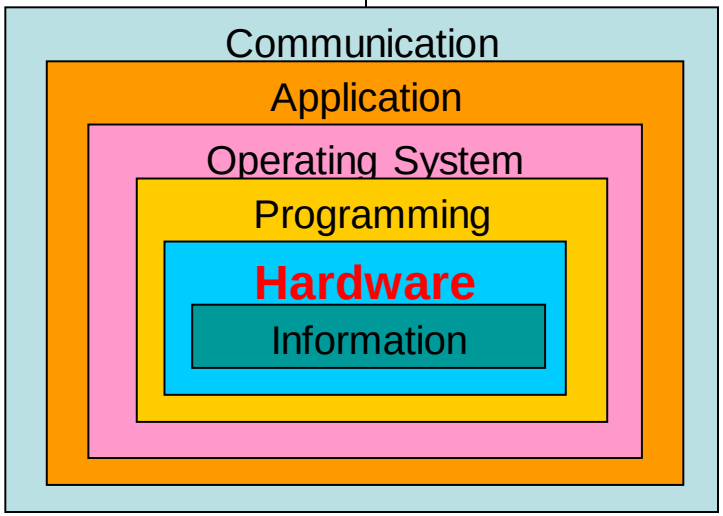
Introduction to Computing
Section 3 – Hardware

Gates & Circuits

Computing Components



Part 2

Computing Components

Computing Components

- Individual Computer Components
- The Stored-Program Concept
- Embedded Systems
- Parallel Architectures

Individual Computer Components

Ad for a laptop computer

Insatavialion 640 Laptop

Exceptional Performance and Portability

- Intel® Core™ 2 Duo (2.66GHz/1066MHz FSB/6MB cache)
- 15.6 High Definition (1080p) LED Backlit LCD Display (1366 x 768)
- 512MB ATI Mobility Radeon Graphics
- Built-in 2.0MP Web Camera
- 4GB Shared Dual Channel DDR2 at 800MHz
- 500GB SATA Hard Drive at 5400RPM
- 8X Slot Load DL DVD+/- RW Drive
- 802.11 a/g/n and Bluetooth 3.0
- 85 WHr Lithium Ion Battery
- (2) USB 2.0, HDMI, 15-pin VGA, Ethernet 10/100/1000, IEEE 1394 Firewire, Express Card, Audio line-in, line-out, mic-in
- 14.8 W X 1.2 H X 10.1 D, 5.6 lbs
- Microsoft® Windows 8® Professional
- Microsoft® Office Home and Student 2007
- 36-Month subscription to McAfee Security Center Anti-virus

Stored-Program Concept

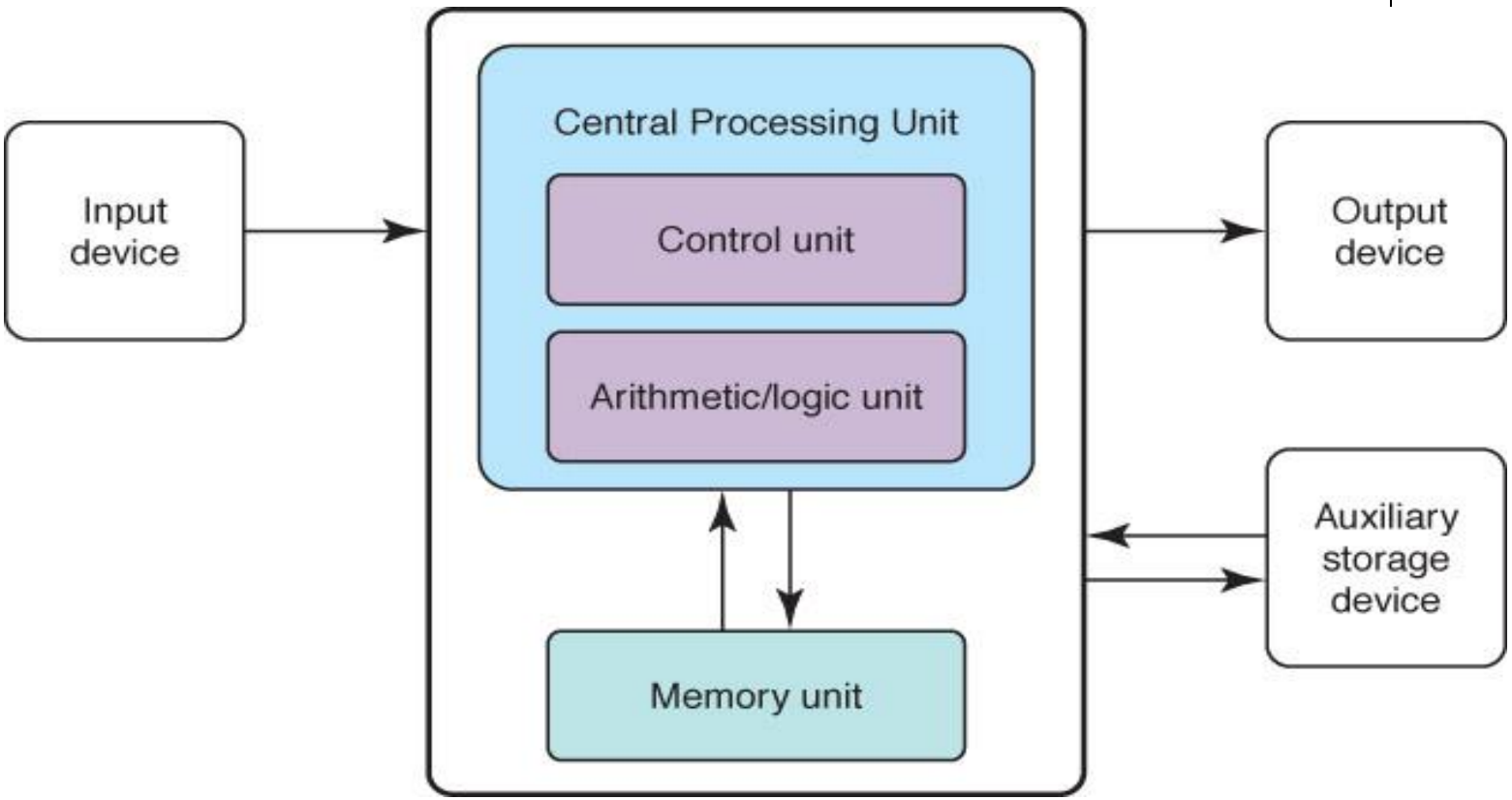
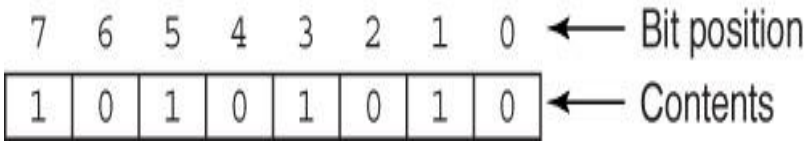


Figure 5.1 **The von Neumann architecture**

Memory

Memory

A collection of cells, each with a unique physical address;both addresses and contents are in binary



Address	Contents
00000000	11100011
00000001	10101001
⋮	⋮
11111100	00000000
11111101	11111111
11111110	10101010
11111111	00110011

Arithmetic/Logic Unit

SCSE

Performs basic arithmetic operations such as addition, subtractions, multiplication, division

Performs logical operations such as AND, OR, and NOT

Most modern ALUs have a small amount of special storage units called **registers**

Input/Output Units

SCSE

Input Unit

A device through which data and programs from the outside world are entered into the computer;

Can you name three?

Output unit

A device through which results stored in the computer memory are made available to the outside world

Can you name two?

Control Unit

Control unit

The organizing force in the computer

Instruction register (IR)

Contains the instruction that is being executed

Program counter (PC)

Contains the address of the next instruction to be executed

Central Processing Unit **(CPU)**

ALU and the control unit called the, or CPU

Flow of Information

Bus

A set of wires that connect all major sections

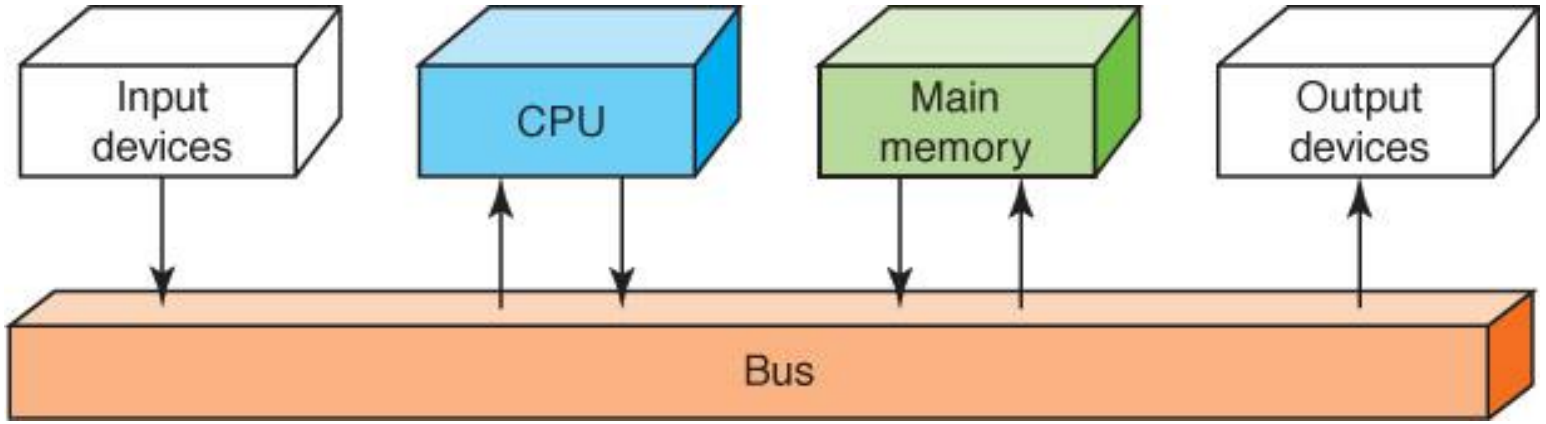


Figure 5.2 **Data flow through a von Neumann architecture**

SCSE

Bus width

The number of bits that can be transferred in parallel over the bus.

Cache memory

A type of small, high-speed memory used to hold frequently used data.

Pipelining

A technique that breaks an instruction into smaller steps that can be overlapped

Motherboard

The main circuit board of a personal computer.

The Fetch-Execute Cycle

Fetch the next instruction

Decode the instruction

Get data if needed

Execute the instruction

Why is it called a cycle?

The Fetch-Execute Cycle

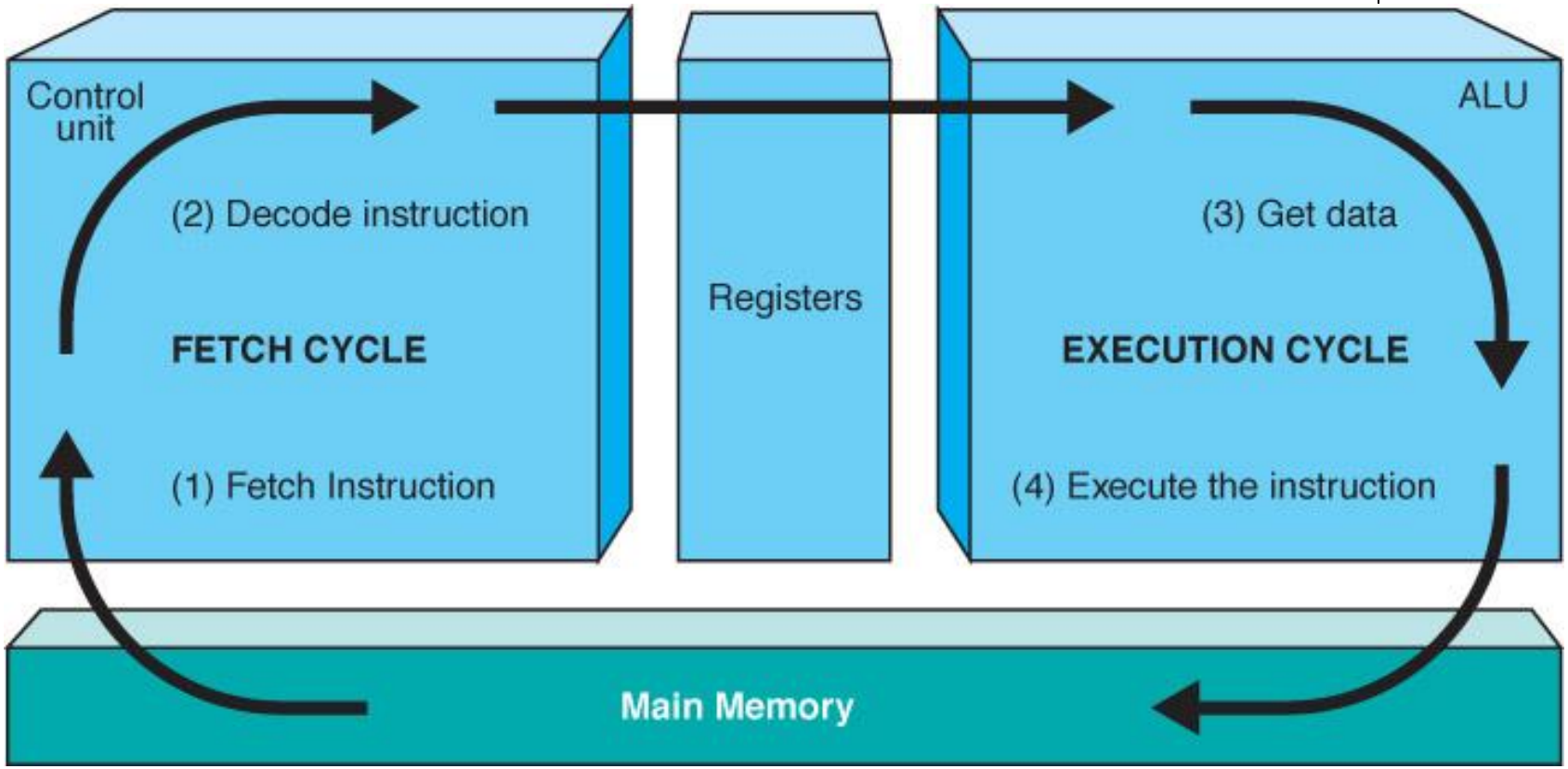
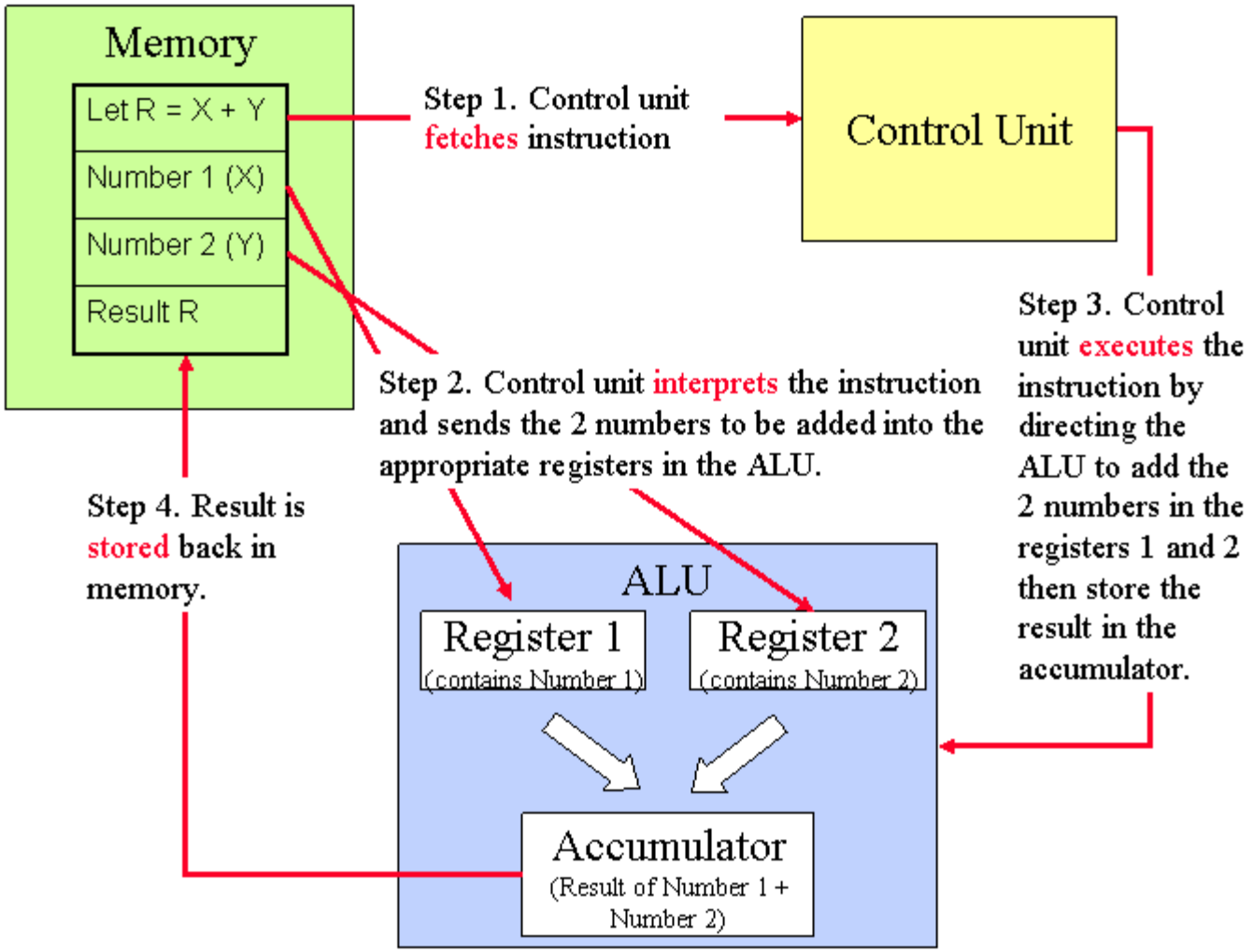


Figure 5.3 **The Fetch-Execute Cycle**


Memory
Let R = X + Y
Number 1 (X)
Number 2 (Y)
Result R
Step 1. Control unit fetches instruction
Control Unit
Step 2. Control unit interprets the instruction and sends the 2 numbers to be added into the appropriate registers in the ALU.
Step 3. Control unit executes the instruction by directing the ALU to add the 2 numbers in the registers 1 and 2 then store the result in the accumulator.
Step 4. Result is stored back in memory.
ALU
Register 1
(contains Number 1)
Register 2
(contains Number 2)
Accumulator
(Result of Number 1 + Number 2)

SCSE

PRACTICE

Draw the The Fetch-Execute Cycle to implement the following function:

F(a,b,c)= ab + bc’ + a’b’c

RAM and ROM

Random Access Memory (RAM)

Memory in which each location can be accessed and changed

Read Only Memory (ROM)

Memory in which each location can be accessed but *not* changed

RAM and ROM

SCSE

one major difference between a ROM and a RAM chip

A ROM chip: non-volatile storage, does not require a constant source of power to retain information stored on it
⇒ When power is lost or turned off, a ROM chip will keep the information stored on it.

a RAM chip: volatile and requires a constant source of power to retain information ⇒ When power is lost or turned off, a RAM chip will lose the information stored on it.

RAM and ROM

SCSE

Other differences between a ROM and a RAM chip

- A ROM chip is used primarily in the start up process of a computer, whereas a RAM chip is used in the normal operations of a computer after starting up and loading the operating system.
- Writing data to a ROM chip is a slow process, whereas writing data to a RAM chip is a faster process.
- A RAM chip can store multiple gigabytes (GB) of data, up to 16 GB or more per chip; A ROM chip typically stores only several megabytes (MB) of data, up to 4 MB or more per chip.

Compact Disks

SCSE

CD

A compact disk that uses a laser to read information stored optically on a plastic disk; data is evenly distributed around track

- CD-ROM read-only memory
- CD-DA digital audio
- CD-WORM write once, read many
- RW or RAM both read from and written to

DVD

Digital Versatile Disk, used for storing audio and video

Summary

Logic gates: NOT, AND, OR, NAND, NOR, XOR

Boolean algebra

Adders, MUX, DEMUX, IC (SSI, MSI), CPU Chips

Memory, ALU, Input/Output

The Fetch-Execute Cycle

RAM, ROM, CD, DVD