LECTURE #1: Digital Machines and Digital Design
EEL 3701: Digital Logic and Computer Systems
Based on lecture notes by Dr. Eric M. Schwartz

Classes of Digital Machines
1) Combinational Circuits/Logic Circuits
2) Sequential Logic
3) Microprocessors/Microcontrollers

Combinational Logic
- No Memory
- Boolean Algebra & K-Maps
- Transitional stages in digital applications

\[
\begin{align*}
X &= \begin{pmatrix}
  x_1 \\
x_2 \\
x_3 \\
  \vdots \\
x_n
\end{pmatrix}, \\
Y &= \begin{pmatrix}
y_1 \\
y_2 \\
y_3 \\
  \vdots \\
y_m
\end{pmatrix}, \\
Y &= F(X) = \begin{pmatrix}
f_1(X) \\
f_2(X) \\
f_3(X) \\
  \vdots \\
f_m(X)
\end{pmatrix}, \text{ where } y_j(t) = f_j(X(t)).
\end{align*}
\]
Sequential Logic
- Finite Memory
- Feedback
- Defined number of states (Finite State Machines)

\[ Y = F(Q, X) \text{ and } Q^+ = G(Q, X), \text{ where } Q \text{ is the current state and } Q^+ \text{ is the next state.} \]

Example: Add 1 to the number I am currently thinking.

- Algorithmic State Machines (ASM)
  - A method for sequential logic design
  - Has programming flavor (flowcharts for design)
Microprocessors/Microcontrollers
- “Infinite” memory and states
- General purpose digital machines
- Von Neumann model

![Von Neumann Computer Architecture](image)

Stages of System Design
1) System Design and Specifications
   a. Break system into subsystems
   b. Specify characteristics of each subsystem

Example: Robot with navigation, locomotion, and sensing systems.

2) Logic Design
   - Connecting basic logic gates to perform the desired function

Example: If front and right sensors detect an object, rotate left.

3) Circuit Design
   - Physically building a circuit from components.

Example: Wiring an AND gate between sensor outputs to a microcontroller input.

Lecture deals primarily with Logic Design.
Laboratory deals with both logic design and circuit design.