NEW PERSPECTIVES

COMPUTER CONCEPTS

2011

Chapter 1

Computers and Digital Basics

1 Chapter Contents

- Section A: All Things Digital
- Section B: Digital Devices
- Section C: Digital Data Representation
- Section D: Digital Processing
- Section E: Password Security

SECTION A

1 All Things Digital

- The Digital Revolution
- Convergence
- Digital Society

1

The Digital Revolution

- The digital revolution is an ongoing process of social, political, and economic change brought about by digital technology, such as computers and the Internet
- Revolves around a constellation of technologies, including digital electronics, computers, communications networks, the Web, and digitization

1

The Digital Revolution

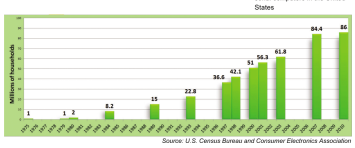
- Digital electronics use electronic circuits to represent data
- Today, digital electronic devices include computers, portable media players such as iPods, digital cameras and camcorders, cell phones, radios and televisions, GPSs, DVD and CD players, e-book readers, digital voice recorders, and handheld gaming consoles

FIGURE 1-1
Digital devices, such as this wireless mouse, are built from solid state circuit boards and computer chips, making them small, light, responsive, inexpensive, and durable.

1

The Digital Revolution

FIGURE 1-2
Household ownership of personal computers in the United States



Source: U.S. Census Bureau and Consumer Electronics Association

1

The Digital Revolution

- The second phase of the digital revolution materialized when the Internet was opened to public use
  - E-mail
  - Bulletin boards
  - Blogs
  - Online social networks

FIGURE 1-4
Online social networks offer netizens a place to look up old friends and meet friends of friends. When using a digital version of your textbook, such as the BookOnCD, click the round icon in this figure for an overview of social networking sites.

1

The Digital Revolution

- A computer network is a group of computers linked by wired or wireless technology to share data and resources
- The Web is a collection of linked documents, graphics, and sounds that can be accessed over the Internet
- Cyberspace is a term that refers to entities that exist largely within computer networks
- Digitization is the process of converting text, numbers, sound, photos, and video into data that can be processed by digital devices

1

Convergence

- Technological convergence is a process by which several technologies with distinct functionalities evolve to form a single product
- Convergence tends to offer enhanced functionality and convenience

FIGURE 1-7
The Apple Newton was an early attempt to develop a handheld computing device that combined an appointment book, contact manager, clock, alarm, and calculator. It lacked a key element for success, which turned out to be the ability to work with digital music.

1

Digital Society

- Digital technologies and communications networks make it easy to cross cultural and geographic boundaries
- Anonymous Internet sites, such as Freenet, and anonymizer tools that cloak a person's identity, even make it possible to exercise freedom of speech in situations where reprisals might repress it
- Citizens of free societies have an expectation of privacy
- Intellectual property refers to the ownership of certain types of information, ideas, or representations

1

Digital Society

- Digital technology is an important factor in global and national economies, in addition to affecting the economic status of individuals
- Globalization can be defined as the worldwide economic interdependence of countries that occurs as cross-border commerce increases and as money flows more freely among countries
- Individuals are affected by the digital divide, a term that refers to the gap between people who have access to technology and those who do not
- Digital technology permeates the very core of modern life

1

SECTION B

Digital Devices

- Computer Basics
- Personal Computers, Servers, Mainframes, and Supercomputers
- Handheld Devices
- Microcontrollers

1 Computer Basics

- A computer is a multipurpose device that accepts input, processes data, stores data, and produces output, all according to a series of stored instructions

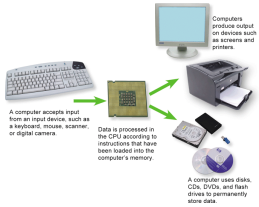
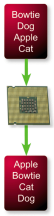


FIGURE 1-12
A computer can be defined by its ability to accept input, process data, store data, and produce output, all according to a set of instructions from a computer program.

1 Computer Basics

- Computer input is whatever is typed, submitted, or transmitted to a computer system
- Output is the result produced by a computer
- Data refers to the symbols that represent facts, objects, and ideas
- Computers manipulate data in many ways, and this manipulation is called processing
  - Central Processing Unit (CPU)
  - Microprocessor

FIGURE 1-13
An unsorted list is input into the computer, where it is processed in the CPU and output as a sorted list.



1 Computer Basics

- Memory is an area of a computer that temporarily holds data waiting to be processed, stored, or output
- Storage is the area where data can be left on a permanent basis when it is not immediately needed for processing
- A file is a named collection of data that exists on a storage medium
- The series of instructions that tells a computer how to carry out processing tasks is referred to as a computer program
  - Software

1

Computer Basics

- A stored program means that a series of instructions for a computing task can be loaded into a computer's memory
  - Allows you to switch between tasks
  - Distinguishes a computer from other simpler and less versatile digital devices

1

Computer Basics

- Application software is a set of computer programs that helps a person carry out a task
- The primary purpose of system software is to help the computer system monitor itself in order to function efficiently
  - Operating system (OS)

1

Personal Computers, Servers, Mainframes, and Supercomputers

- A personal computer is a microprocessor-based computing device designed to meet the computing needs of an individual

FIGURE 1-14
Personal computer designs run the gamut from drab gray boxes to colorful curvy cases.

1 Personal Computers, Servers, Mainframes, and Supercomputers

- The term workstation has two meanings:
  - An ordinary personal computer that is connected to a network
  - A powerful desktop computer used for high-performance tasks

FIGURE 1-15
A workstation resembles a desktop computer, but typically features more processing power and storage capacity.

1 Personal Computers, Servers, Mainframes, and Supercomputers

- A videogame console, such as Nintendo's Wii, Sony's PlayStation, or Microsoft's Xbox, is not generally referred to as personal computer because of their history as dedicated game devices

FIGURE 1-16
A videogame console includes circuitry similar to a personal computer's, but its input and output devices are optimized for gaming.

1 Personal Computers, Servers, Mainframes, and Supercomputers

- The purpose of a server is to *serve* computers on a network (such as the Internet or a home network) by supplying them with data
- A mainframe computer (or simply a mainframe) is a large and expensive computer capable of simultaneously processing data for hundreds or thousands of users
- A computer falls into the supercomputer category if it is, at the time of construction, one of the fastest computers in the world
  - A compute-intensive problem is one that requires massive amounts of data to be processed using complex mathematical calculations

1 Personal Computers, Servers, Mainframes, and Supercomputers

FIGURE 1-18
This IBM z10 E12 mainframe computer weighs 2,807 pounds and is about 6.5 feet tall.

FIGURE 1-19
In 2010, a Cray XT5HE computer named Jaguar was the fastest supercomputer. Using more than 18,000 processors, the Jaguar clocks peak performance speeds of 2.3 petaflops or 2.3 quadrillion operations per second.

1 Handheld Devices

- A PDA (personal digital assistant) is a pocket-sized digital appointment book with a small keyboard or a touch-sensitive screen, designed to run on batteries and be used while holding it
- A smartphone, in addition to voice communication, includes features such as touch screen, full qwerty keypad, text messaging, e-mail, Web access, removable storage, camera, FM radio, digital music player, GPS navigation, and a wide selection of applications and maps
- iPods and similar devices are classified as portable media players because their main strength is playing music, showing videos, and storing photos

1 Handheld Devices

FIGURE 1-20
Many mobile phones feature a small keyboard, others accept handwriting input, and some work with touch screen icons.

FIGURE 1-21
The iPod and other portable media players work with music, videos, and photos.

1

Microcontrollers

- A microcontroller is a special-purpose microprocessor that is built into the machine it controls
- Microcontrollers can be embedded in all sorts of everyday devices

FIGURE 1-22
A microcontroller is usually mounted on a circuit board and then installed in a machine or appliance using wires to carry input and output signals.

1

SECTION C

Digital Data Representation

- Data Representation Basics
- Representing Numbers, Text, Images, and Sound
- Quantifying Bits and Bytes
- Circuits and Chips

1

Data Representation

- Data representation refers to the form in which data is stored, processed, and transmitted
- Digital data is text, numbers, graphics, sound, and video that has been converted into discrete digits such as 0s and 1s
- Analog data is represented using an infinite scale of values

FIGURE 1-23
A computer is a digital device, more like a standard light switch than a dimmer switch.

1 Representing Numbers, Text, Images, and Sound

- Numeric data
  - Binary number system
- Character data
  - ASCII, Extended ASCII, EBCDIC, and Unicode

Decimal (Base 10)	Binary (Base 2)
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
1000	1111101000

FIGURE 1-24
The decimal system uses ten symbols to represent numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The binary number system uses only two symbols: 0 and 1.

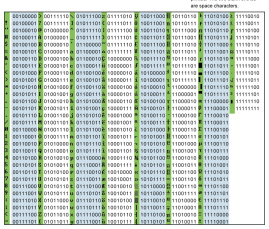
1 Data Representation

FIGURE 1-25
A computer treats the letters and symbols in the word HI! as character data, which can be represented by a string of 0s and 1s.

HI!

01001000 01001001 00100001

FIGURE 1-26
The Extended ASCII code uses eight 1s and 0s to represent letters, symbols, and numerals. The first 32 ASCII characters are not shown in the table because they represent special control sequences that cannot be printed. The two blank entries are space characters.



1 Quantifying Bits and Bytes

Bit	One binary digit	Gigabit	2^{30} bits
Byte	8 bits	Gigabyte	2^{30} bytes
Kilobit	1,024 or 2^{10} bits	Terabyte	2^{40} bytes
Kilobyte	1,024 or 2^{10} bytes	Petabyte	2^{50} bytes
Megabit	1,048,576 or 2^{20} bits	Exabyte	2^{60} bytes
Megabyte	1,048,576 or 2^{20} bytes		

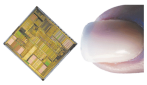
FIGURE 1-29
Quantifying Digital Data

1

Circuits and Chips

- An integrated circuit (IC) is a super-thin slice of semiconducting material packed with microscopic circuit elements

FIGURE 1-30
The first computer chips contained fewer than 100 miniaturized components, such as diodes and transistors. The chips used as the CPUs for today's computers and cutting edge graphics cards contain billions of transistors.



A DIP has two rows of pins that connect the IC circuitry to a circuit board.

A PGA is a square chip package with pins arranged in concentric squares, typically used for microprocessors.

FIGURE 1-31
Integrated circuits can be used for microprocessors, memory, and support circuitry. They are housed within a ceramic carrier. These carriers exist in several configurations, or chip packages, such as DIPs and PGAs.

1

Circuits and Chips

- The electronic components of most digital devices are mounted on a circuit board called a system board, motherboard, or main board

FIGURE 1-32
The electronic components of computers and handheld devices have many similar elements, including microchips and circuit boards. Circuit boards are usually green, whereas microchips are usually black.

1

SECTION D

Digital Processing

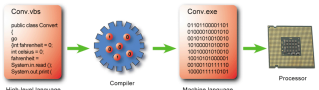
- Programs and Instruction Sets
- Processor Logic

1 Programs and Instruction Sets

- Computers, portable media players, PDAs, and smartphones all work with digital data
- Computer programmers create programs that control digital devices. These programs are usually written in a high-level programming language
- The human-readable version of a program created in a high-level language by a programmer is called source code

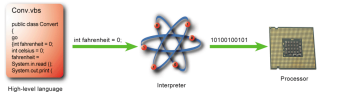
1 Programs and Instruction Sets

FIGURE 1-34
A compiler converts statements written in a high-level programming language into object code that the processor can execute.
Watch a compiler in action.



1 Programs and Instruction Sets

FIGURE 1-35
An interpreter converts high-level statements one at a time as the program is running.
Watch an interpreter in action.

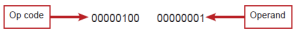


1 Programs and Instruction Sets

- An instruction set is a collection of preprogrammed activities a microprocessor is hardwired to perform
- Each instruction has a corresponding sequence of 0s and 1s
- The end product is called machine code
  - 1s and 0s

1 Programs and Instruction Sets

- An op code (short for operation code) is a command word for an operation such as add, compare, or jump
- The operand for an instruction specifies the data, or the address of the data, for the operation
- In the following instruction, the op code means add and the operand is 1, so the instruction means Add 1



1 Programs and Instruction Sets

```
#include <stdio.h>
int main ()
{
int i;

for (i=1; i<=100; i=i+1)
  printf("%d\n",i);
return(0);
}
```

```
00100011101111011111111111100000
10101111101111110000000000010100
10101111101001000000000001000000
10101111101001010000000000100100
10101111101000000000000000011000
10101111101000000000000000011100
10001111101111000000000000011100
10001111101111000000000000011000
00000000111001110000000000011001
00100101110010000000000000000001
00101001000000010000000011001011
10101111101010000000000000011100
00000000000000001111000000010010
00000011000011111110010000100001
00010100001000001111111111110111
10101111101111001000000000011000
00111100000001000010000000000000
10001111101001010000000000011000
00001100000100000000000011010000
00000000000000000000000000000000
```

FIGURE 1-36

The source code program on the left prints numbers from 1 to 100. This source code is converted to machine language instructions shown in the right column that the computer can directly process.

1 Processor Logic

- The ALU (arithmetic logic unit) is the part of the microprocessor that performs arithmetic operations
- The ALU uses registers to hold data that is being processed
- The microprocessor's control unit fetches each instruction, just as you get each ingredient out of a cupboard or the refrigerator
- The term instruction cycle refers to the process in which a computer executes a single instruction

1

Processor Logic

FIGURE 1-37
The control unit fetches the ADD instruction, then loads data into the ALU's registers where it is processed.

FIGURE 1-38
The instruction cycle includes four activities.

1

Processor Logic

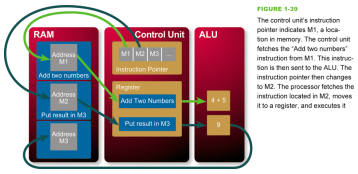


FIGURE 1-39
The control unit's instruction pointer indicates M1, a location in memory. The control unit fetches the "Add two numbers" instruction from M1. This instruction is then sent to the ALU. The instruction pointer then changes to M2. The processor fetches the instruction located in M2, moves it to a register, and executes it

1

SECTION E

Password Security

- Authentication Protocols
- Password Hacks
- Secure Passwords

1

Authentication Protocols

- Security experts use the term authentication protocol to refer to any method that confirms a person's identity using something the person knows, something the person possesses, or something the person is
  - A person can be identified by biometrics, such as a fingerprint, facial features (photo), or retinal pattern
  - A user ID is a series of characters—letters and possibly numbers or special symbols—that becomes a person's unique identifier
  - A password is a series of characters that verifies a user ID and guarantees that you are the person you claim to be

1

Authentication Protocols

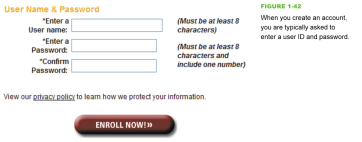


FIGURE 1-42
When you create an account, you are typically asked to enter a user ID and password.

1

Password Hacks

- When someone gains unauthorized access to your personal data and uses it illegally, it is called identity theft
- Hackers can employ a whole range of ways to steal passwords
- A dictionary attack helps hackers guess your password by stepping through a dictionary containing thousands of the most commonly used passwords
- The brute force attack uses password-cracking software, but its range is much more extensive than the dictionary attack

1

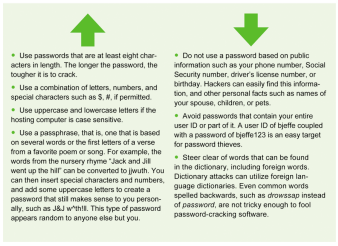
Password Hacks

- If hackers can't guess a password, they can use another technique called sniffing, which intercepts information sent out over computer networks
- An even more sophisticated approach to password theft is phishing
- A keylogger is software that secretly records a user's keystrokes and sends the information to a hacker

1

Password Security

FIGURE 1-45
Tips for Creating Secure Passwords



- Use passwords that are at least eight characters in length. The longer the password, the tougher it is to crack.
- Use a combination of letters, numbers, and special characters such as $, #, if permitted.
- Use uppercase and lowercase letters if the hosting computer is case sensitive.
- Use a passphrase, that is, one that is based on several words or the first letters of a verse from a favorite poem or song. For example, the words from the nursery rhyme "Jack and Jill went up the hill" can be converted to jjwuth. You can then insert special characters and numbers, and add some uppercase letters to create a password that still makes sense to you personally, such as J&J w^th'll. This type of password appears random to anyone else but you.

- Do not use a password based on public information such as your phone number, Social Security number, driver's license number, or birthday. Hackers can easily find this information, and other personal facts such as names of your spouse, children, or pets.
- Avoid passwords that contain your entire user ID or part of it. A user ID of bjeffe coupled with a password of bjeffe123 is an easy target for password thieves.
- Steer clear of words that can be found in the dictionary, including foreign words. Dictionary attacks can utilize foreign language dictionaries. Even common words spelled backwards, such as *drowssap* instead of *password*, are not tricky enough to fool password-cracking software.

1

Password Security

- Strive to select a unique user ID that you can use for more than one site
- Maintain two or three tiers of passwords

Tier 1: High security
Password: BBx98$$NN26
Uses:
Online banking
PayPal
iTunes
Amazon.com

Tier 2: Low security
Password: Rover
Uses:
New York Times archive
Google
Wikipedia
photoSIG

FIGURE 1-46
Tiered passwords reduce the number of user IDs and passwords that you have to remember; however, the disadvantage is that a hacker who discovers one of your passwords will be able to use it to access many of your accounts.