EEE119 - Digital System Engineering

2013/2014

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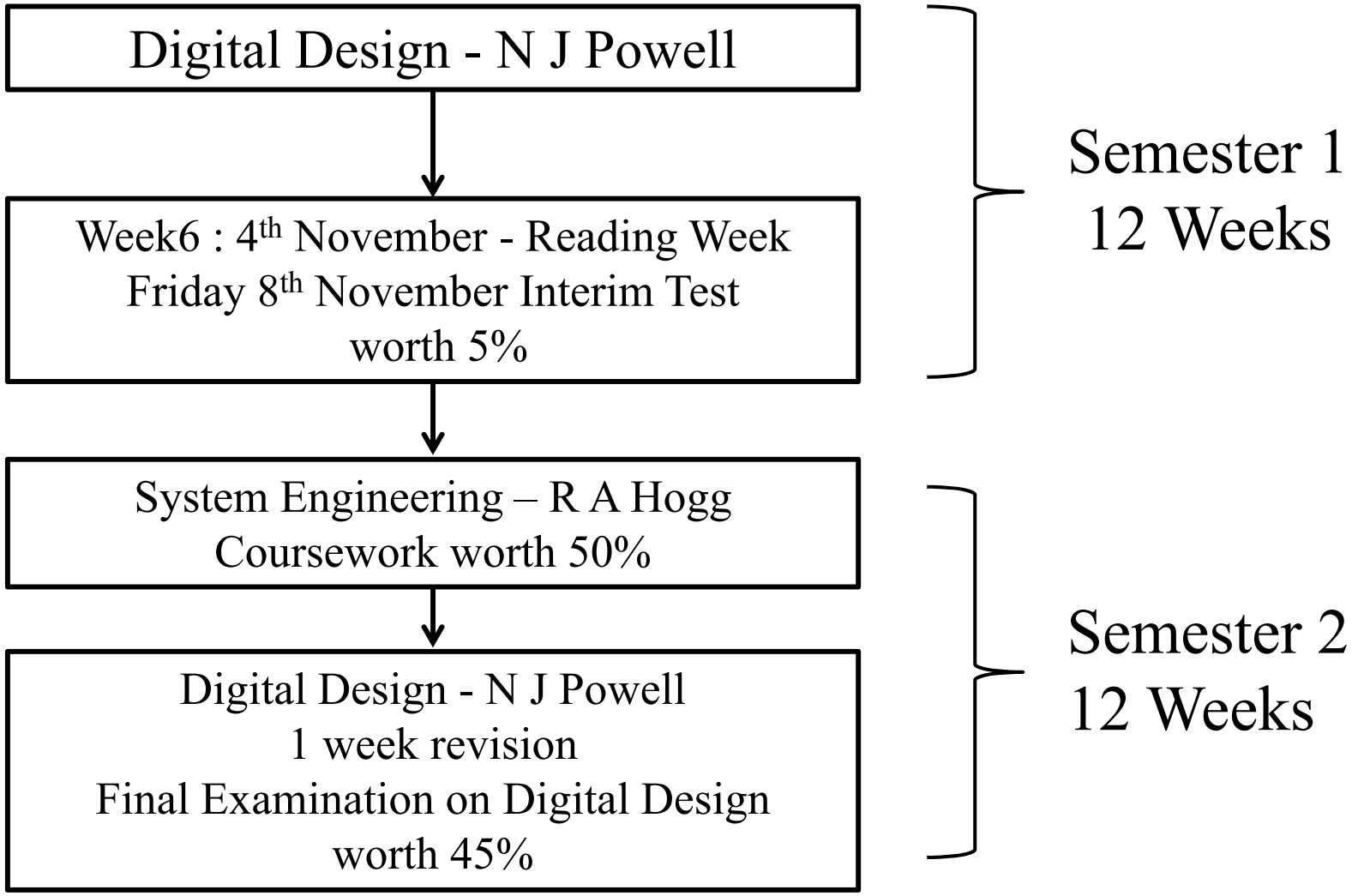
Course Structure



Course Aims

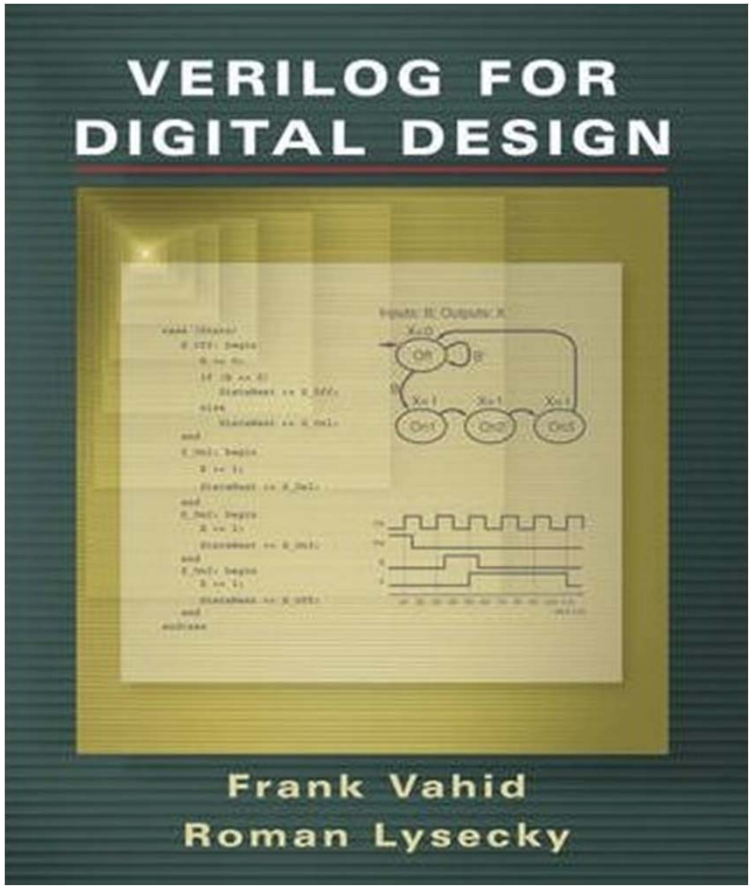
- Provide a basic understanding of modern digital systems.
- Develop skills to analyse and design digital systems.
- Provide essential background knowledge for higher level courses.

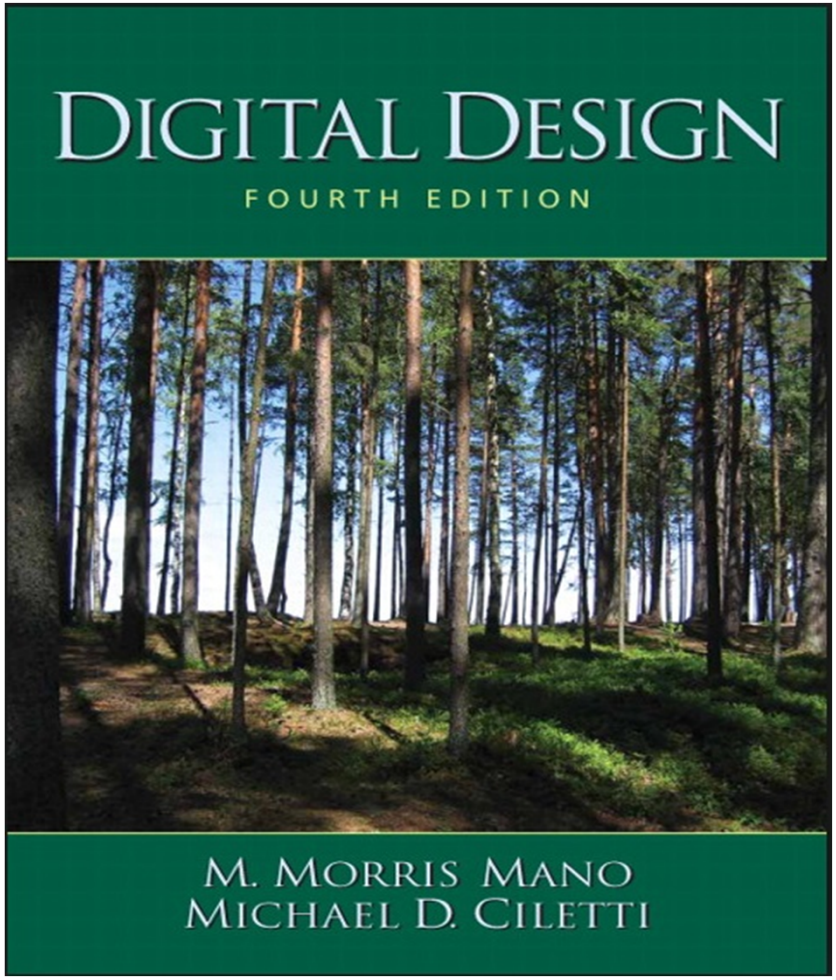
Course Outline

- Boolean Algebra
- Combinational Circuits
- Sequential Circuits
- Digital System Components
- Design Flow

Useful Books

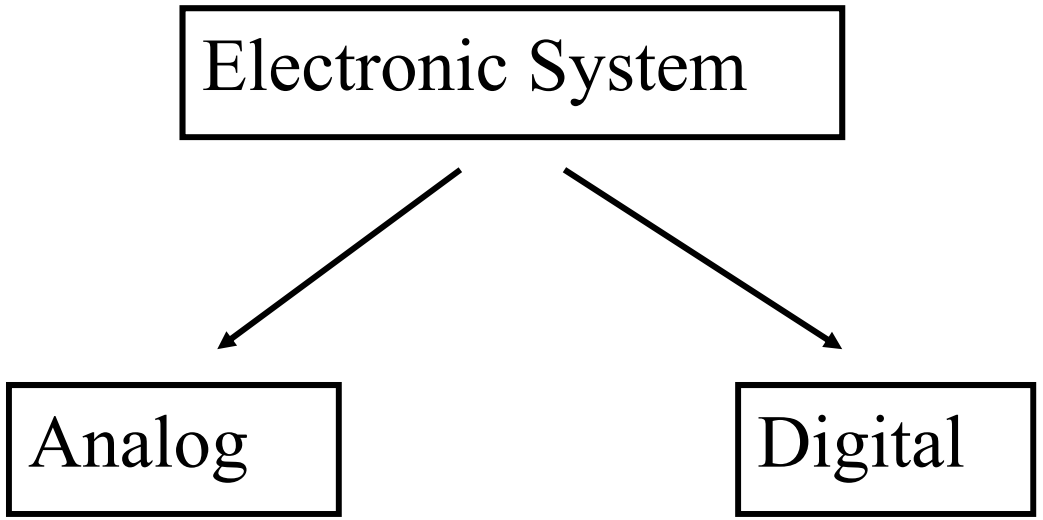
- Mano — Digital Design (3e or 4e)
- Vahid — Verilog For Digital Design / Digital Design
- Mano & Kime — Logic and Computer Design Fundamentals (4e)
- Floyd — Digital Fundamentals
- Gajski — Principles of Digital Design
- Katz — Contemporary Logic Design


VERILOG FOR
DIGITAL DESIGN
Frank Vahid
Roman Lysecky

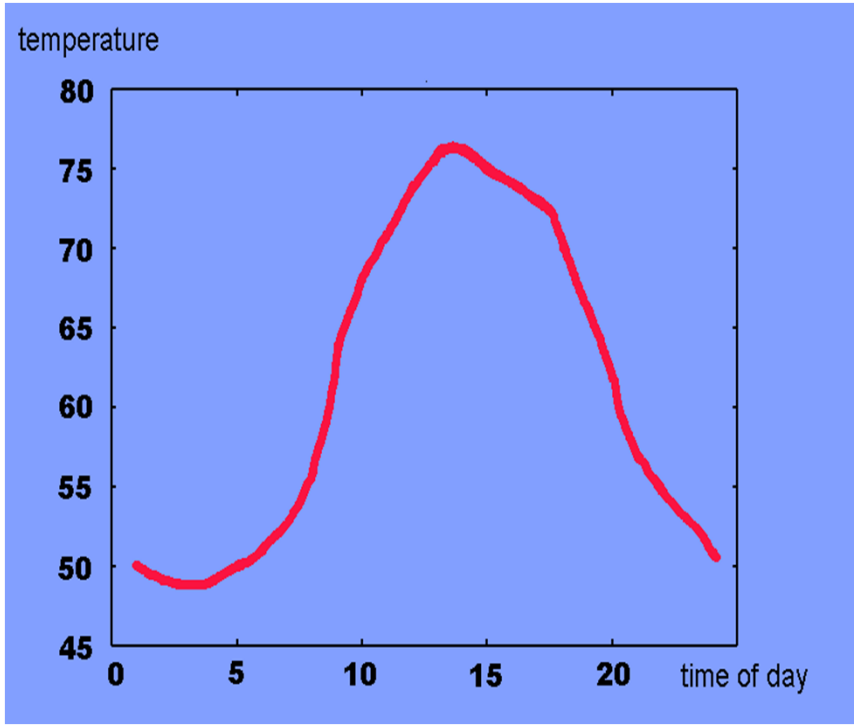

DIGITAL DESIGN
FOURTH EDITION
M. MORRIS MANO
MICHAEL D. CILETTI

Electronic Systems

A system is a group of interrelated parts forming a more complex whole. Electronic systems can be divided into two broad categories, analog and digital.



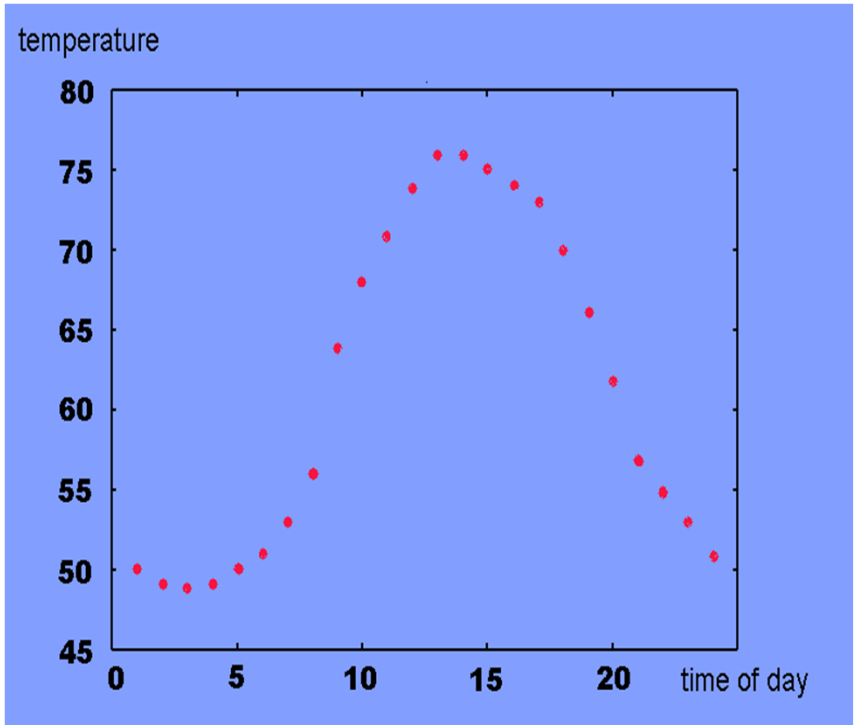
Digital and Analog Quantities



Analog - continuous values

Consider the variation of temperature throughout the day. It varies in a continuous way. When plotted on a graph, this gives a smooth curve. Temperatures do not suddenly jump from one value to the next.

Digital and Analog Quantities

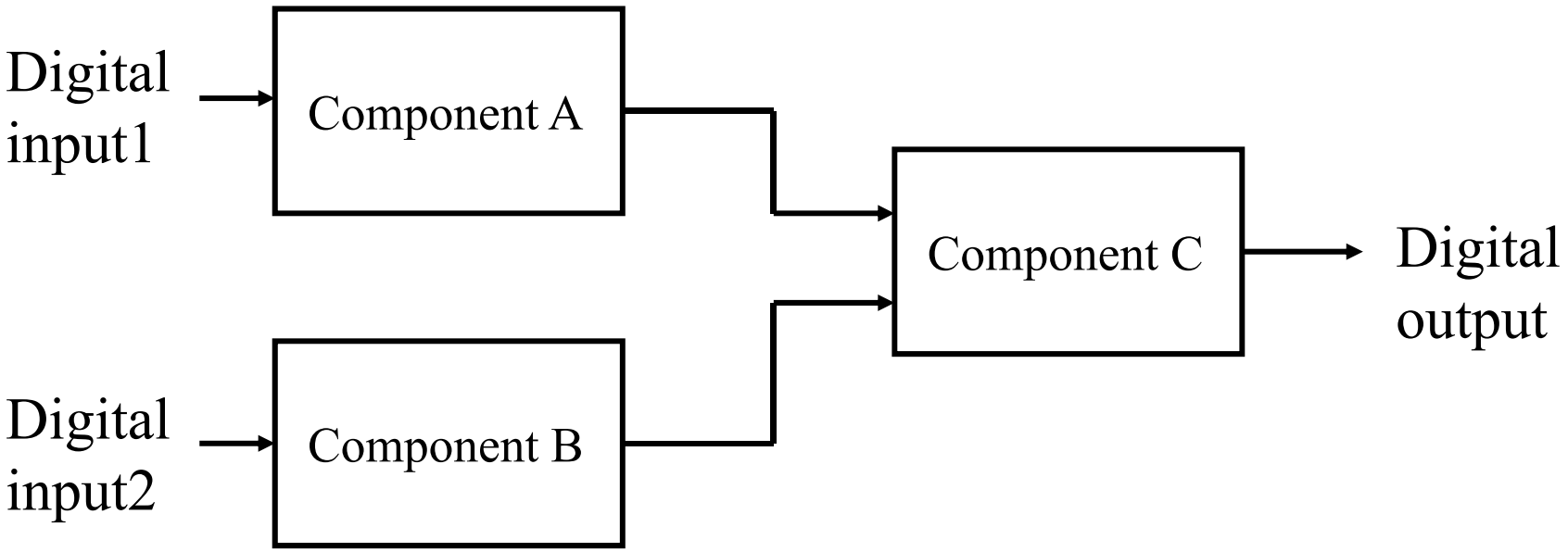


Digital - discrete values

Now consider recording the value of the temperature every hour. You obtain 24 samples of the temperature at discrete points in time. These samples can be represented by digital codes.

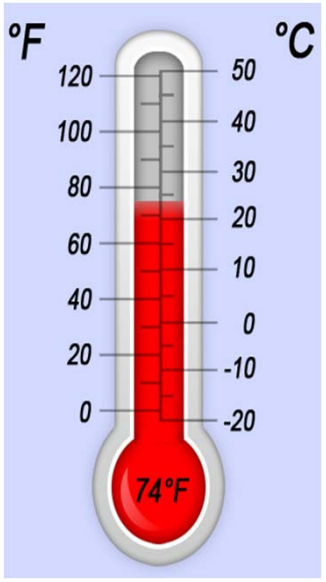
At 10:00 hrs the temperature is 68 degrees and can be represented by the digits 6 and 8.

Digital Systems



A digital system is a group of interrelated components forming a more complex whole.

Digital Systems - Heating Controller



Component A

Store the set temperature

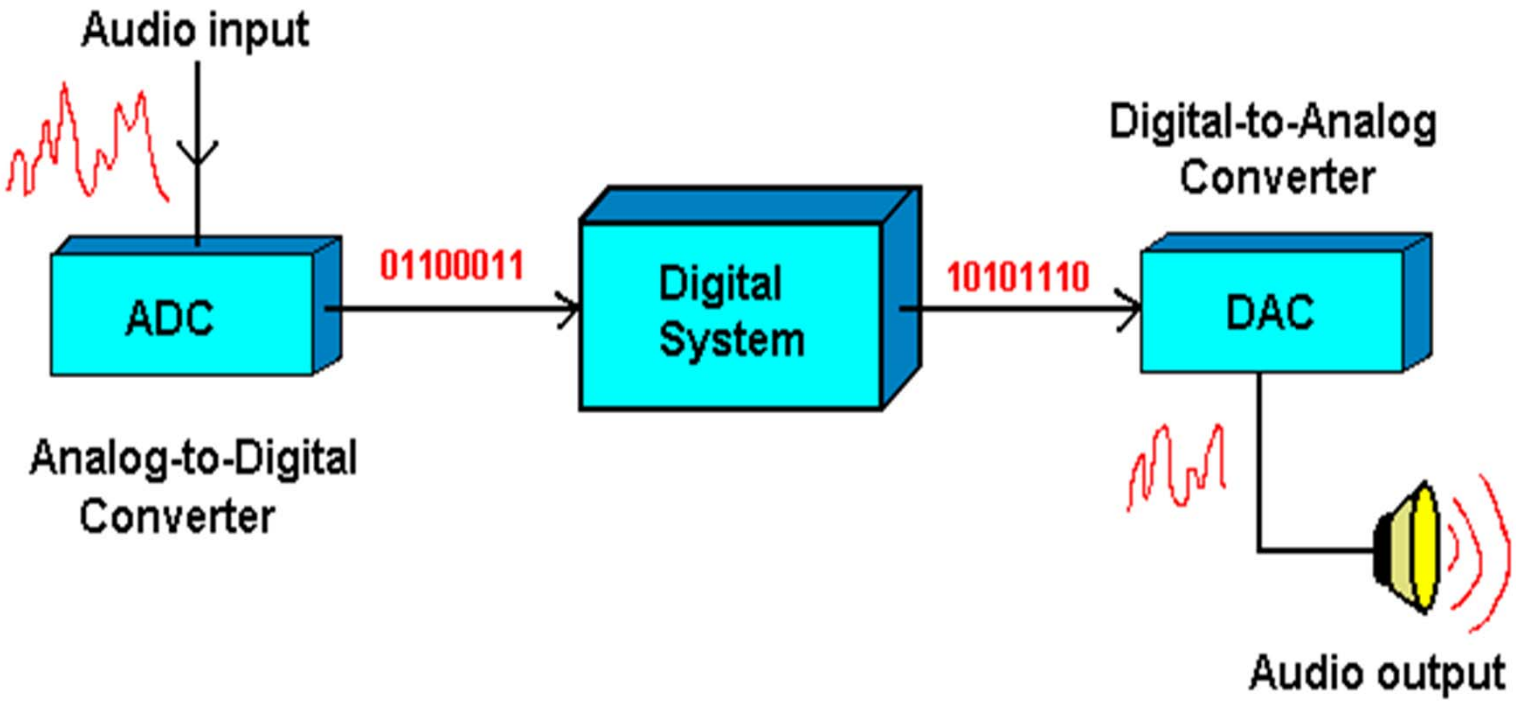
Component B

Store current temperature

Component C

Compare Values

An electronic audio system



The values in a digital system are binary and can take the value of 0 or 1. Physically they are represented by a high or low voltage.

The Digital Advantage

- Efficient and reliable transmission of data

- Tolerant to fluctuations in operating conditions

- Greater system complexities - designs readily partitionable, advanced technology, design reuse

- Flexibility - software programs or reconfigurable hardware

- Efficient compact storage of data

Modern Digital Design

- Digital electronics are now part of most consumer goods
- Products have smaller and smaller lifetimes
- Electronic Design Automation (EDA) essential to keep pace with rapid change and complexity of designs
- Hardware Description Languages (VHDL,Verilog) provide a standard way of describing digital systems
- Design Reuse, IP (Intellectual Property)

A Binary Logic System

- A digital system is a logic or switching system
- Ideas used are similar to those used in human reasoning

TRUE	FALSE
ON	OFF
HIGH	LOW
1	0

- Binary digit or ‘bit’ - two discrete values
- Represented by binary variables such as A, B, C etc.

Basic Logic Operations

- Three basic operations - NOT, AND, OR
- Operate on logic variables A,B,C …..

Operator	Symbol	Usage
NOT	$\overline{\ }$ or ’	$\overline{\mathbf{X}}$ or **X**’
AND	.	**X.Y**
OR	+	**X + Y**

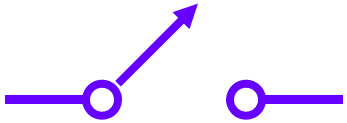
- The AND operation is known as a PRODUCT term.
- The OR operation is known as a SUM term.

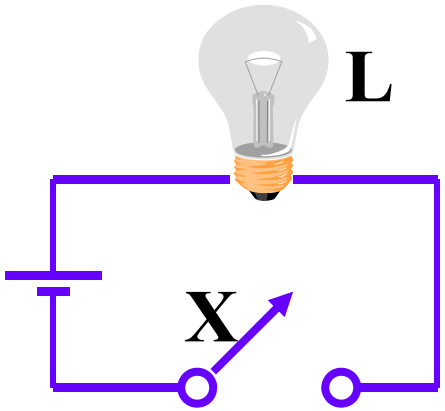
Logic Representation by Switches

The state of a switch can be represented by a variable, say **X**.

X = 1

X = 0





The state of the bulb can be represented by another variable, say **L**.

Bulb is ON, **L = 1**

Bulb is OFF, **L = 0**

If **X = 0 , L = 0**

If **X = 1 , L = 1**

Therefore

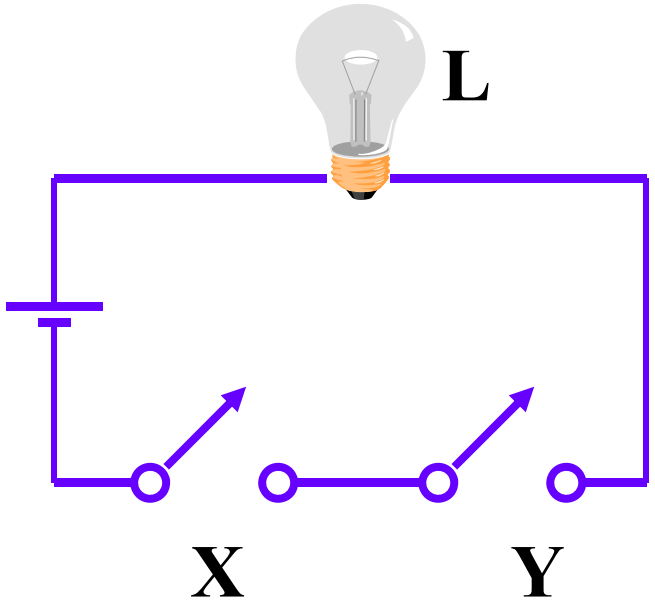
L = X

AND logic operation

Switches in series represent the **AND**ing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	
1 (closed)	0 (open)	
1 (closed)	1 (closed)	



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State of switches

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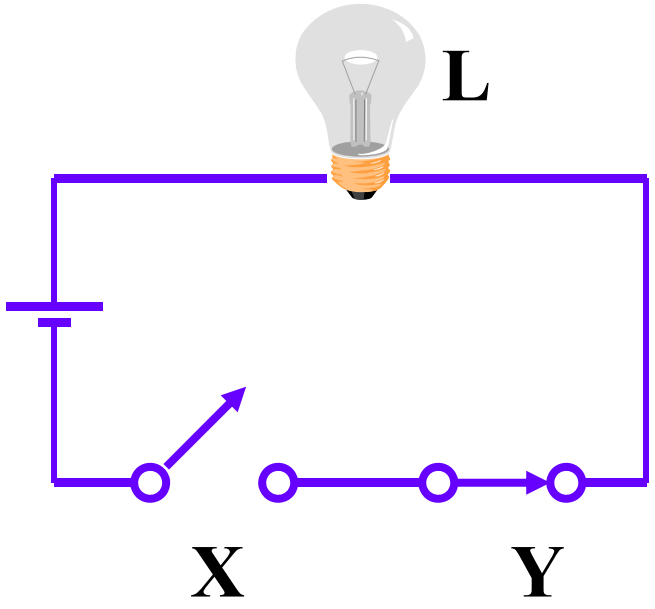

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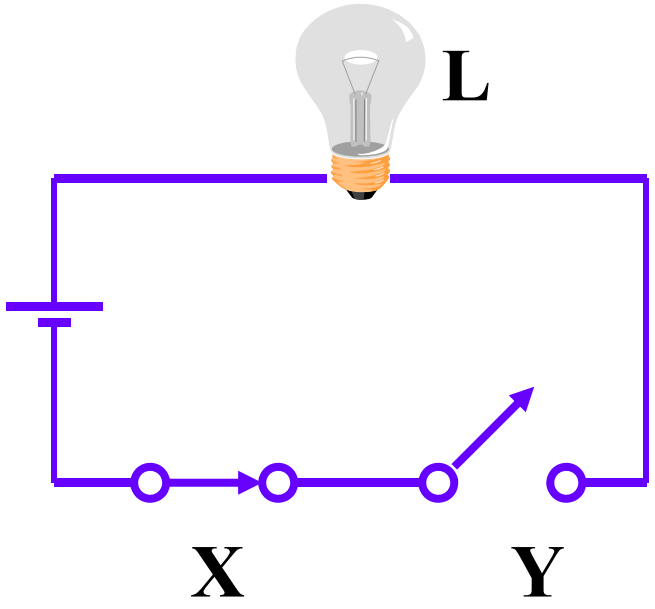
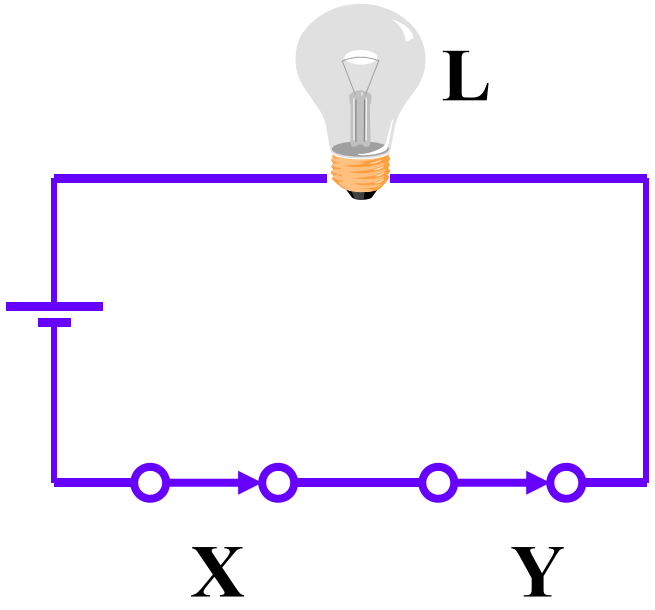


AND logic operation

Switches in series represent the **AND**ing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	0
1 (closed)	0 (open)	0
1 (closed)	1 (closed)	1



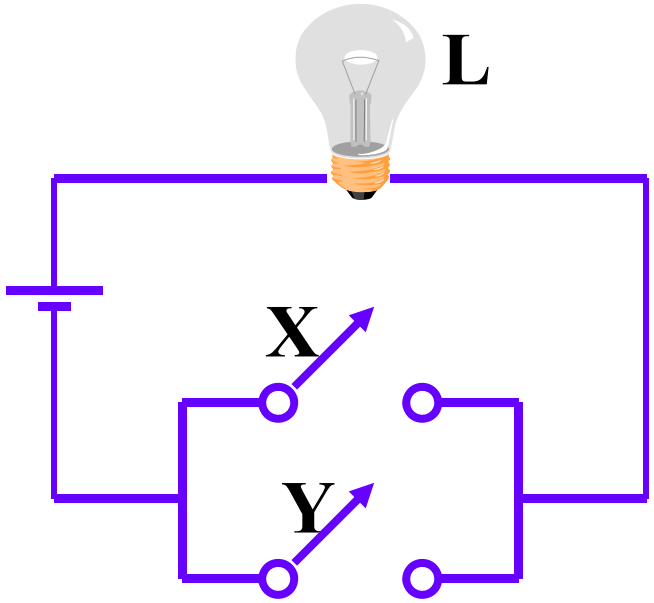
L = X.Y

OR logic operation

Switches in parallel represent the **OR**ing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	
1 (closed)	0 (open)	
1 (closed)	1 (closed)	

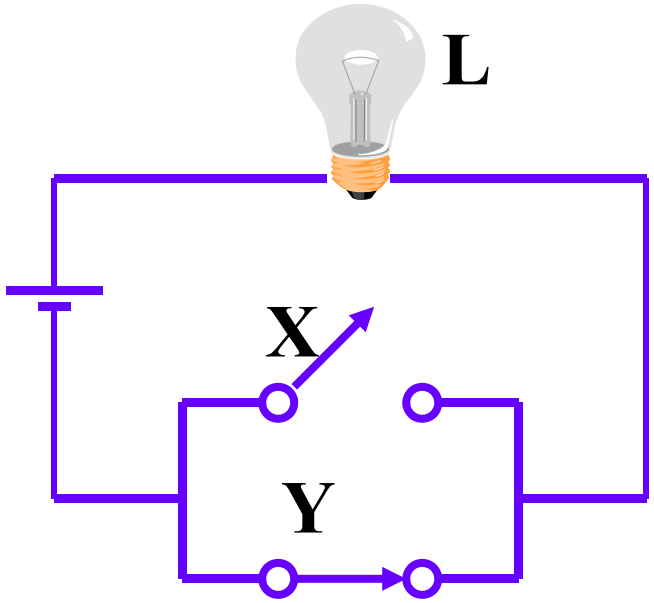


OR logic operation

Switches in parallel represent the **OR**ing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	1
1 (closed)	0 (open)	
1 (closed)	1 (closed)	

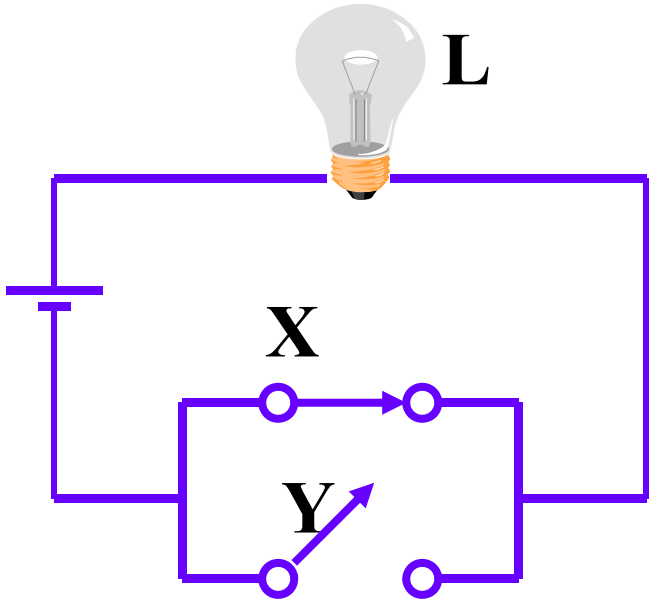


OR logic operation

Switches in parallel represent the **OR**ing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	1
1 (closed)	0 (open)	1
1 (closed)	1 (closed)	

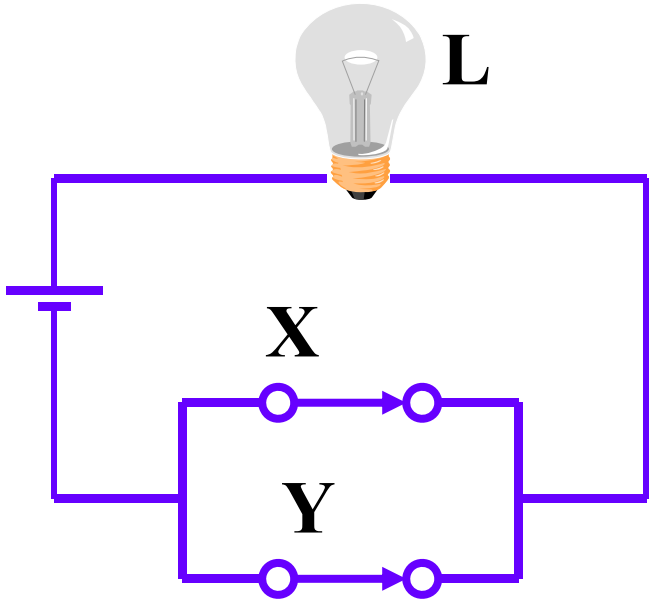


OR logic operation

Switches in parallel represent the ORing of the variables.

State of switches

X	Y	L
0 (open)	0 (open)	0
0 (open)	1 (closed)	1
1 (closed)	0 (open)	1
1 (closed)	1 (closed)	1



L = X + Y

Summary

- An analog quantity has continuous values
- A digital quantity has a set of discrete values
- A binary system has two values represented by **0** and **1**
- Switches can be used to demonstrate the basic logic operations **AND** and **OR**