tricky....
- Reliability: Related to Target Technology
- Cost of manufacturing: Related to Target Technology
- Rapid Prototyping...
- Use of CAD/CAE Tools...
- We will study all of these!

Digital Design: A Historical Perspective

- Genesis of Logic Theory: Roman civilization...
- Logical Analysis was a domain of the Philosophers
- Mathematicians picked it up and formalized a theory
- Set Theory (Discrete Math) -; Set theory over Binary variables
-; Boolean algebra -; logic theory -; Engineering solutions
- In the early days of telephony: Switching Algebra
- Once switching technology became reliable.....
- Millions of switching circuits cannot be designed manually:
Tedious, Error-prone, cannot be easily debugged.
- Hence the use of Computer-aided Design Tools

Wrapping-up today's Lecture

- Reading Assignment: Chapter 1.
- Next Lecture: Introduction to Boolean Algebra
 - Sets, relations and functions
 - Sets of binary valued elements, their relations and functions
 - Introduction to Boolean algebra
 - Introduction to Logic Circuits
- Next Class notes & slides will be available on the class website on Wednesday!