CS221: Logic Design

Instructors:

Dr. Ahmed Shalaby http://bu.edu.eg/staff/ahmedshalaby14#

Dr. Fatma Sakr

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Dr. Ahmed Shalaby

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Current Administrative Position:
Ex-Administrative Position:
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Department: Computer Science
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Scientific Name: Ahmed Shalaby
Publications [Titles(11) :: Papers(3) :: Abstracts(11)]
Courses Files(93)
Inlinks: (0)
External links: (41)

News

Great Teams: Embedded System Course: CanSat Project. [2022-07-04]
https://www.youtube.com/watch?v=w7v8W1ENgqMmore

Research Interests

Hardware Security, System on Chip, Network on Chip, VLSI, Embedded System, High Efficiency Video Coding (HEVC)

Selected Publications

Efficient autoencoder-based human body communication transceiver for WBAN

Sentry-NoC: a statically-scheduled NoC for secure SoCs

Automatic arrival time detection for earthquakes based on Modified Laplacian of Gaussian filter

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Dr. Ahmed Shalaby :: Courses Details:

Number of courses : 11

Number of uploaded files for these courses from students : 0

Course	Files	URL	Assignments	Exam
CS 221: logic Design - 2022	Files(-)	URL(-)	Assignments(-)	Exam(-)
CS 324: Introduction to Embedded Systems - 2022	Files(21)	URL(-)	Assignments(-)	Exam(-)
CS 222: Computer Architecture - 2022	Files(30)	URL(14)	Assignments(-)	Exam(-)
CSW 353: Assembly Language	Files(-)	URL(3)	Assignments(-)	Exam(-)
CHW 261: Logic Design	Files(13)	URL(6)	Assignments(7)	Exam(-)
CHW 362 : Computer Architecture and Organization	Files(4)	URL(9)	Assignments(1)	Exam(-)
CHW 469 : Embedded Systems	Files(11)	URL(6)	Assignments(-)	Exam(-)
FPGA prototyping	Files(-)	URL(-)	Assignments(-)	Exam(-)
Hardware Description Languages	Files(-)	URL(-)	Assignments(-)	Exam(-)

(edit)

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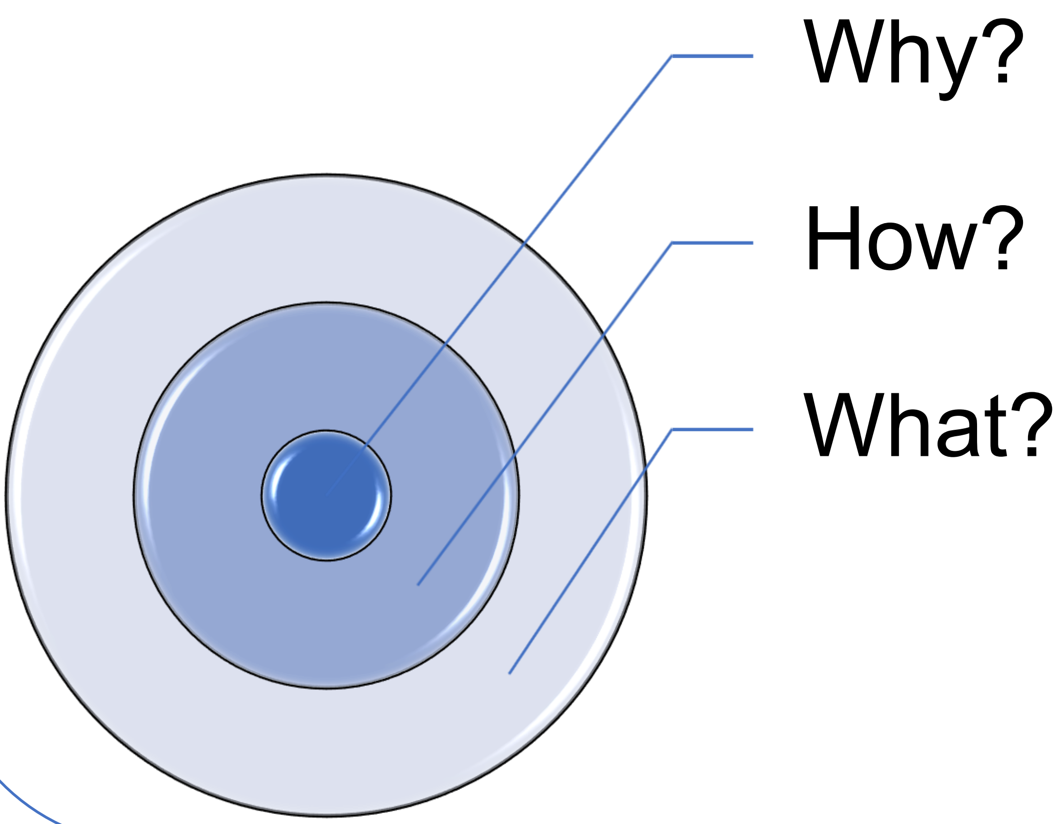
- Photo Gallery
- Staff Statement

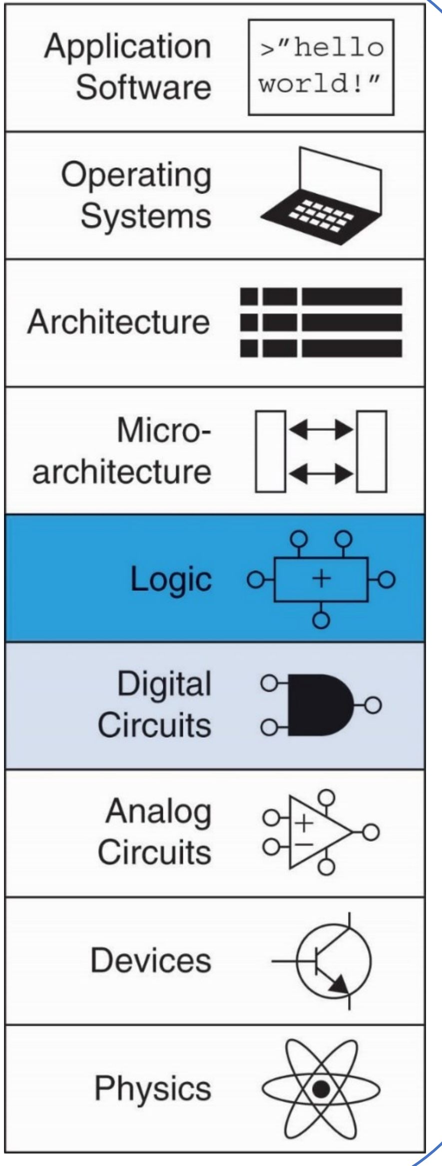
URL
Learn any language!
Past, Present, and Future of Computer Architecture
History of computers | تاريخ الكمبيوتر
History of Operating Systems | تاريخ أنظمة التشغيل
Try to understand and Improve your English: Surah al-Kahf (in-depth) Tafsir
WHY IS JESUS WHITE BY MUHAMMAD ALI
Improve you English ... audio books
Motivation: جيل الألفية - سيمون سينك
What If Money Was No Object? - Alan Watts
awesome Tech : Michi Yamamoto Channel
BBC Learning English
Longman 3000 Words List Pronunciation
Longman Communication 3000 Words
Speak English: English Coach Chad
IEEE Spectrum Magazine
MIT Technology Review
zAmericanEnglish - Channel
50 years of Computer Architecture- by David Patterson
ملخص كتاب : 12 قاعده للحياه - جوردن بيترسون
Silicon Run : manufacture microchips
يابانية اعتنقت الإسلام وتطرح أسئلة جميلة
أول منصة عربية متخصصة في التحديات البرمجية
Calculus - anaHr
The Now Habit - عاده الإنجاز
The astounding athletic power of quadcopters
PROJECTION MAPPING

Study: CS221: Logic Design



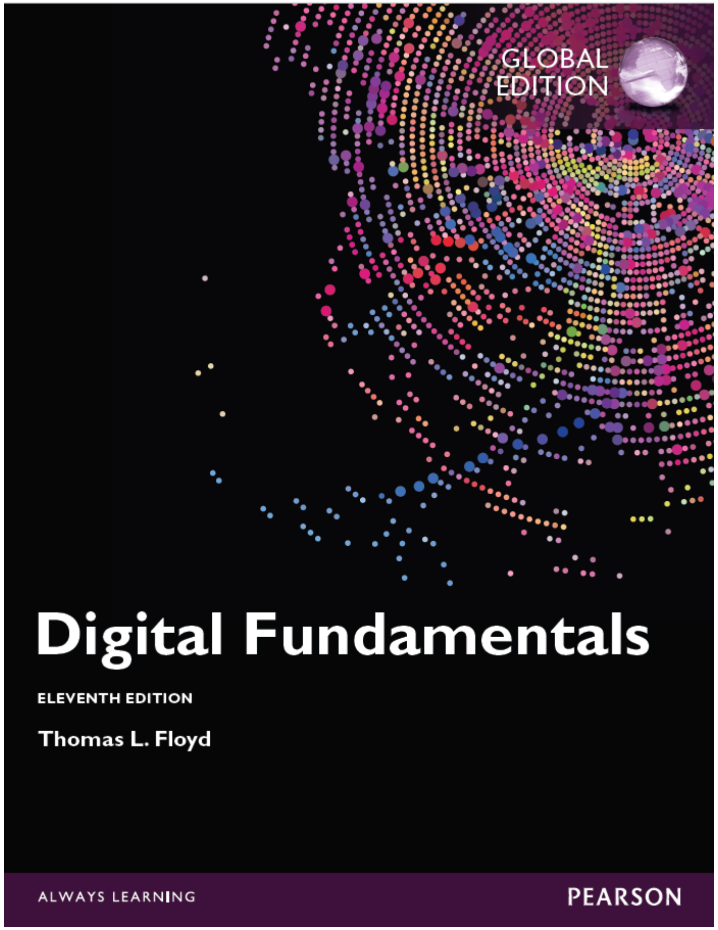
What? Logic Design

- **Logic Design** defines the fundamentals of Digital systems, such as computers and cell phones.




Semester 1
Semester 2
Semester 3
Semester 4
Semester 5
Semester 6
Semester 7
Semester 8
Computer Science Fundamentals
English 1
Structured Programming
Calculus
Physics
Human Rights and the Fight against Corruption
Discrete Mathematics
Probability & Statistics
Object Oriented Programming
Technical Writing
Electronics
Humanities 1
Introduction to Information Systems
Statistical Analysis
Data Structures
Linear Algebra
Logic Design
Humanities 2
Systems Analysis and Design 1
Introduction to Computer Networks
Design and Analysis of Algorithms
Differential Equations
Computer Architecture
Humanities 3
Operating Systems
Databases 1
Artificial Intelligence
Software Engineering 1
Microprocessors and Assembly Language
Elective 1
Advanced Computer Networks
Information Storage and Management
Neural Networks
Computer Security
Computer Graphics
Elective 2
Image Processing
Cloud Computing
Machine Learning
Elective 3
Elective 4
Capstone Project I
Computer Vision
Internet of Things
Compilers
Elective 5
Elective 6
Capstone Project II

How ? Course Book

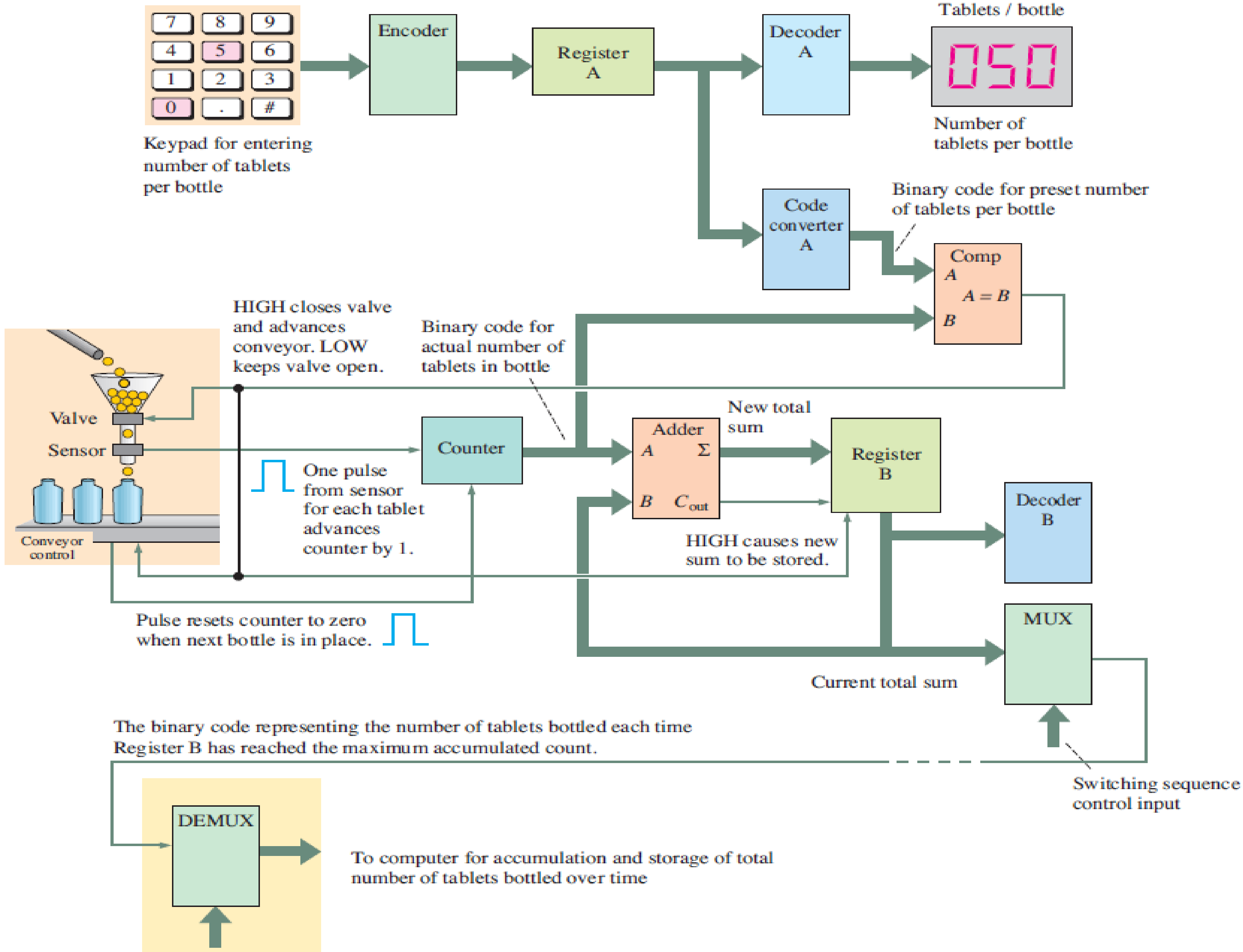


You can study from this course [Digital Electronics - YouTube]

How ? Course Content

Subject
Chapter 1: Introduction Concepts
Chapter 2: Number Systems, Operations, and Codes
Chapter 3: Logic Gates
Chapter 4 : Boolean Algebra and Logic Simplification
Chapter 5: Combinational Logic Analysis
Chapter 6: Functions of Combinational Logic
Midterm Exam
Chapter 7: Latches, Flip-Flops, and Timers
Chapter 8: Shift Registers
Chapter 9: Counters
Chapter 10: Programmable Logic

Why ? Logic Design



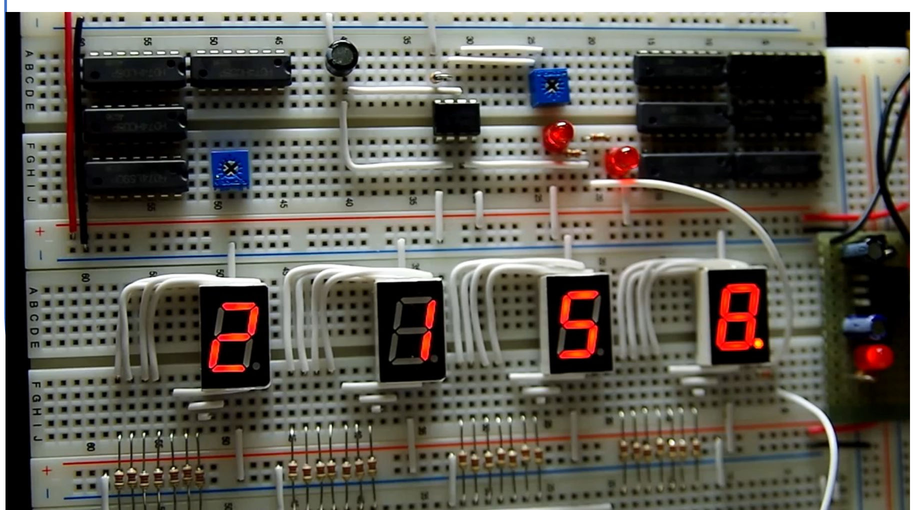
7 8 9
4 5 6
1 2 3
0 . #
Keypad for entering number of tablets per bottle
Encoder
Register A
Decoder A
Tablets / bottle
050
Number of tablets per bottle
Code converter A
Binary code for preset number of tablets per bottle
Comp
A
A = B
B
HIGH closes valve and advances conveyor. LOW keeps valve open.
Binary code for actual number of tablets in bottle
Valve
Sensor
Conveyor control
Counter
One pulse from sensor for each tablet advances counter by 1.
Adder
A
Σ
B
C_{out}
New total sum
Register B
HIGH causes new sum to be stored.
Decoder B
MUX
Pulse resets counter to zero when next bottle is in place.
Current total sum
The binary code representing the number of tablets bottled each time Register B has reached the maximum accumulated count.
Switching sequence control input
DEMUX
To computer for accumulation and storage of total number of tablets bottled over time

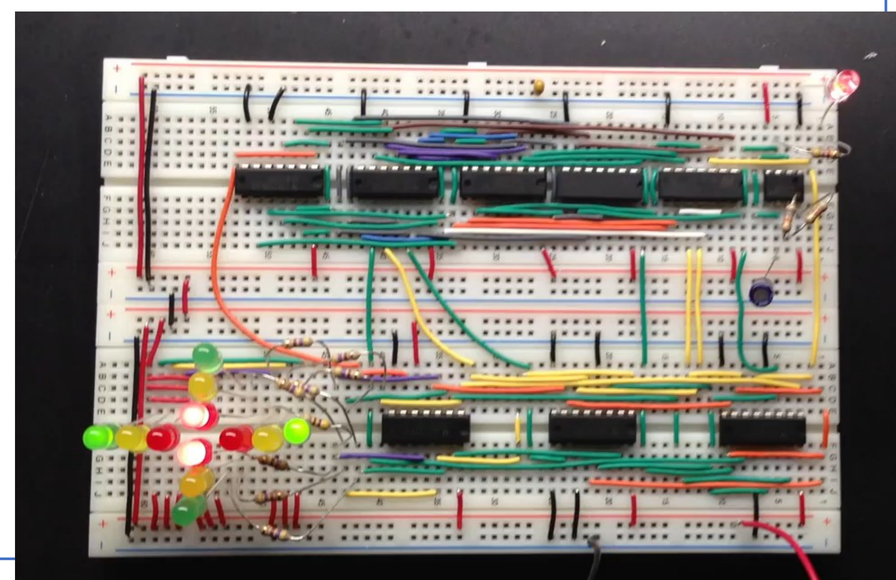
Assessment

Final-Term Examination	**50**
Practical Examination (Project) + labs + Quiz (~~Assignments~~)	**30**
Mid-Term Examination	**10**
Oral Examination	**10**

Projects:

Digital Clock. **Traffic Light.**



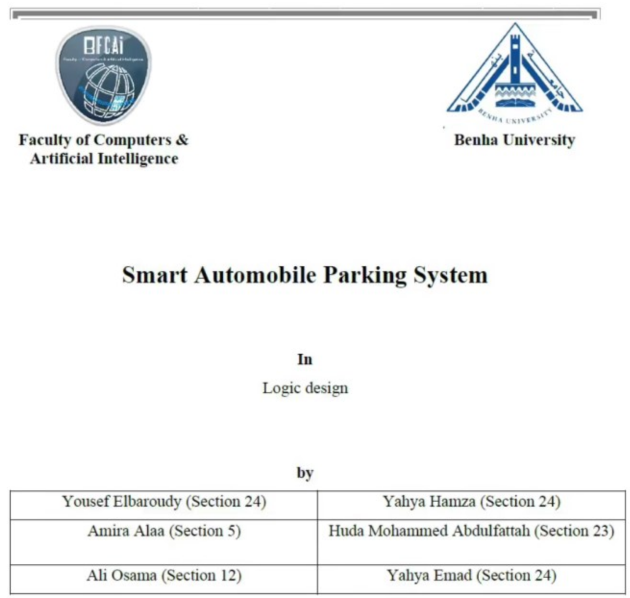


Projects

Projects

Elevator

Parking System


Faculty of Computers & Artificial Intelligence

Benha University

Smart Automobile Parking System

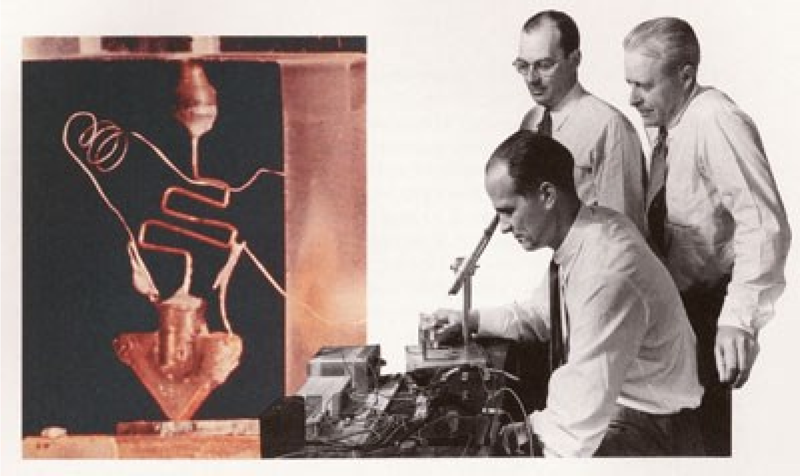
In

Logic design

by

Yousef Elbaroudy (Section 24)	Yahya Hamza (Section 24)
Amira Alaa (Section 5)	Huda Mohammed Abdulfattah (Section 23)
Ali Osama (Section 12)	Yahya Emad (Section 24)

History Snapshots



- **1947:** The **transistor** was invented

- **1958: Integrated Circuit (IC),** A transistor was integrated with resistors and capacitors on a single semiconductor chips.

- **1971: first commercially microprocessor**, Intel Corporation produced the Intel 4004 , giving birth to a family of **processors on a chip**.

- **1981:** The IBM PC (5150) was announced.

Digital System (How)

Chip Manufacturing - How are Microchips made? | Infineon

Silicon Run 1 2nd Edition.rm

IC Technologies

- ASIC (Application Specific Integrated Circuit)
  - ❑ Full Custom (Transistor Level)
  - ❑ Standard Cell (Gate Level – libraries)
  - ❑ Gate Array (Gate Level already created of the wafer)
- Filed Programmable Devices
  - ❑ Complex
    - **Complex Programmable Logic Devices (CPLD)**
    - **Field Programmable Gate Array (FPGA)**
  - ❑ Simple
    - **Programmable logic Devices (PLD)**
- Off-The-Shelf Components
  - ❑ MSI / SSI (Transistor Transistor Logic TTL - Series 7400),

(Complementary Metal Oxide Semiconductor CMOS - Series 4000)

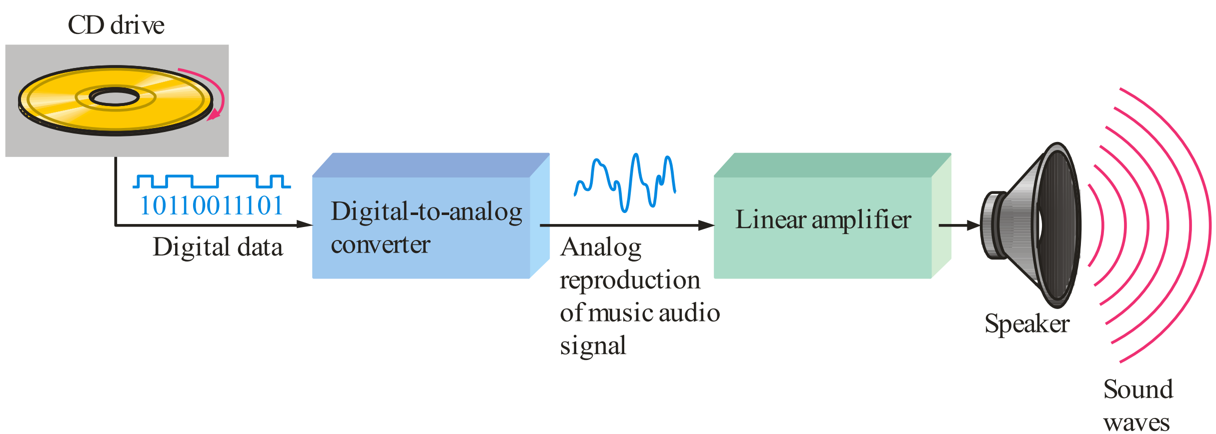
Digital Fundamentals

CHAPTER 1
Digital Concepts

Digital and Analog Quantities

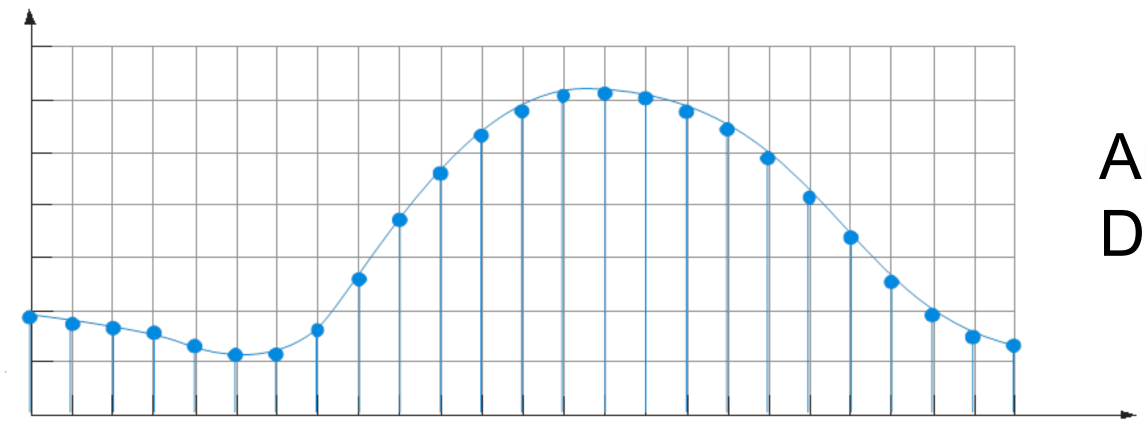
Digital System (Why)

- Easier to design.
- Flexibility and functionality.
  easier to store, transmit and manipulate information.
- Cheaper device.



Digital System (Why)
Analog vs. Digital

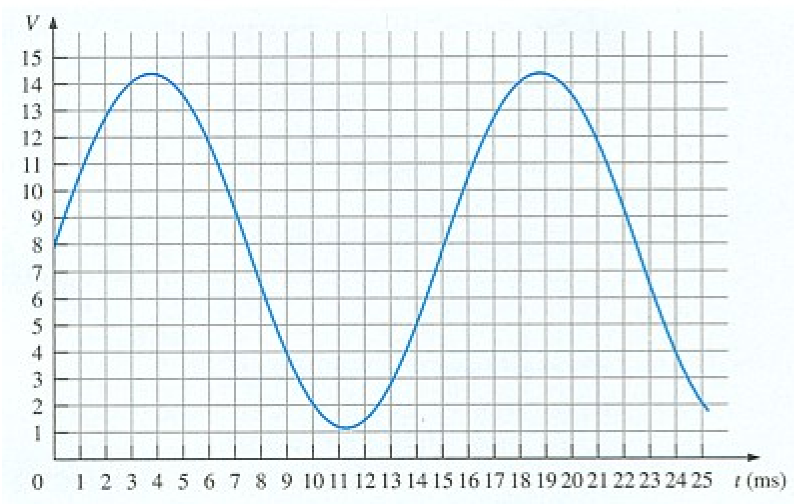
Most natural quantities (such as temperature, pressure, light intensity, …) are **analog** quantities that vary continuously.

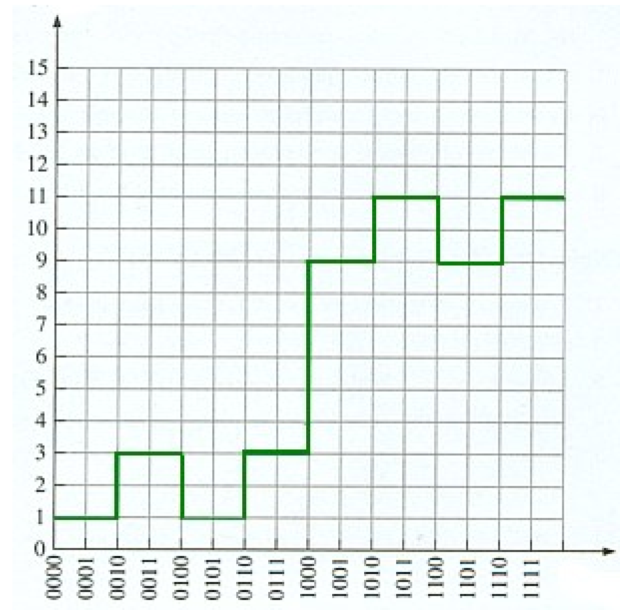


Analog = continuous
Digital = discrete

Digital systems can process, store, and transmit data more efficiently but can only assign discrete values to each point.

Digital and Analog Quantities





Analog quantities have continuous values

Digital quantities have discrete sets of values

- Analog to Digital Converters …Sampling and Quantization

Digital and Analog Quantities

Types of electronic devices or instruments:

- Analog
- Digital
- Combination analog and digital

Binary Digits, Logic Levels, and Digital Waveforms

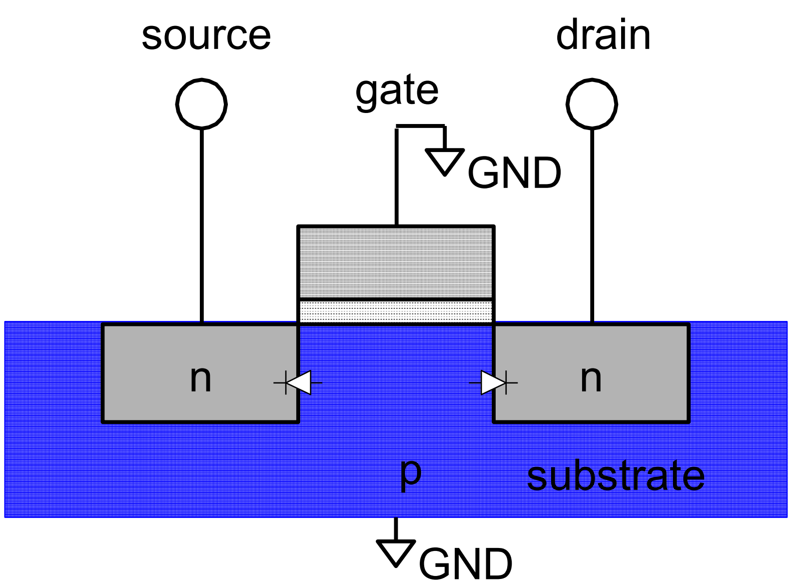
Binary Digits, Logic Levels, and Digital Waveforms

- The conventional numbering system uses ten digits: 0,1,2,3,4,5,6,7,8, and 9.
- The binary numbering system uses just two digits: **0** and **1.**
- They can also be called LOW and HIGH, where **LOW = 0** and **HIGH = 1**

Transistors: nMOS

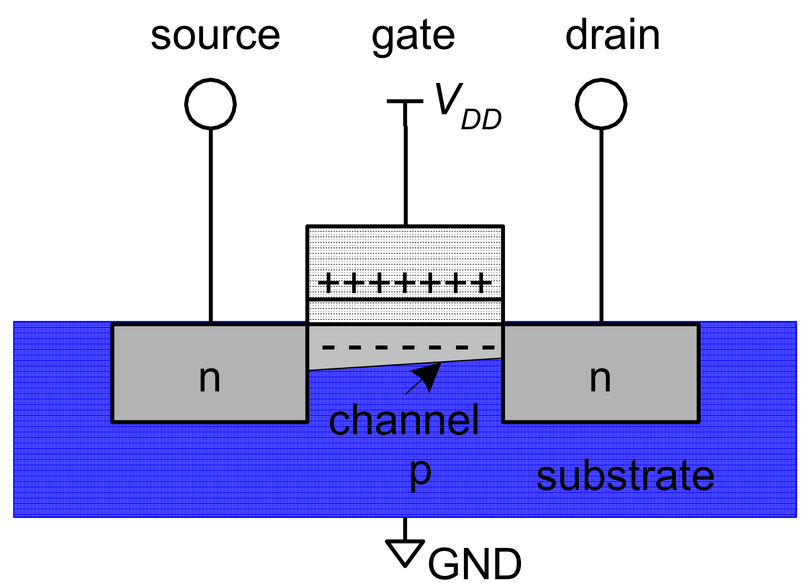
Gate = 0

OFF (no connection between source and drain)

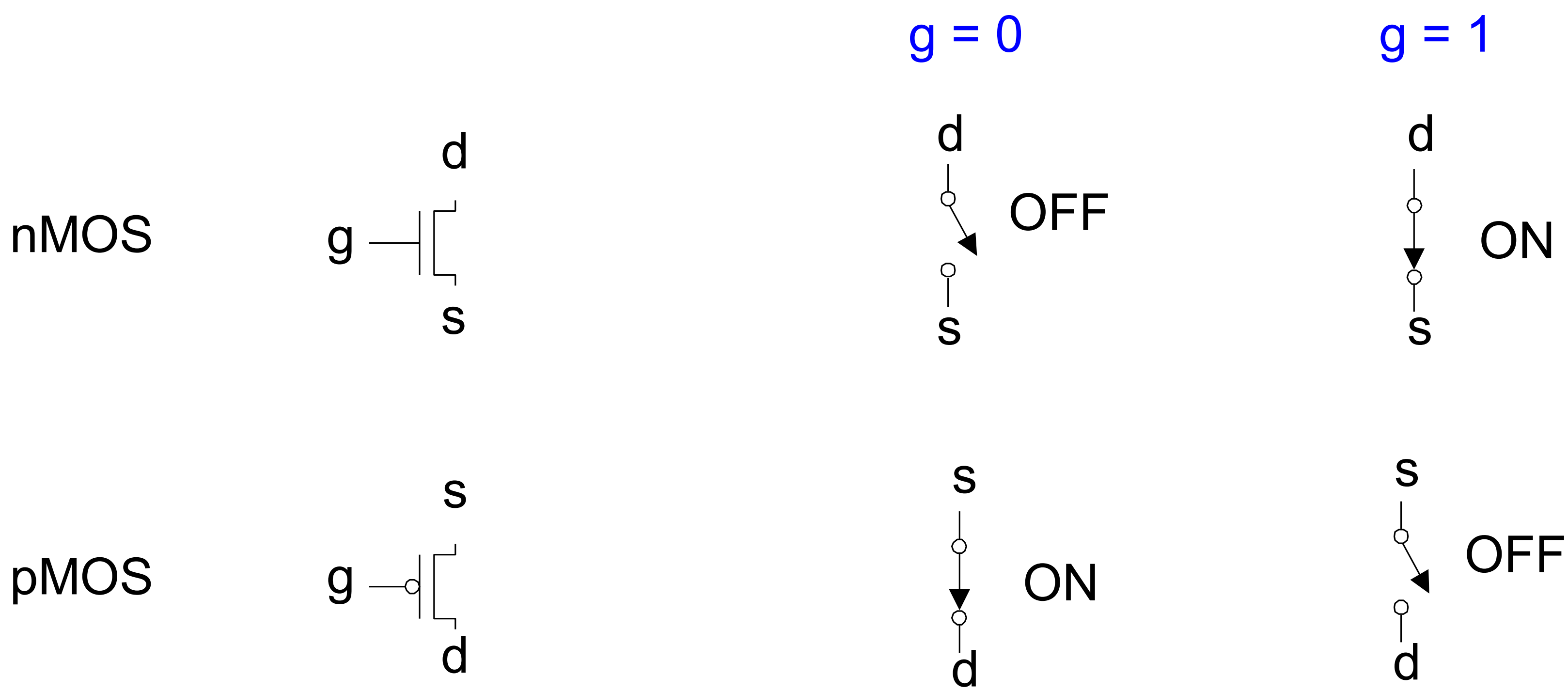


Gate = 1

ON (channel between source and drain)

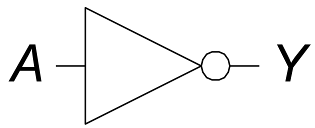


Transistor Function



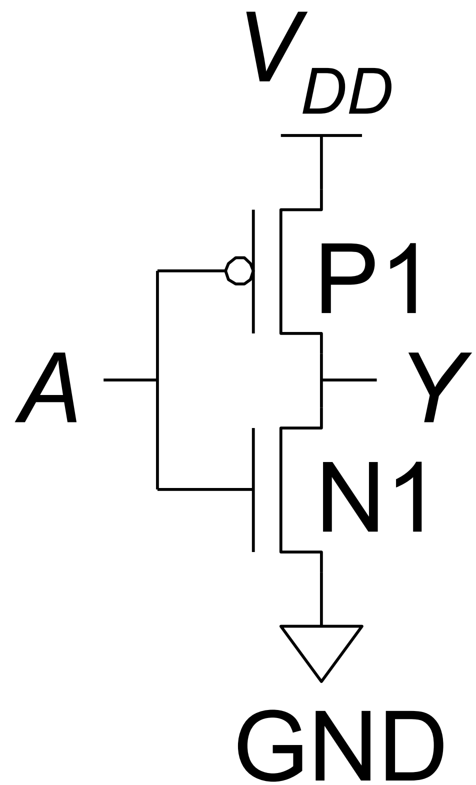
CMOS Gates: NOT Gate

NOT



$$Y = \overline{A}$$

A	Y
0	1
1	0

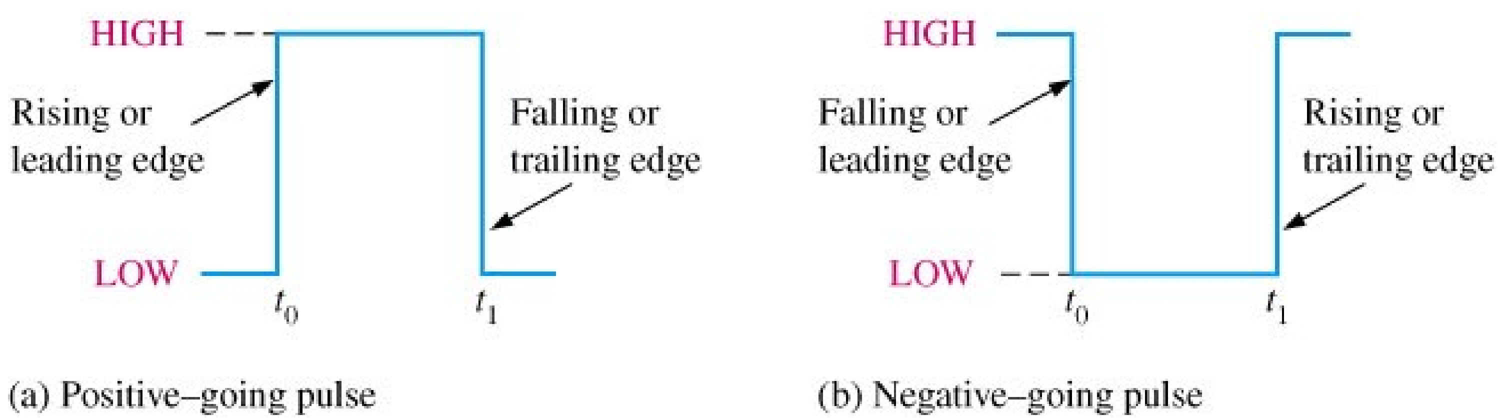


A	P1	N1	*Y*
0	ON	OFF	1
1	OFF	ON	0

Binary Digits, Logic Levels, and Digital Waveforms

The binary numbering system uses just two digits: **0** and **1.**

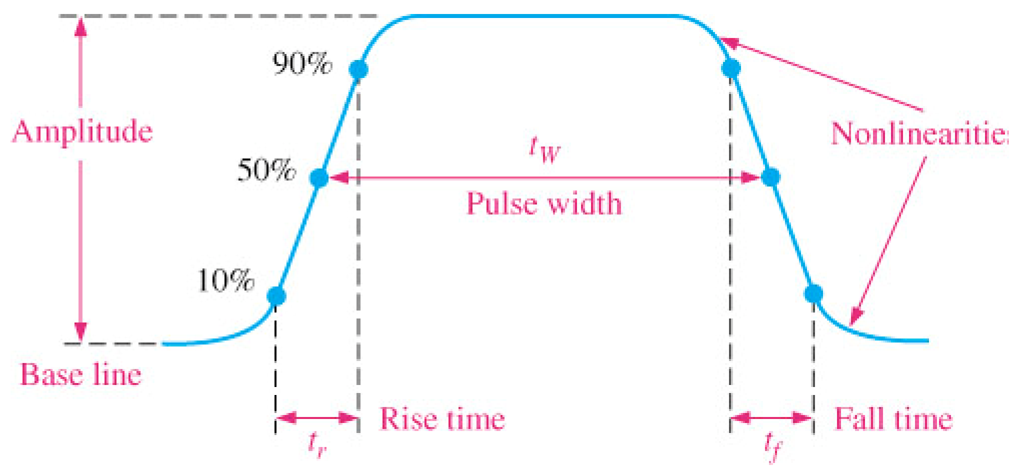
Binary values are also represented by voltage levels



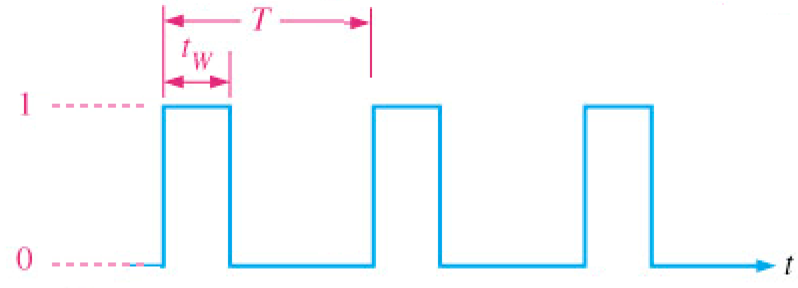
They can also be called LOW and HIGH, where **LOW = 0** and **HIGH = 1**

Major parts of a digital pulse

- Base line
- Amplitude
- Rise time (t_r)
- Pulse width (t_w)
- Fall time (t_f)



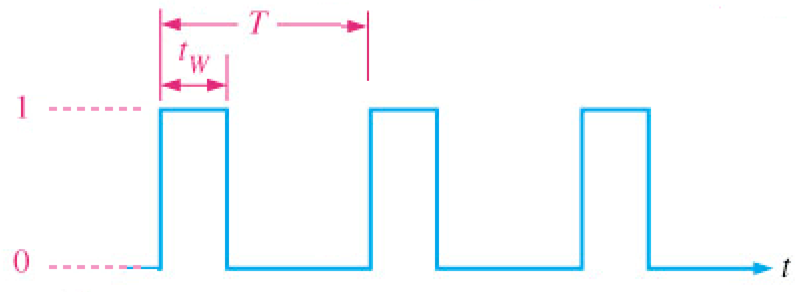
Binary Digits, Logic Levels, and Digital Waveforms



- t_w = pulse width
- T = period of the waveform
- f = frequency of the waveform

$$f = \frac{1}{T}$$

Binary Digits, Logic Levels, and Digital Waveforms



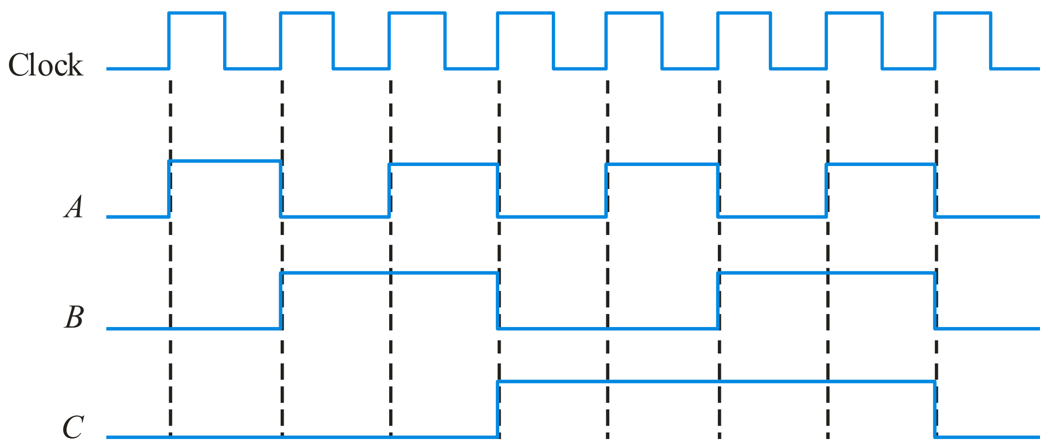
The duty cycle of a binary waveform is defined as:

$$\textbf{Duty cycle} = \left(\frac{t_w}{T}\right)100\%$$

Binary Digits, Logic Levels, and Digital Waveforms

Timing Diagrams

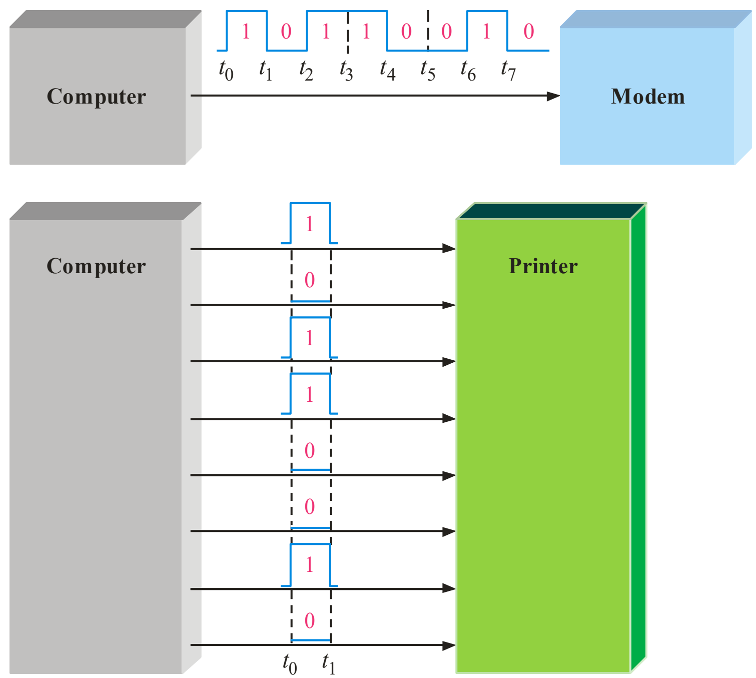
A **timing diagram** (or **waveform diagram**) is used to show the relationship between two or more digital waveforms.



Binary Digits, Logic Levels, and Digital Waveforms

Serial and Parallel Data

Data can be transmitted by either serial transfer or parallel transfer.



Ports on a Typical Laptop Computer

USB (Serial)

RS-232 (Serial)

PS/2 Mouse (Serial)

IEEE 1394 (Serial)

Printer (Parallel)

VGA (Analog video)

Quiz

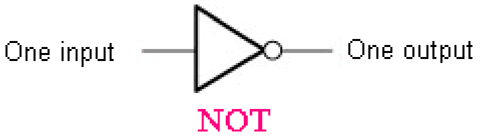
- **Question 1**: How long will it take to transmit an 8-bit binary string using **serial** transmission if the clock frequency is 100 MHz?

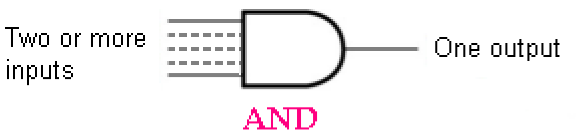
- **Question 2**: How long will it take to transmit an 8-bit binary string using **parallel** transmission if the clock frequency is 100 MHz?

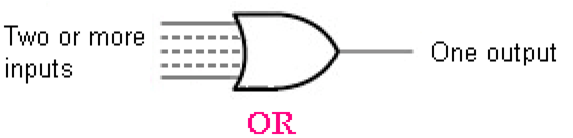
Basic Logic Operations

Basic Logic Operations

There are only three basic logic operations:

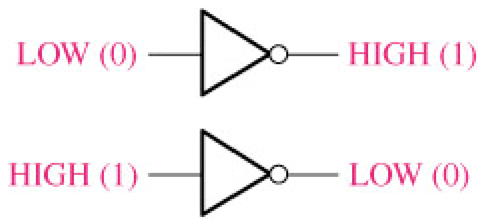






Basic Logic Operations

The NOT operation

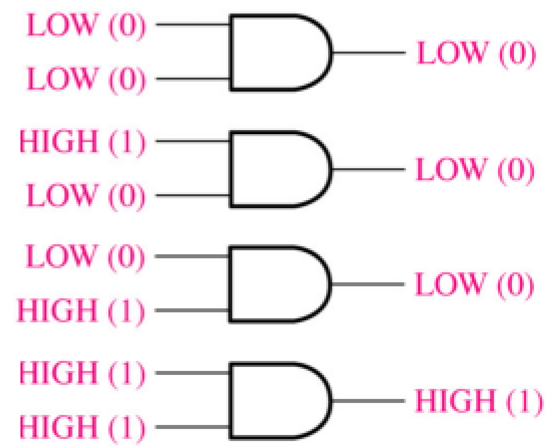


- When the input is LOW, the output is HIGH
- When the input is HIGH, the output is LOW

The output logic level is always opposite the input logic level.

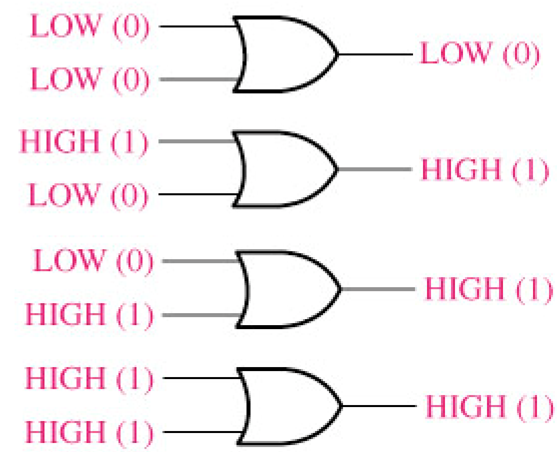
Basic Logic Operations

- The AND operation
  - When any input is LOW, the output is LOW
  - When both inputs are HIGH, the output is HIGH



Basic Logic Operations

- The OR operation
  - When any input is HIGH, the output is HIGH
  - When both inputs are LOW, the output is LOW



Overview of Basic Logic Functions

Overview of Basic Logic Functions

- Comparison function
- Arithmetic functions
- Code conversion function
- Encoding function
- Decoding function
- Data selection function
- Data storage function
- Counting function

Overview of Basic Logic Functions

Comparison function

- Compares two binary values and determines whether or not they are equal

Overview of Basic Logic Functions

Arithmetic functions

- Perform the basic arithmetic operations on two binary values:
  - Addition
  - Subtraction of two values
  - Multiplication
  - Division

Overview of Basic Logic Functions

Code conversion function

- Converts, or translates, information from one code format to another

Overview of Basic Logic Functions

Encoding function

- Converts non-binary information into a binary code

Overview of Basic Logic Functions

Decoding function

- Converts binary-coded information into a non-binary form

Overview of Basic Logic Functions

Data selection function

- Multiplexer (mux)
  - Switches digital data from any number of input sources to a single output line
- Demultiplexer (demux)
  - switches digital data from a single input to any number of output lines

Overview of Basic Logic Functions

Data storage function

- Retains binary data for a period of time
  - Flip-flops (bistable multvibrators)
  - Registers
  - Semiconductor memories
  - Magnetic-media memories
  - Optical-media memories

Overview of Basic Logic Functions

Counting function

- Generates sequences of digital pulse that represent numbers

Fixed-Function Integrated Circuits

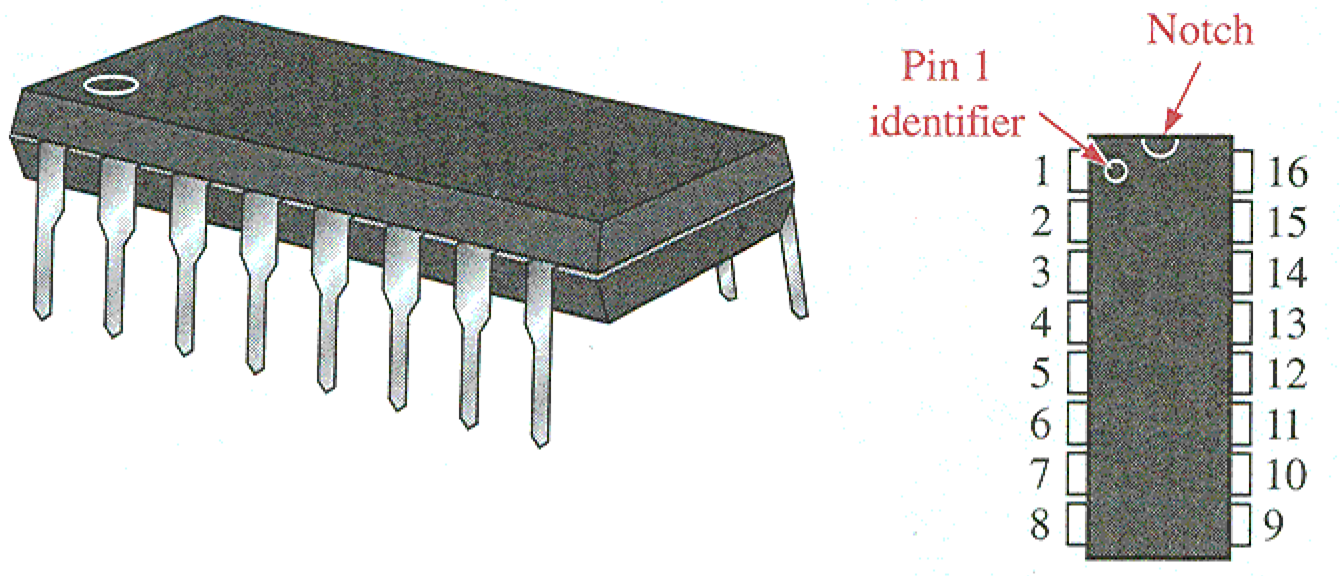
Fixed-Function Integrated Circuits

IC package styles

- Dual in-line package (DIP)
- Small-outline IC (SOIC)
- Flat pack (FP)
- Plastic-leaded chip carrier (PLCC)
- Leadless-ceramic chip carrier (LCCC)

Fixed-Function Integrated Circuits

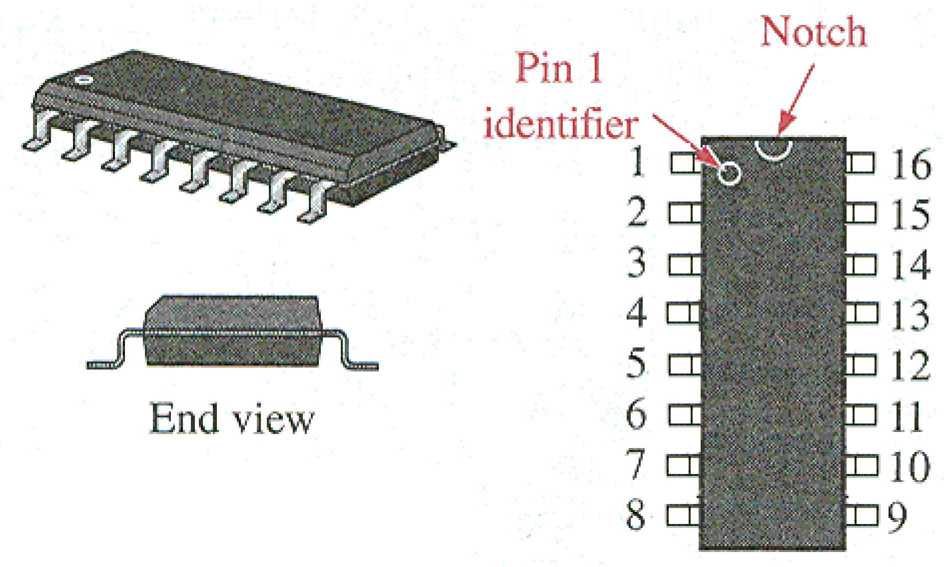
- Dual in-line package (DIP)



DataSheet Ex.

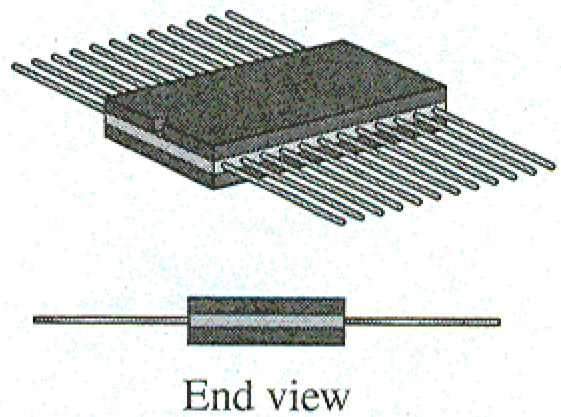
Fixed-Function Integrated Circuits

- Small-outline IC (SOIC)



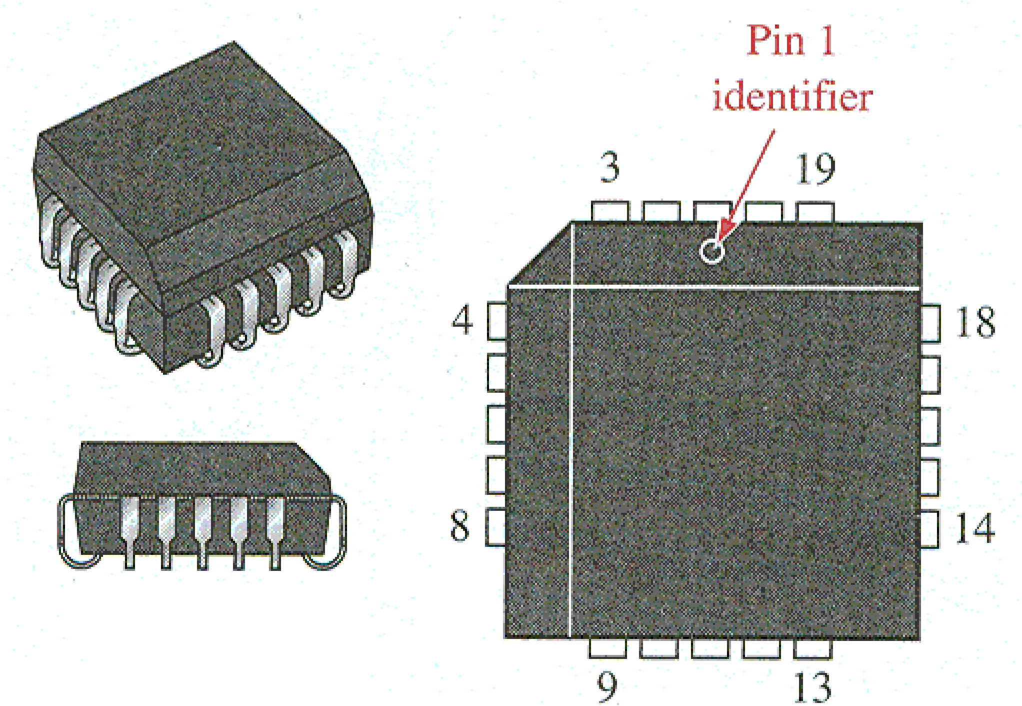
Fixed-Function Integrated Circuits

- Flat pack (FP)



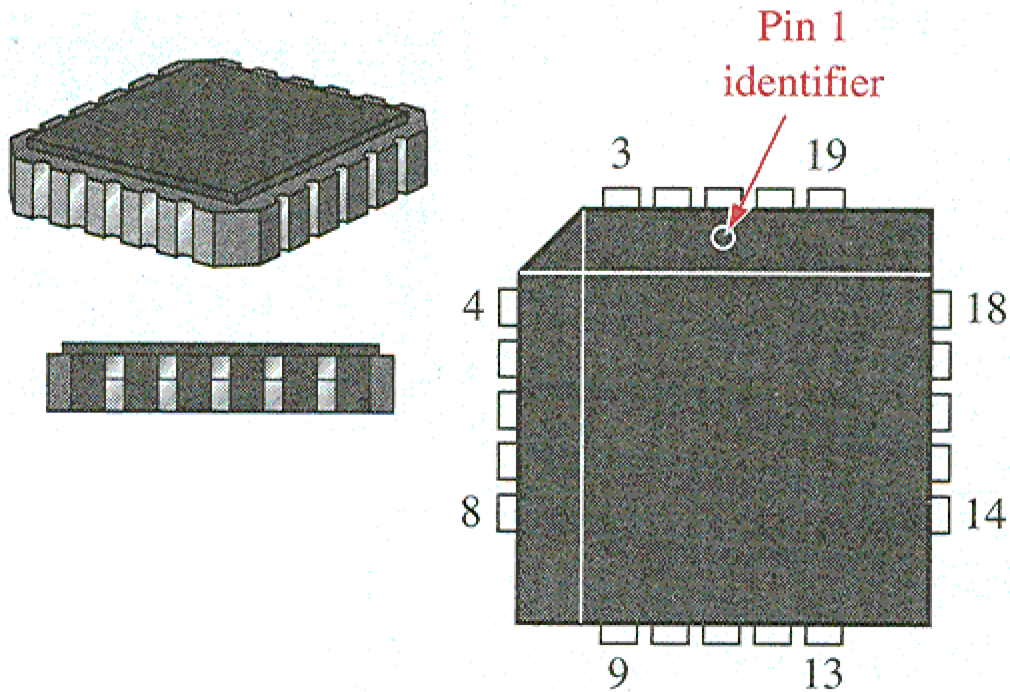
Fixed-Function Integrated Circuits

- Plastic-leaded chip carrier (PLCC)

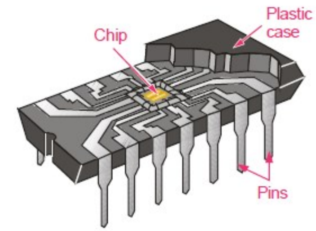


Fixed-Function Integrated Circuits

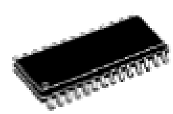
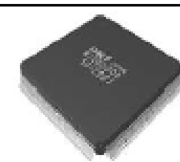
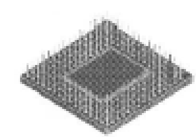
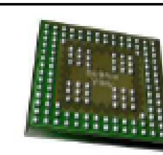
- Leadless-ceramic chip carrier (LCCC)



IC Packaging



- ICs are packaged in ceramic or plastic.

IC Packaging	Dual In-line Package (DIP)	Small Outline IC (SOIC)	Quad Flat Package (QFP)	Pin Grid Array (PGA)	Ball Grid Array (BGA)
Type	lead frame	lead frame	lead frame	area array	area array
Pins connected to	two sides	two sides	four sides	bottom	bottom
Lead count	< 64	< 80	32 – 200	64 – 500	64 – 500
Through hole Surface mount	Yes No	No Yes	No Yes	Yes Yes	Yes Yes
Cost	very low	very low	low	high	moderate
Electrical performance	very poor	poor	poor	optimized	better
Shrink version	Yes: SDIP	Yes: SSOIC	No	No	No
					

Test and Measurement Instruments

Digital Multimeter

Function Generator

Logic Probe, Pulser, and Current Probe

Home Work

- 7400 Series and 4000 Series
  - A popular series of TTL chips is the 7400 series
  - A popular series of CMOS chips is the 4000 series

Circuit simulators.

[Circuit Simulator Applet (falstad.com)]

[Circuits | Tinkercad]

Technology Magazines

- https://spectrum.ieee.org/
- https://www.technologyreview.com/

Electronics Shops

- https://store.fut-electronics.com/
- http://ram-e-shop.com/oscmax/catalog/