ANDIJAN STATE PEDAGOGICAL INSTITUTE

Lecture materials · 2026–2027 academic year

SUBJECT

Information Systems and Digital Technologies

Lecture 2 · Course Overview and Expectations

Part 2 of 2 · 2 hours

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LECTURE 02 · 2 HOURS · PART 2/2

1

CHAPTER ONE

Fundamentals of Computers

Understanding the Computer

What a computer is · how it evolved · how we classify it

- Input → Process → Output
- Five generations
- Classification
- Applications

LEARNING OBJECTIVES

By the end of this lesson you will be able to…

7 **Compare the five generations of computers by technology, size, speed and programming.**

8 **Classify any given computer by operating principle, application, and size and capability.**

04

Five Generations of Computers

Each generation is a phase of improvement — smaller, cheaper, faster, more reliable and more productive

Vacuum tubes

Transistors

Integrated circuits

Microprocessor · ULSI

Vacuum tubes and machine language

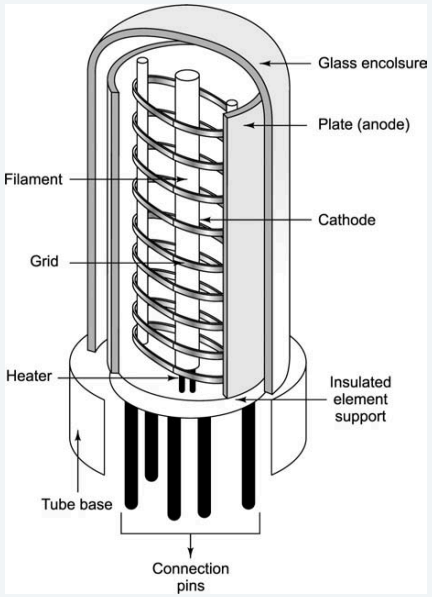


Fig. 1.5 A vacuum tube

Vacuum tubes

Used for calculation as well as for storage and control. Also known as thermionic valve based machines.

HOW IT WORKS

Glass tube with filaments; heated filaments generate electrons that amplify and deamplify signals.

INPUT / OUTPUT

Punched card for input, printout for output.

ADVANTAGES

- Fastest computing devices of their time
- Could execute complex mathematical problems efficiently

LIMITATIONS

- Machine language only — hard to program
- Very large, bulky and hard to install
- Generated huge heat; single tasking

Examples: ENIAC, EDVAC, EDSAC and UNIVAC

Transistors and assembly language

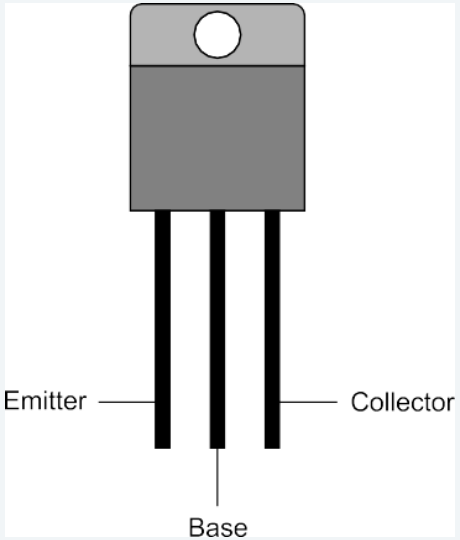


Fig. 1.6 A transistor

Transistors

Invented by Shockley, Brattain and Bardeen in 1947, for which they won the Nobel Prize.

THREE CONNECTIONS

Base — input gate for the signal. Collector — collects the amplified signal. Emitter — output gate.

ALSO NEW

Printers, secondary storage and operating system technology. Input/output still punched card and printout.

ADVANTAGES

- Smaller, faster, cheaper, less heat
- Easy to program using assembly language
- Light weight and easily transferable
- Needed very little power

LIMITATIONS

- Input and output media barely improved
- Had to be placed in air-conditioned places
- Very high cost — beyond home users
- Special purpose only

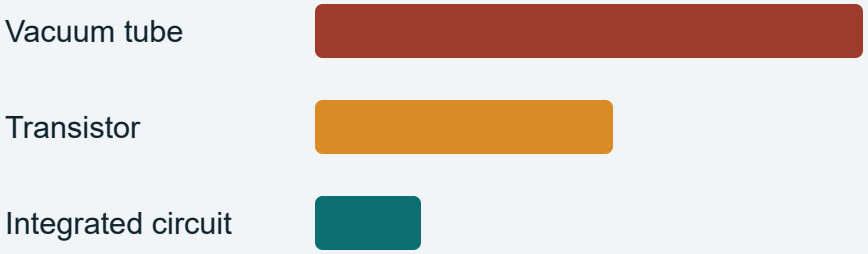
Examples: PDP-8, IBM 1401 and IBM 7090

Integrated circuits and high-level languages

Integrated Circuits (ICs)

Circuits that combine transistors, resistors, capacitors and other components onto a single small silicon chip. Also known as microelectronics technology. The first IC was developed by Jack Kilby and Robert Noyce in 1958.

Why ICs beat what came before



Relative size, cost and power required

Examples: NCR 395, B6500, IBM 370, PDP 11, CDC 7600

Speed
Fastest so far — computational time measured in nanoseconds

Programming
High-level languages: independent of machine details, so a program written on one computer runs on another

Purpose
Able to execute business and scientific applications — general-purpose computers

Still a problem
Storage capacity remained very small, cost was very high, and air-conditioned rooms were still required

The microprocessor arrives

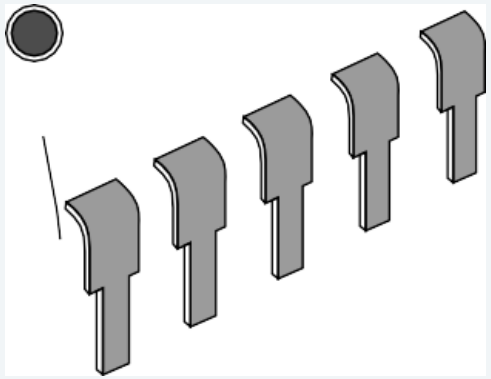


Fig. 1.8 The Intel P4004 microprocessor chip, 1971

LSI, VLSI & the microprocessor

LSI fitted thousands of transistors on one silicon chip; VLSI fitted hundreds of thousands. ICs were still used for the basic circuits.

WHAT A MICROPROCESSOR IS

It puts the CPU, memory and I/O controls of a computer onto a single chip.

ALSO IN THIS ERA

Personal Computers (PCs), Graphical User Interfaces, new operating systems, static and dynamic RAM, and Local Area Networks.

ADVANTAGES

- Very powerful; large and fast storage
- User-friendly thanks to GUIs
- Highly portable programs; very versatile
- Highly reliable, very little power needed

LIMITATIONS

- Soldering LSI and VLSI chips onto the wiring board needed complicated technology
- Still entirely dependent on the instructions given by the programmer

Examples: IBM PC, IBM PC/AT, Apple and CRAY-1. Later microprocessors: Intel 386, Intel 486, Pentium

ULSI — ten million components on one chip

Ultra Large Scale Integration (ULSI)

Allows almost ten million electronic components to be fabricated on one small chip, increasing the power and speed of microprocessors and the capacity of primary and secondary storage.

Portable computers

Laptop, pocket computer, Personal Digital Assistant (PDA)

Parallel processors

Several instructions executed at the same time

Servers

Centralised computers serving many users

Optical disks

A new storage technology

The Internet

And its different services

ADVANTAGES

- Fastest and most powerful computers to date
- Run many applications at once, at very high speed
- So small that some can be used while travelling
- Versatile for communication and resource sharing

THE MAJOR DISADVANTAGE

They are not provided with an intelligent program that could guide them in performing different operations. Artificial intelligence and expert system applications are the results of ongoing efforts in this field.

COMPARISON

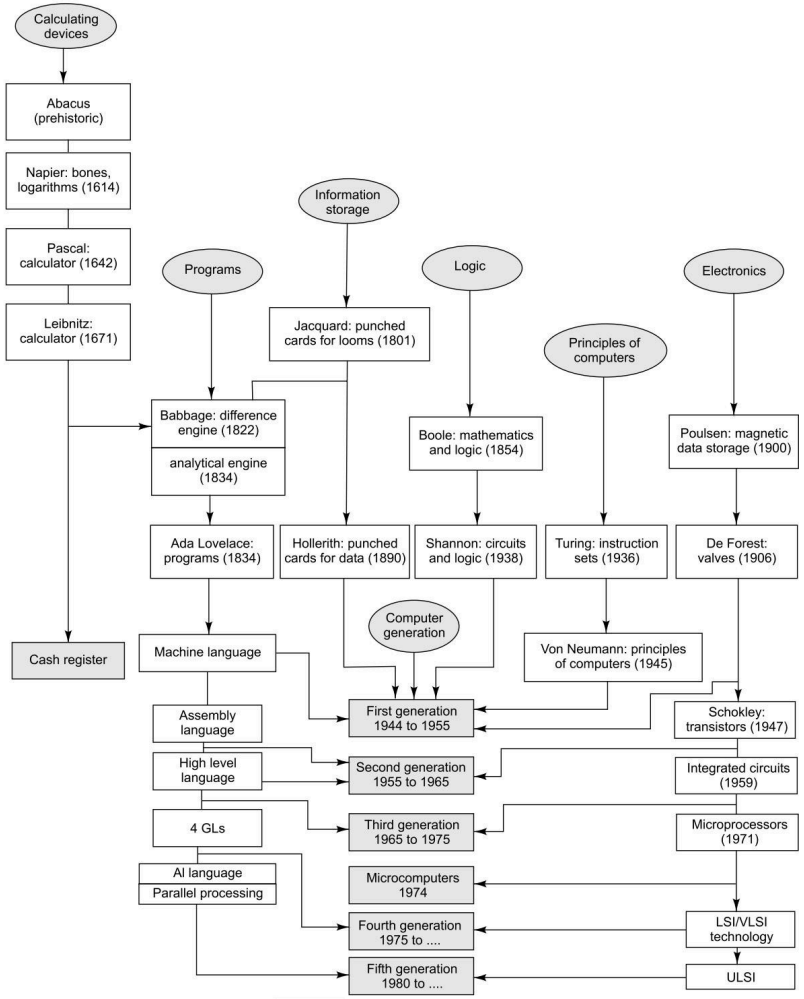
The five generations side by side

Generation	Period	Main technology	Size	Speed	Programming technology	Examples
First	1940–1956	Vacuum tubes	Very large and bulky	Fastest of its time	Machine language	ENIAC, EDVAC, EDSAC, UNIVAC
Second	1956–1963	Transistors	Smaller, light weight	Faster than 1st generation	Assembly language	PDP-8, IBM 1401, IBM 7090
Third	1964–1975	Integrated circuits	Smaller, transportable	Computation in nanoseconds	High-level languages	NCR 395, B6500, IBM 370, PDP 11, CDC 7600
Fourth	1975–1989	LSI / VLSI, microprocessor	Small and compact	Very high; fast access time	High-level languages, GUI, 4 GLs	IBM PC, IBM PC/AT, Apple, CRAY-1
Fifth	Modern digital computers	ULSI	Very small, portable	Fastest and most powerful to date	Parallel processing, AI languages	Laptops, PDAs, servers, modern PCs

Period, technology and examples are taken from the chapter text. “4 GLs”, “AI languages” and “parallel processing” come from Fig. 1.9, the tree of the computer family, on the next slide.

FIG. 1.9

The tree of the computer family



Five separate lines of development feed into the computer we use today.

1 Calculating devices

Abacus → Napier → Pascal → Leibnitz

2 Programs

Babbage → Ada Lovelace → machine, assembly and high-level languages

3 Information storage

Jacquard's punched cards → Hollerith

4 Logic

Boole → Shannon

5 Electronics

De Forest's valves → Shockley's transistors → ICs → microprocessors → LSI/VLSI → ULSI

Note: this figure dates the generations 1944–1955, 1955–1965, 1965–1975, 1975– and 1980–. Use the chapter text dates for tests.

CHECK FOR UNDERSTANDING

Sort it · say the generation number

Which generation does each technology belong to?

1	2	3	4
Transistors	Ultra Large Scale Integration (ULSI)	Integrated circuits	Microprocessor, LSI and VLSI
Technology A	*Technology B*	*Technology C*	*Technology D*

Answers: A — second. B — fifth. C — third. D — fourth. The missing one is vacuum tubes — first generation. Predict: why did each new generation make computers cheaper as well as faster?

05

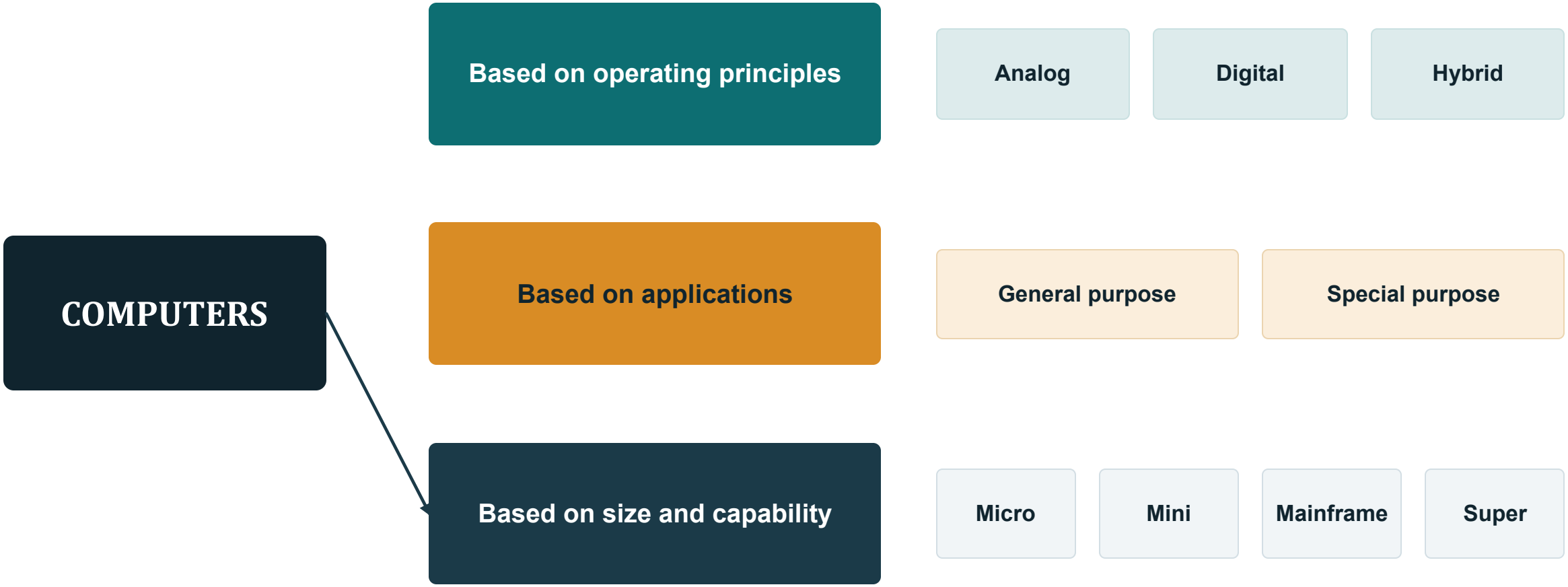
Classification of Computers

Every computer processes data — but they differ in how they handle it, what they are for, and how big they are

- Operating principles
- Applications
- Size and capability
- Inside a microcomputer

CONCEPT MAP

Three ways to classify any computer



BASED ON OPERATING PRINCIPLES

Analog, digital and hybrid

Analog

CONTINUOUS SIGNALS

Represents data as continuous electrical signals with a specific magnitude. Very fast, and several operations can run at the same time.

- Results are not very accurate
- Used where accuracy is not a major concern
- Powerful tools for solving differential equations
- Built on an Operational Amplifier (Op-Amp)

Digital

0S AND 1S

Stores and processes data in digital form — every kind of data is held as 0s and 1s, and the output is digital too.

- Faster, more reliable and more accurate than analog
- Can process analog data once it is converted
- Components: ALU, Control Unit, memory unit, I/O units
- Example: the computer used by a home user

Hybrid

BEST OF BOTH

Combines analog and digital computers, so its hardware is a mixture of analog and digital components.

- Fast, efficient and reliable
- Accepts a continuously varying input signal and converts it to discrete values
- Cost-effective for complex simulations
- Example: the machine that measures a patient's heartbeat

BASED ON APPLICATIONS

General purpose or special purpose

General purpose

Designed so that they can work in all environments.

Versatility
Versatile — can store a number of programs meant for distinct tasks

Efficiency
Not efficient; consumes a large amount of time in generating the result

Special purpose

Designed so that they can perform only one specified task.

Versatility
Not versatile; speed and memory size depend on the task to be performed

Efficiency
Efficient and consumes less time; also less expensive, with no redundant information

Remember from earlier in the chapter

Colossus was a special purpose electronic device, designed to perform only some specific functions. · ENIAC was a general purpose computer, capable of solving all types of computing problems. · First and second generation computers were generally designed as special purpose machines; third generation computers were general purpose.

BASED ON SIZE AND CAPABILITY

From microcomputer to super computer

Microcomputer

Individual use

- Small and cheap digital computer built around a microprocessor, a storage unit and an I/O channel
- Available as PCs, workstations and notebook computers
- Desktop · Laptop · Hand-held (PDA)

Mini computer

Midrange · 1960, DEC

- Handles more data and more I/O than a microcomputer; less powerful than a mainframe
- Serves between 4 and 200 users at the same time
- Used as a centralised computer, network server or web server
- PDP 11, IBM 8000 series, VAX 7500

Mainframe computer

Large organisations

- Very large; handles almost millions of records in a day
- Up to 16 microprocessors; RAM between 128 MB and 8 GB
- Runs multiple operating systems — called ‘virtual machines’
- IBM 3000, VAX 8000, CDC 6600

Super computer

Fastest · 1960, Seymour Cray

- The fastest type of computer; performs complex operations at very high speed
- Runs only a small number of programs at a time — that is why it is fast
- Uses pipelining and parallelism
- CRAY 3, Cyber 205, NEC SX-3, PARAM (India)

Super computers are used for: weather forecasting · animated graphics · fluid mechanics · nuclear energy research · petroleum exploration

Four parts joined by the system bus

1 Microprocessor

The heart of the microcomputer

- ALU — arithmetic and logic operations
- Register unit — temporary storage for the ALU
- Control unit — manages and directs operations

2 Memory

Stores data and instructions

- Primary (main) memory — temporary storage
- Secondary (auxiliary) memory — permanent storage
- Magnetic disks and magnetic tapes

3 Peripheral devices

Input and output

- Input: keyboard, mouse
- Output: monitor, printer
- Output devices convert binary results into a readable form

SYSTEM BUS

Connects microprocessor, memory and peripheral devices into a single unit. Also called the frontside bus, memory bus, local bus or host bus.

Address bus

Unidirectional — identifies a peripheral device or a memory location

Data bus

Bidirectional — transfers data between microprocessor, memory and peripherals

Control bus

Carries control signals from the microprocessor to the various devices

CHECK FOR UNDERSTANDING

Classify it · give all three labels where you can

Classify each of these computers.

1

The machine used in a hospital to measure a patient's heartbeat.

Example 1

2

The computer used by a family at home.

Example 2

3

A machine used for weather forecasting and nuclear energy research.

Example 3

4

A network server for a medium-sized business, serving 150 users.

Example 4

Answers: 1 — hybrid. 2 — digital, general purpose, microcomputer. 3 — super computer. 4 — mini computer (midrange).

Four sub-systems every computer needs

Hardware | **Software** | **Data** | **People**

Hardware

The physical devices that make up the computer: keyboard, mouse, memory, CPU, monitor and printer. They enter, store and process the data and then display the output.

Inside the CPU

ALU	Arithmetic Logic Unit — arithmetic operations such as addition and subtraction, and logic operations such as AND and OR
CU	Control Unit — controls input and output activity; obtains instructions from memory, decodes them and executes them

Software

The programs and instructions that help the computer carry out its processing. There are two main types.

Application software

Designed to perform a specific task for the user. Also called end-user programs.

Word processors · databases · presentation programs · spreadsheets

System software

Designed to control the operations of the computer and manage the hardware.

Operating systems · compilers · assemblers · interpreters · device drivers

Data and people

Data

The raw facts entered into the computer system by the user in order to generate the desired output. Data is presented in a form the computer understands; the result is delivered in a form the user understands.

Qualitative data
Represented in words or text form. Can also include images, videos and audio used for graphical presentation.

Quantitative data
Represented in numerical form — numbers and symbols used to represent a particular quantity.

1 bit = the smallest unit of information. **1 byte** = a group of eight bits.

People

Computer systems are designed by the people, for the people.

1 Systems people

The people who design and build hardware and software: hardware engineers, software engineers, programmers.

2 Users

The people who actually use computer systems for their applications — in education, business, entertainment, training and other areas. They may use standard software or develop their own.

Hardware · Software · Data · People — all four are essential

APPLICATIONS OF COMPUTERS

Where computers are used today

1 Education

Teaching, presentations, online forms and exams, distance education, web-based learning.

2 Business

Databases of information, web conferencing between remote locations, buying and selling online.

3 Communication

Transferring data between connected computers; e-mail for text, graphics and file attachments.

4 Science

Research and analysis of new theories; moving towards predicting earthquakes and tsunamis.

5 Engineering

Complex drawings and designs in fields such as automobiles and construction; numerical computing.

6 Entertainment

Creating graphics and animations with free and proprietary graphics software.

7 Banking

Online banking — transferring and receiving money, and paying bills through bank websites.

8 Health

Diagnosing diseases, monitoring patients, viewing internal organs, patient records, tele-medicine.

9 Government

Revenue, industry, census, police and defence departments; the idea of ‘e-governance’.

REAL-WORLD CONNECTIONS

The textbook concept, and where you meet it today

Concept from this chapter	What the textbook says	Where you meet it today
CPU — the brain	Controls and executes instructions	*The processor chip inside your phone or laptop*
Microcomputer	Small, cheap, built around a microprocessor, for one person	*Your laptop or desktop PC*
Hand-held computer / PDA	Pocket-sized, pen or stylus input, small storage cards	*Your smartphone and tablet*
Mainframe computer	Millions of records a day; financial transaction processing	*The bank system behind an ATM or a card payment*
Super computer	Weather forecasting, animated graphics, nuclear energy research	*National weather forecasts; film animation studios*
Hybrid computer	Measures a patient's heartbeat	*Hospital monitors and fitness trackers*
Special purpose computer	Performs only one specified task	*A calculator, a digital watch, a washing-machine controller*

OPTIONAL CLARIFICATION — NOT EXAMINABLE

Where the textbook and modern sources differ

For all tests and exercises, use the chapter as written. The notes below are background only, so that nobody is confused by another source.

Generation dates

The chapter text gives 1940–1956, 1956–1963, 1964–1975 and 1975–1989. Fig. 1.9 in the same chapter gives 1944–1955, 1955–1965, 1965–1975, 1975– and 1980–.

→ ***Use the chapter text.***

Colossus

The chapter credits “Alan Mathison”, a British mathematician. The full name is Alan Mathison Turing; most modern histories credit the engineer Tommy Flowers with building Colossus.

→ ***Answer as the chapter does.***

ENIAC's builders

The chapter writes “John Ecker” once and “John Eckert” elsewhere. The usual modern form is J. Presper Eckert.

→ ***Either spelling of Eckert is accepted.***

Fifth generation and AI

The chapter says fifth generation machines are not provided with an intelligent program, with AI and expert systems still being worked on. Written before AI became a common everyday technology.

→ ***Answer as the chapter does.***

Hand-held computers

Apple Newton, Casio Cassiopeia and Franklin eBookMan are the chapter's examples of PDAs.

→ ***Smartphones have taken over this role.***

Spelling

The chapter writes “napier bones” and “Leibriz”. Most sources write “Napier's Bones” and “Leibniz”.

→ ***Same device, same person.***

REVIEW

Eight questions before we finish

1. Which component of the computer is known as the brain of the computer?
2. Which device arranged stones in three channels in the sand?
3. Who is known as the father of modern digital computers?
4. Which was the first pure electronic programmable computer, developed in 1944?
5. Which technology was used in third generation computers?
6. Which generation uses ULSI technology?
7. Name the three classes of computer based on operating principles.
8. Which type of computer is known as a midrange computer?

REVIEW

Answers

1 **CPU**
Central Processing Unit — it controls and executes instructions.

2 **The sand table**
Three channels in the sand, maximum ten stones per channel.

3 **Charles Babbage**
Professor of mathematics at Cambridge University.

4 **Colossus**
Developed in 1944; a special purpose electronic device using vacuum tubes.

5 **Integrated circuits (ICs)**
Also known as microelectronics technology.

6 **The fifth generation**
Ultra Large Scale Integration — about ten million components on one chip.

7 **Analog, digital and hybrid**
The three classes based on operating principles.

8 **The mini computer**
Less powerful than a mainframe, more powerful than a microcomputer.

EXIT TICKET

Answer these three before you leave

Write your answers on a slip of paper with your name and hand it in at the door.

1

In one sentence, define a computer using the words input, processing and output.

Tests objective 3

2

Name the main technology of each of the five generations, in order.

Tests objective 7

3

Give one example of a special purpose computer and say why it is special purpose.

Tests objective 8

Next: five interactive activities — components, the evolution timeline, the five generations, classification, and the final knowledge challenge.