COE 272
Digital Systems

Lecture 0: Course Outline

Henry Nunoo-Mensah

Email: hnunoo-mensah@knust.edu.gh, hnmensah@gmail.com

Phone: 0207534396

Office: College of Engineering, A-Block, Room 423

Office Hours: Wednesdays 1pm – 5pm

(Appointments can also be scheduled)

Teaching Assistant (2016):

Godwill Amankwa Asare Mensah

Course Objective

- The aim of the course is to expose students to the fundamentals of digital electronics system design.
  - through gate level system design optimization techniques and
  - the design procedures for both memoryless and memory-based systems will be elucidated.

Recommended Textbooks

- "Digital Electronics (Digital Logic Design)" by Sanjay Sharma, Kwatson Books, 2011, 3ed, ISBN: 978-81-907386-7-5

- "Digital Systems Principles and Applications" by Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, Pearson Education, Inc, 2007, 10ed, ISBN: 0-13-173969-7.

- An digital systems textbook that covers the relevant areas to be treated.

Course Outline

- Introduction to digital systems

- Boolean Algebra and Binary Logic
  - Boolean Laws
  - Duality Theorem
  - DeMorgan's Theorem
  - Boolean functions and expressions
  - SOP and POS representation for Logic expressions
  - Minterms and Maxterms Designation
  - Simplification using Karnaugh-map (K-Map)
  - Quine-McClusKey Minimization

Course Outline

- Logic Implementation using resistors, Diodes and Transistors
  - Diode Logic
  - Bipolar transistor logic
  - Field Effect Transistor Logic
- Combinational Circuit
  - Combinational logic design procedure
  - Classification of combinational circuits
  - Adder circuit
  - Subtractor circuit
  - Multiplexer circuit
  - Decoder circuit

Course Outline

- Sequential Circuits
  - Latch
  - Flip flops
  - Registers
  - Counters
  - Finite State Machines

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Digital Systems

Lecture 1: Introduction to Digital Systems

Introduction

- In our day-to-day activities, we come across various types of signals and systems
  - Analog signal
  - Analog system
  - Digital signal
  - Digital system

Analog Signal

- A signal that has infinite number of different magnitudes or values. It basically varies continuously with time.
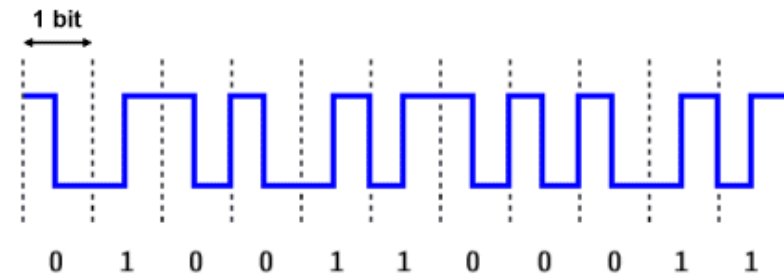- Examples are sine waves and triangular waves

Digital Signal

- A signal is known as a digital signal if it has only finite number of predetermined distinct values.

- Depending on the number of distinct values, the signal can be classified under

#	Number of distinct magnitudes	Type of digital signal
1	2	Binary
2	8	Octal
3	16	Hexadecimal

Comparison of Digital and Analog Signals

#	Parameter	Analog Signals	Digital Signals
1	Number of values	Infinite	Finite (2,8,16, etc.)
2	Number of signals	Continuous-time	Discrete-time
3	Source of signal	Signal generators, transducers, etc.	Computers, ADC, etc.
4	Examples	Sine wave, triangular wave	Binary signal

Analog Systems

- These are systems that process analog signals

- They have been in existence for a long time

- Examples of analog systems are:
  - Filter circuits
  - Amplifier circuits
  - Signal generators
  - Motor speed controllers

NB: the display of these analog systems are made up of analog meters having moving parts

Drawbacks of Analog Systems

- Analog devices have more drawbacks than advantages. Some drawbacks are:
  - Storage and processing of data is not possible
  - Analysis of analog systems require time-domain analysis which requires very sound mathematical background
  - Analog systems are mostly affected by undesirable electrical disturbances called noise
  - Their performance changes with variation in temperature.
  - Analog devices are less versatile
  - The use of analog meters, make it difficult to take accurate readings

Digital Systems

- It is an interconnection of digital modules
  - *Which manipulates discrete elements of information in binary form*

- A digital device like a computer can be programmed to perform a variety of tasks

- Displays on digital systems are made with either LEDs or LCDs

Comparison of Digital and Analog Systems

#	Parameter	Analog	Digital
1	Type of signals processed	Analog signals	Digital signals
2	Type of display	Analog meters	Digital display using LED and LCD
3	Accuracy of system	Small	High
4	Design complexity	Difficult	Easy
5	Memory attached	No memory	Memory available
6	Storage of information	Not possible	Possible
7	Noise effect	High	Small
8	Versatility	Small	High
9	Distortion	High	Small
10	Effect on temperature on performance	High	Small
11	Communication between systems	Not easy	Easy
12	Examples	Filters, amplifiers, power supply, signal generators	Counters, registers, microprocessors, computers

Basic Digital Devices

- The following are the basic devices comprising a digital system.
  - Logic gates
    - *Basic element of a digital system. It operates on a number of binary inputs in order to perform a particular logical function*
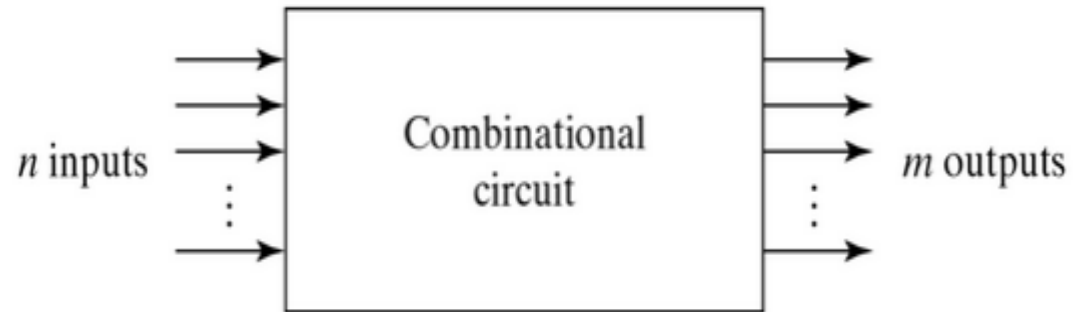   - *Available gates are NOT, AND, OR, NAND, XOR, XNOR*
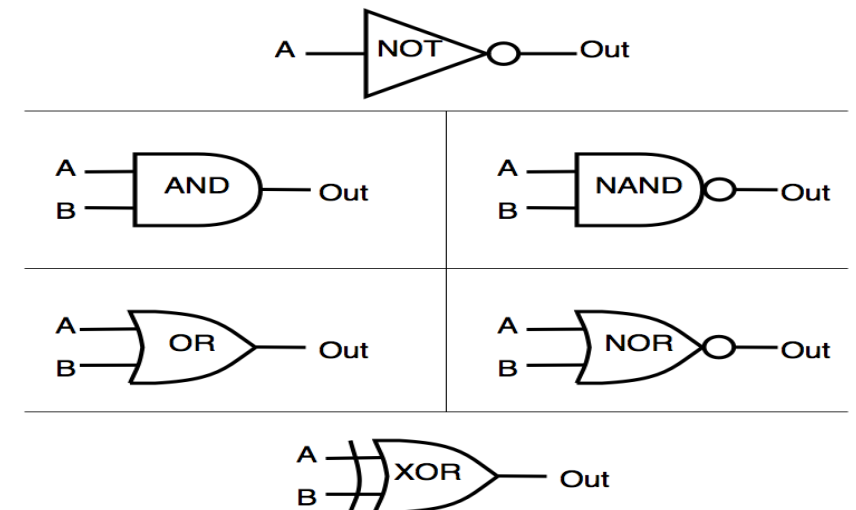
Basic Digital Devices

- Combinational Circuits
  - *A connection of logic gates to produce a specified output for a certain specified combination of input variables*
  - *No storage is involved*
 - *Output is generated based on only the present input variables*

Basic Digital Devices

- Sequential Circuits
  - *Certain digital outputs require to be generated in accordance with the sequence of the input signals are received*
  - *Output is generated based on both the present input variables and also depend upon the past history of these inputs*
  - *A memory device is present*
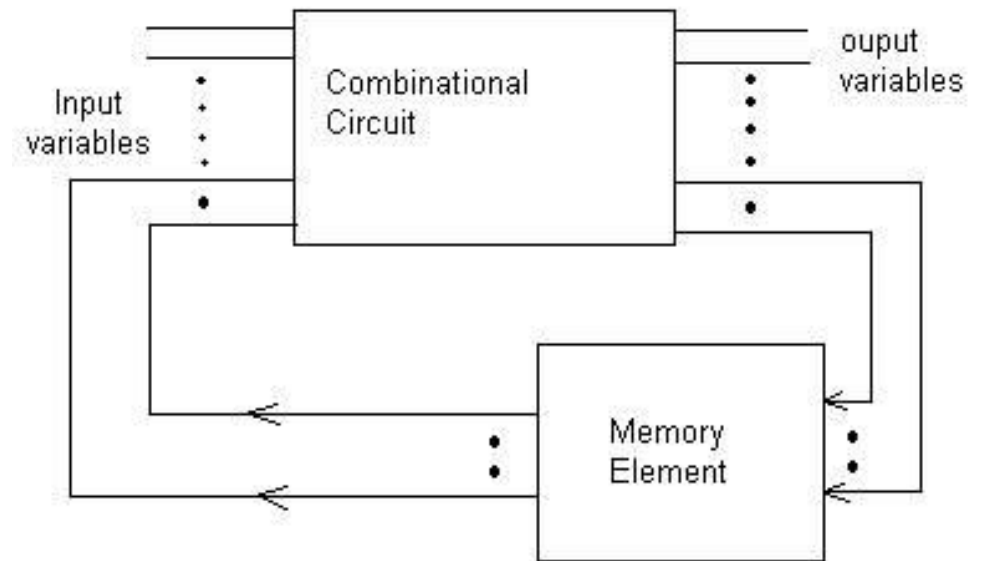
Some terms in digital systems

- Some terms often used in digital systems include:
  - Positive logic
  - Negative logic
  - Bit
  - Nibble
  - Byte
  - Word
  - Double Word