THE PENNSYLVANIA STATE UNIVERSITY
MONT ALTO CAMPUS
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Introduction to Digital Systems

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Office location: 314 Sci/Tech. Building
Office Hours: WF 1:00 - 2:00 and MWF 4:00 - 5:00
Course title: CMPEN 271 "Introduction to Digital Systems"
Section: 001
Credits: 3
Class Meeting: MWF 12:00 - 12:50 in 306 GNRL STD Building
Prerequisites: Concurrent PHYS 212
Text and Material:

- The following textbook will be used for the course. It is available at the campus book store.
  - "Logic and Computer Design Fundamentals" 4th Edition by M. Morris Mano and Charles R. Kime. Printice Hall. ISBN: 978013198926.
- Class notes will be posted on ANGEL. You need your user ID and Password to access the notes.
- LogicWorks software: Available on lab computers, room 311 Sci/Tech. Building.

Course Overview:

This course introduces students to logic design and digital systems. The course begins with an overview of number systems, base conversions, and binary arithmetic. Boolean algebra is presented and several basic theorems and postulates are introduced. Boolean algebra is then used to model digital devices. Canonical forms for expressing Boolean functions are introduced including sum-of-products and product-of-sum forms. Basic Small Scale Integrated (SSI) combinational devices are introduced along with a description of their operations characterization, and use. The basic symbols used in a logic diagram/schematic are introduced and the principles involved in reading and creating logic diagrams/schematics are discussed. A systematic design methodology for combinational circuits is covered, including the concepts of function minimization using Karnaugh maps, handling don't care conditions, and designing multiple output circuits. Medium Scale Integrated (MSI) combinational devices and functions such as multiplexers and decoders are discussed and their use in a variety of applications is explained. Simple programmable logic devices and their use in implementing combinational functions is covered. The process of combinational circuit analysis is discussed and the use and interpretation of timing diagrams is introduced. Binary arithmetic is reviewed along with binary addition and subtraction circuits. Various negative number codes are discussed

including 2's complement, 1's complement and sign-magnitude representation. The concept of state and memory is introduced along with various sequential devices including the R-S latch, the D latch and the D, T, and J-K flip-flops. Timing considerations such as set-up and hold times for sequential devices is discussed along with various flip-flop triggering methods. The basic model for a sequential circuit/finite state machine is introduced. A systematic design methodology for creating synchronous sequential circuits is covered including state table/diagram creation, state reduction, state assignment, and circuit implementation. The process of sequential circuit analysis is also described. Special sequential devices and circuits are introduced including counters and registers. Their use in various applications is highlighted. The course ends with a discussion of memory devices including RAM's and ROM'S. Throughout the course, students use LogicWorks software to model and test a variety of circuits.

Course Objectives:

- Understand how to convert between numbering representations.
- Understand how to design a combinational logic circuit from a word statement to a circuit diagram.
- Understand and manipulate a logic function representations; truth table, symbolic, and circuit diagram.
- Understand how to use Karnaugh maps to minimize logic functions.
- Understand how adders, comparators, multiplexers and decoders are built and operate.
- Understand how D, T, SR, JK; latches, clock latches and flip flops are supposed to operate.
- Understand how registers, shift registers, counters, tri-state logic and RAMs are built and operate.
- Understand how to design Finite State Machines.

Class Policies

The following are ground rules to help us maintain a steady progress through the semester:

- **Attendance**
  - Attendance will not be taken on regular basis, however, students are expected to attend all classes.
- **Assignments and Reports**
  - Assignments are due at the start of the class before the lecture begins. Late assignments will not be accepted.
  - Make up exams/homework are only permitted for extreme cases and must be supported by written documentation, such as a doctor's note.

- It is the student's responsibility to get any missing notes or assignments. If you miss a class, make sure to contact me or some one else in class to get important information that you might have missed.
- Assignment papers must be clean, easy to follow and stapled. Do not fold or rip from a spiral notebook.

- **Contacts**
  - I will keep in touch with you over the course of the semester through e-mail. Please check your e-mail, frequently.
  - When sending me an email, make sure to use your PSU email account. I do not respond to emails from unidentified sources.
  - Feel free to send me any comment or thought about the course. I will be glad to hear from you.

- **Academic Integrity**

  Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and you are expected to act in accordance with this principle. Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others. The list of academic integrity violations includes cheating, copying on a test, plagiarism, acts of aiding or abetting, submitting previous work, tampering with work, ghosting, altering exams and computer theft of programs/ materials. An explicit list of examples of academic integrity violations is found at:
  http://www.engr.psu.edu/Forms/AcademicIntegrity/precedent_students.pdf
  This class will be expected to follow the academic integrity guidelines. Violations will be addressed using the steps outlined at
  http://www.engr.psu.edu/Forms/AcademicIntegrity/policies.pdf

- **Disability Statement**

  Students with disabilities who need accommodations in this course, should contact the instructor within the first week of classes. You may refer to the nondiscrimination policy in the Student Guide to University Policies and Rules.

Grading System

- Grades will be distributed as follows:

  - First Exam 20%
  - Second Exam 20%
  - All Homeworks 30%
  - Final Exam 30%

- Final letter grade will be assigned as follows:

94 – 100	A
90 – 93	A-
87 – 89	B+
83 – 86	B
80 – 82	B-
75 – 79	C+
70 – 74	C
60 – 69	D
below 60	F

Schedule

The table below shows the topics covered on weekly basis.

Week 1	- Digital Systems - Binary, Octal and Hexadecimal Numbers - Number Base Conversions and Binary Codes
Week 2	- Binary Logic and gates - Boolean Algebra - Min-terms and max-terms
Week 3	- Two-Level Minimization - Map manipulation
Week 4	- Design Concept and Automation - The Design Space and Design Procedure
Week 5	- Technology Mapping and Verification - Programmable Implementation Tech
Week 6	- **Exam 1** - Combinational Circuits - Decoding and Encoding
Week 7	- Selecting - Combinational Function Implementation
Week 8	- Iterative Combinational Circuits - Binary Adder and Binary Subtraction
Week 9	- Binary Multiplication - Other Arithmetic Functions - Sequential Circuits
Week 10	- Latches and Flip-Flops
Week 11	- Sequential Circuit Analysis - Sequential Circuit Design - **Exam 2**
Week 12	- Registers, Register Transfers and Operations
Week 13	- Microoperations - Counters - Register Cell Design
Week 14	- The Control Unit - Algorithmic State Machines - ASM Examples
Week 15	- Hardwired Control - Review for Final Exam