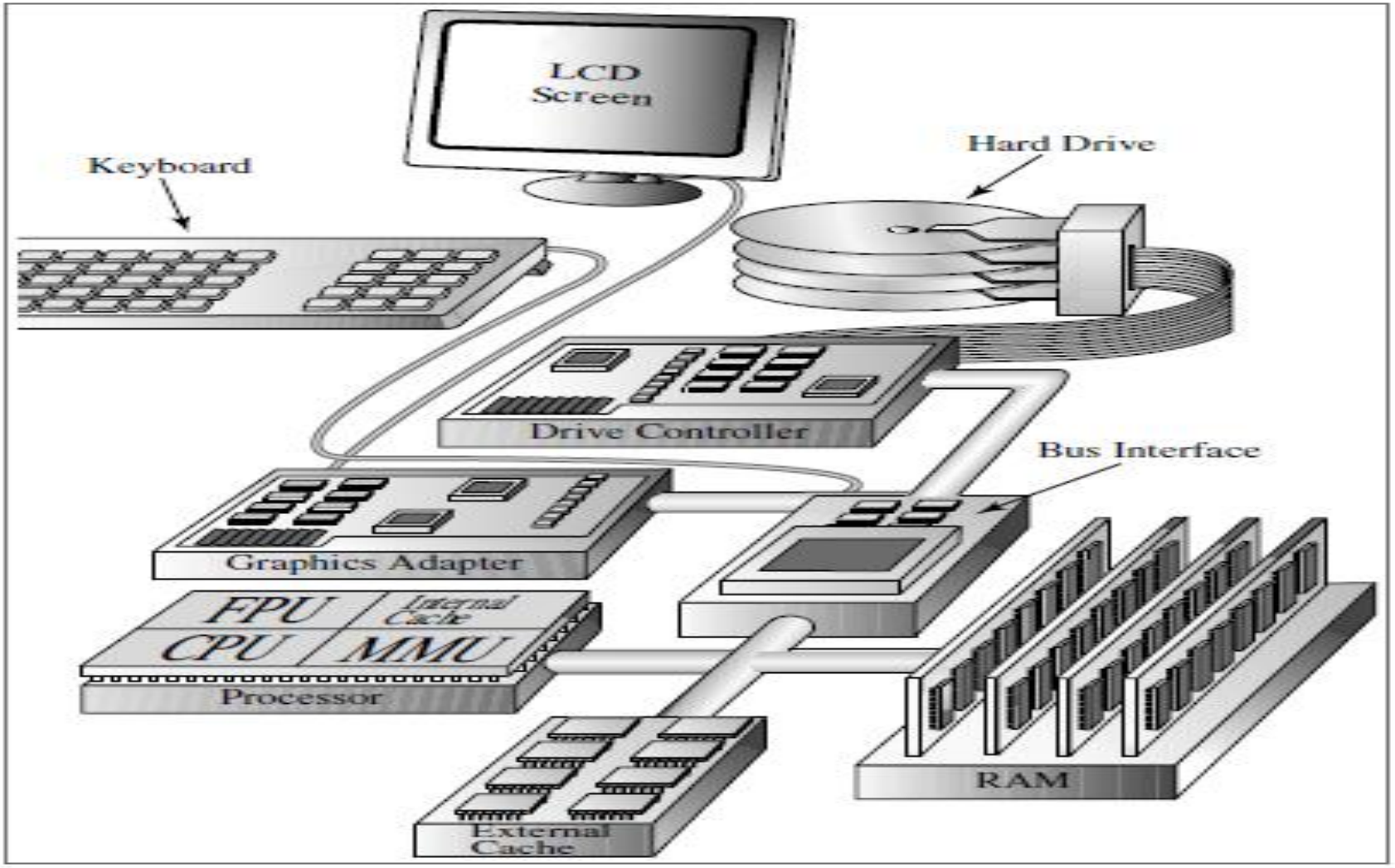
# Introduction




**Generic Computer**

# Application Areas

- Digital logic design is all about logic circuits-the circuits from which computers are built.
- Logic circuits are found in commonly used products, such as digital telephones, digital watches, digital televisions, digital cameras, and other household appliances, like Digital Versatile Discs(DVDs), CD players, and electronic games.
- They are also used in large communication systems, business transactions, traffic control, space guidance, space guidance, medical treatment, weather monitoring, the internet, and many other commercial, industrial, and scientific enterprises.
- Logic circuits are extensively used in computing and embedded systems.

# Applications in Computing Systems

- These circuits are a key ingredient of computers and form part of memory, multiplexed bus, memory addressing, Arithmetic and Logic Unit(ALU) and other hardware components of Personal Computers(PCs).
- In terms of world impact, computers, such as the PC are not the end of the story. Smaller, often less powerful, single-chip computers called *micro-controllers*, or special-purpose computers called *digital signal processors* are more prevalent in our lives. As consequence of being an integral part of many products and often enclosed within them, they are called Embedded Systems.

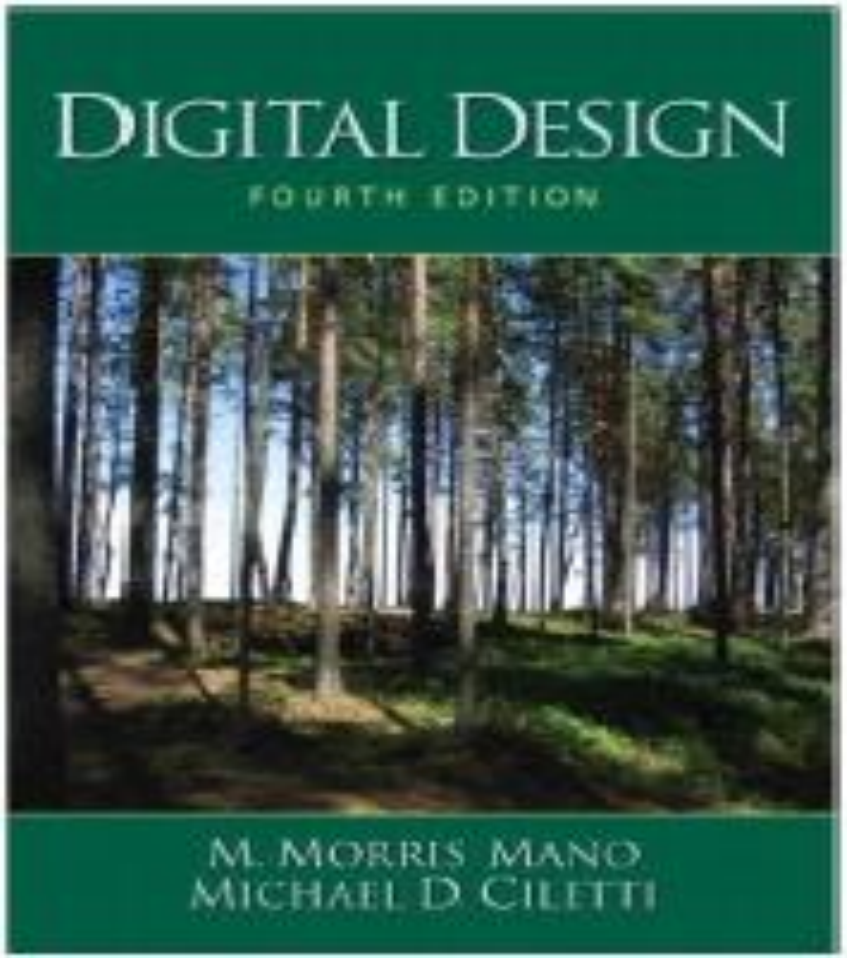
# Applications in Embedded Systems

| Application Area | Product |
|---|---|
| Banking, Commerce, and manufacturing | Copiers, Fax machines, UPC scanners, vending machines, automatic teller machines(ATM), automated ware houses, industrial robots, 3D printers |
| Communications | Wireless access points, network routers, satellites |
| Games and toys | Video games, handheld games |
| Home appliances | Digital alarm clocks, microwave ovens, dishwashers |
| Media | CD players, DVD players, flat panel TVs, digital cameras, digital video cameras |
| Medical equipment | Pacemakers, incubators, magnetic resonance imaging(MRI) |
| Personal | Digital watches, MP3 players, smart phones, wearable fitness trackers |
| Transportation and Navigation | Electronic engine controls, traffic light controllers, aircraft, flight controls, global position systems(GPS) |

# EE221: Digital Logic Design
# (3+1)

# Text Book:

Digital Design (4th Edition) by M. Morris Mano and Michael D. Ciletti



# Reference Books:

1. **Digital Fundamentals (11th Edition) by Floyd**
2. **Logic and Computer Design Fundamentals (4th Edition) by M. Morris Mano and Charles R. Kime**
3. **Fundamentals of Logic Design (6th Edition) by Charles H. Roth, Jr**
4. **Digital Systems: Principles and Applications (10th Edition) by Tocci. Widmer**
5. **Contemporary Logic Design(2nd Edition) by Randy H. Katz**
6. **Verilog HDL: A guide to Digital Design and Synthesis (2nd Edition) by Samir Palnitkar**

# Course Objective

- A one semester course that provides Computer Science students with materials fundamental to the design and analysis of digital circuits. This course introduces the logic operators and gates to lay the framework for strengthening the understanding of computer building blocks. Combinational and sequential circuits are studied along with their constituent elements comprising adders, decoders/encoders and multiplexers as well as flip-flops, latches and registers etc. The course provides necessary information to the students for in-depth study of Computer Engineering subjects.
- Upon successful completion of the course the students will be expected to design practical logic circuits using digital integrated circuits and perform simulation and synthesis using Verilog HDL.

# Course Learning Outcomes(CLOs)

- **Understand** digital systems, computer arithmetic, and **simplify** Boolean functions.
- **Analyze** combinational and sequential medium-scale integration circuits using standard analysis procedures to determine their functionality.
- **Design** combinational and sequential circuits of moderate complexity within given hardware constraints.
- **Conduct** lab experiments as well as **analyze** and **interpret** experimental data.
- **Construct** digital systems of moderate complexity using laboratory equipment and simulation tools
- **Exhibit** good professional and ethical behavior. **Adhere** to laboratory safety rules.
- **Function** effectively both individually and member of a team.

# Course Contents

- Digital Systems. Binary Numbers. Number Base Conversions. Octal and Hexadecimal Numbers. Complements. Signed Numbers. Binary Codes. Floating Point Numbers
- 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
- The K-Map Method. Four-Variable Map. Product of Sums and Sum of Products simplifications. Introduction to Five-Variable Map. Simplification using Quine-McCluskey minimization technique.
- Don't-Care Conditions. NAND and NOR Implementation. Other Two-Level Implementations

**…contd**





# Course Contents

- Combinational Circuits. Analysis Procedure. Design Procedure. Binary Adder-Subtract or. Decimal Adder
- Binary Multiplier. Magnitude Comparator. Decoders. Encoders. Multiplexers and De multiplexers.
- Arithmetic Logic Unit
- Sequential Circuits. Latches
- Flip-Flops. Analysis of Clocked Sequential Circuits. State Reduction and Assignment
- Registers. Shift Registers. Ripple Counters
- Synchronous Counters. Other Counters

# Assessment Modules and Weight ages

Quizzes: 12@12%

Assignments: 8@8%

OHT1: 12@16%

OHT2: 12@16%

End Semester Exam: 36@48%

Theory Total: 75

Labs: 17.5 @70%

Semester Project/Final Exam: 7.5@30%

Lab Total: 25

# Lecture Breakdown

| | |
|---|---|
| **1** | **Introduction:** Digital Systems and motivation for study |
| 2 | Number Systems; Binary, Octal, Decimal and Hexadecimal numbers and Base conversions. Floating Point Numbers |
| 3 | Complements; Subtraction of unsigned numbers using complements. |
| 4 | Signed Binary numbers, arithmetic addition and subtraction of signed Binary numbers. |
| 5 | Binary codes. |
| 6 | Binary storage and Registers, Binary Logic and Logic gates. |
| **7** | **Introduction:** Boolean Algebra; Basic and Axiomatic definition of Boolean Algebra; Two-valued Boolean Algebra |
| 8 | Basic Theorems and Properties of Boolean Algebra. |
| 9 | Boolean Functions. |
| 10 | Canonical and Standard forms. |
| 11 | Other Logic operations. |
| 12 | Digital Logic Gates and Integrated Circuits. |
| **13** | **Introduction:** The Map method; Two, Three, and Four - variable K-Maps. |
| 14 | Sum-of-Product and Product-of-Sum simplification using Four-variable K-Maps; Essential and Non-essential Prime Implicants. |
| 15 | Five-variable K-Maps; Sum-of-Product and Product-of-Sum simplification using Five-variable K-Maps. |
| 16 | Don't Care Conditions |
| 17 | NAND and NOR implementations. |
| 18 | Other Two-Level implementations. |
| 19 | Exclusive-OR function; Parity Generation and Checking. |
| **20** | **Introduction:** Combinational Circuits and their Analysis Procedure. |
| 21 | Design Procedure with Code Conversion Example |
| 22 | Binary Adder-Subtractor; Half and Full Adders, Design of 4-BIT Binary Ripple Carry Adder. |
| 23. | Design of 4-Bit Adder using Carry look ahead Generator |
| 24. | Binary Subtract or and overflow |
| 25. | Decimal Adder. |
| 26. | Binary Multiplier. |
| 27. | Magnitude Comparator. |
| 28. | Decoders and Encoders. |
| 29. | Multiplexers and Tri-State gates. |
| 30. | ALU Design |
| **31.** | **Introduction:** Sequential Circuits and different types of Latches. |
| 32. | Flip-Flops: Edge-Triggered D Flip-Flop |
| 33. | Other Flip-Flops |
| 34. | Analysis of Clocked-Sequential Circuits; State Equations, State Table, State Diagram, and Flip-Flop Input Equations. |
| 35. | Analysis with D Flip-Flops, JK Flip-Flops, and T Flip-Flops. |
| 36. | Mealy and Moore Models. State Reduction and Assignment. |
| 37. | Design Procedure-Synthesis using D Flip-Flops. |
| 38. | Design Procedure- Synthesis using JK , and T Flip-Flops. |
| **39.** | **Introduction:** Registers with Parallel Load. |
| 40. | Shift Registers; 4-Bit Shift Register; Serial Transfer and Serial Addition. |
| 41. | 4-Bit Universal Shift Registers**.** |
| 42. | Ripple Counters; Binary and BCD Ripple Counters. |
| 43. | Synchronous Counters: Binary and BCD Counters. |
| 44. | Other Counters; Counter with unused States. |
| 45. | Other Counters; Ring Counter and Johnson Counters. |

- **The committment!**


COMMITMENT
Administrator
Psychologist
Leader
Communicator
Teacher
Counselor
Instructor
Organizer
Moderator
Evaluator
Facilitator
Researcher
Disciplinarian
Manager
Innovator

# Important Themes in Digital Design

- **Good tools do not guarantee good design, but they help a lot by taking the pain of doing things right.**
- **Digital circuits have analog characteristics.**
- **Understand and use standard functional building blocks.**
- **Design for minimum cost at the system level, including your own engineering effort as part of the design.**
- **Use Programmable Logic to simply design, reduce cost, and accommodate last-minute changes.**

# Classroom Etiquettes

It is the collective responsibility of all the students to make the class environment conducive for learning. To create and maintain a friendly atmosphere, the following standards of classroom behavior will be observed:-

* Students will be punctual for the class. The teacher considers late comers disrespectful of those who manage to be on time.
* If a student decides to attend the class, he or she will not disrupt class by leaving before the lecture has ended.
* All the cell phones must be switched OFF prior to entering the classroom.
* The classes will be conducted both in DL and FTF modes. The students are instructed to wear face masks, sanitize their hands, and maintain social distance due to COVID-19.

# Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other's work, including the copying of assignments and laboratory results from the other students. Plagiarism is considered a serious offence by the university and severe penalties apply. Therefore, all the students must display originality of efforts and avoid plagiarism in any form, otherwise strict disciplinary action will be taken against those using unfair means in any assessment module.

# A Few Tips for Good Learning and Grade Management

- Punctuality and active participation in the class discussions
- Prior study of course material to the taught in the next class
- Timely and non-plagiarized assignment submissions.
- Regularity in lab work and adherence to lab safety rules.
- Apply compensation for any missed evaluation immediately on occurrence.
- Optimal use of online discussion forums like Piazza/Team/WhatsApp.
- Regular end chapter problems solving both from text and reference books
- Judicious time management of different evaluations like quizzes, assignments, labs, and comprehensive exams.
- Teach others for better conceptualization, analysis and design of logic circuits

# Thank you