Grade 12 A/L ICT · Lesson 2

2.1 History of Computers: Generations, Processors and Classification

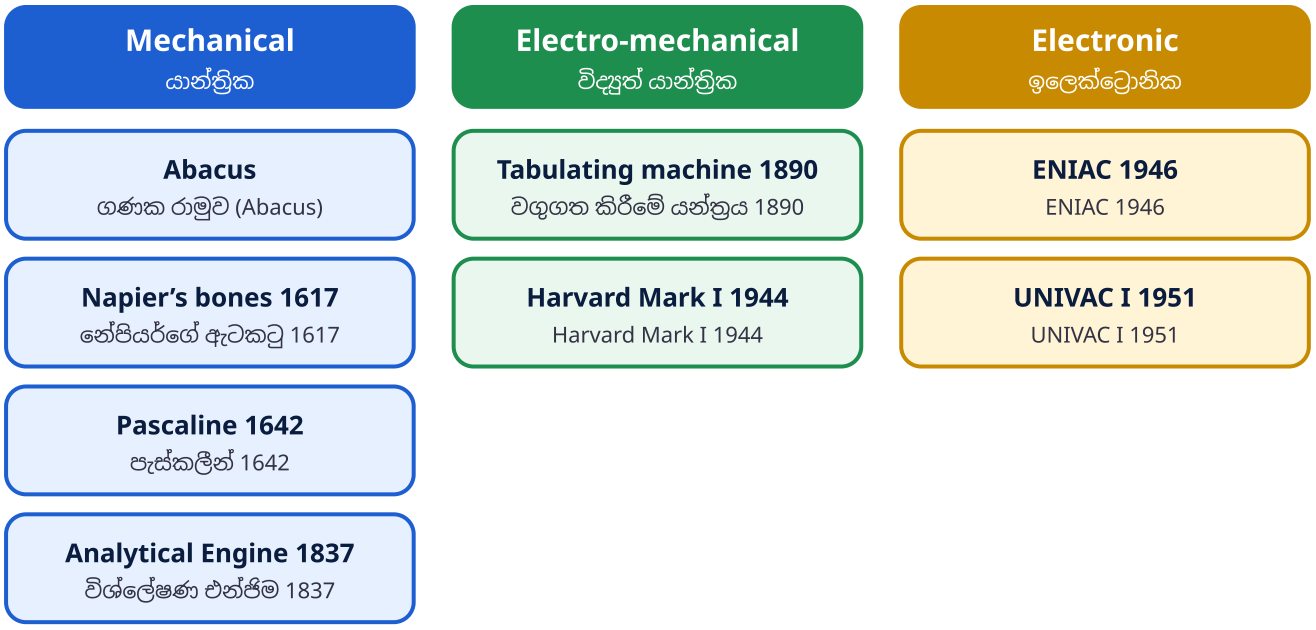
Syllabus 2.1. People have always wanted machines that help them count and calculate. The story goes from the **abacus** to **mechanical** machines, then **electro-mechanical** machines, and finally **electronic** computers. Electronic computers grew through **five generations**, each smaller, faster and cheaper than the one before. In this part you also learn how **processors** evolved and how we **classify** computers by technology, by purpose and by size.

1. Early calculating aids

Before electricity, people used **mechanical** aids that worked with beads, rods, gears and wheels. Later, **electro-mechanical** machines used electric motors and switches (relays) to move mechanical parts. Then came fully **electronic** computers with no moving parts for calculation.

Aid / machine	Year and person	Type	What it did
Abacus	Ancient (about 2400 BC)	Mechanical (moved by hand)	Beads on rods for adding and subtracting
Napier’s bones	1617, John Napier	Mechanical	Numbered rods for multiplication
Slide rule	1620s, William Oughtred	Mechanical (analog)	Sliding scales for multiply and divide
Pascaline	1642, Blaise Pascal	Mechanical	Gear wheels that add and subtract
Stepped Reckoner	1673, Gottfried Leibniz	Mechanical	Could also multiply and divide
Jacquard loom	1801, Joseph Jacquard	Mechanical	Punched cards controlled the weaving pattern
Difference and Analytical Engine	1822 and 1837, Charles Babbage	Mechanical	Analytical Engine had input, store, mill (processor) and output – the idea of a modern computer
Tabulating machine	1890, Herman Hollerith	Electro-mechanical	Read punched cards to count the US census
Harvard Mark I	1944, Howard Aiken	Electro-mechanical	Large relay calculator, 15 m long
ENIAC	1946, Eckert and Mauchly	Electronic	About 18,000 vacuum tubes; first general purpose electronic computer

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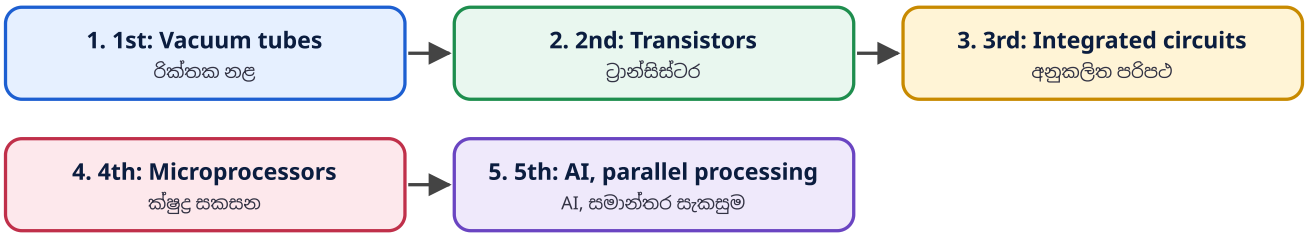
Mechanical, electro-mechanical and electronic aids.

💡 **Charles Babbage** is called the "father of the computer". **Ada Lovelace** wrote steps for his Analytical Engine, so she is called the first programmer.

2. Generations of computers

A **generation** is a stage in computer history marked by the main **electronic part** used to build it. Each new part made computers smaller, faster, more reliable, cheaper and lower in power use.

Generation	Period	Main technology	Examples
1st	1940–1956	Vacuum tubes	ENIAC, UNIVAC I
2nd	1956–1963	Transistors	IBM 1401, IBM 7090
3rd	1964–1971	Integrated circuits (ICs)	IBM System/360
4th	1971–present	Microprocessors (VLSI)	IBM PC, Apple Macintosh, laptops
5th	Present and future	AI, parallel processing (ULSI)	AI systems, supercomputers



The five generations of computers.

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1st – vacuum tubes
Huge, very hot, used much power, often failed. Machine language only. Punched cards for input.

2nd – transistors
Smaller, cooler and more reliable. Assembly language and early high level languages (FORTRAN, COBOL). Magnetic core memory.

3rd – integrated circuits
Many transistors on one silicon chip. Keyboards, monitors and operating systems; many users at once.

4th – microprocessors
The whole CPU on one chip (VLSI). Personal computers, GUIs, networks and the Internet.

5th – AI and parallel
Artificial intelligence, parallel processing, natural language and voice. ULSI chips. Still developing.

3. Evolution of processors

A **microprocessor** is a CPU built on one chip. The first was the **Intel 4004 (1971)**. Since then the number of **transistors**, the **word size** (bits handled at once) and the **clock speed** have grown, and now one chip has several **cores**.

Year	Processor	Word size	Transistors
1971	Intel 4004	4-bit	2,300
1974	Intel 8080	8-bit	4,500
1978	Intel 8086	16-bit	29,000
1985	Intel 80386	32-bit	275,000
1993	Intel Pentium	32-bit	3.1 million
2006	Intel Core 2 Duo	64-bit, 2 cores	291 million
2020	Apple M1	64-bit, 8 cores	16 billion

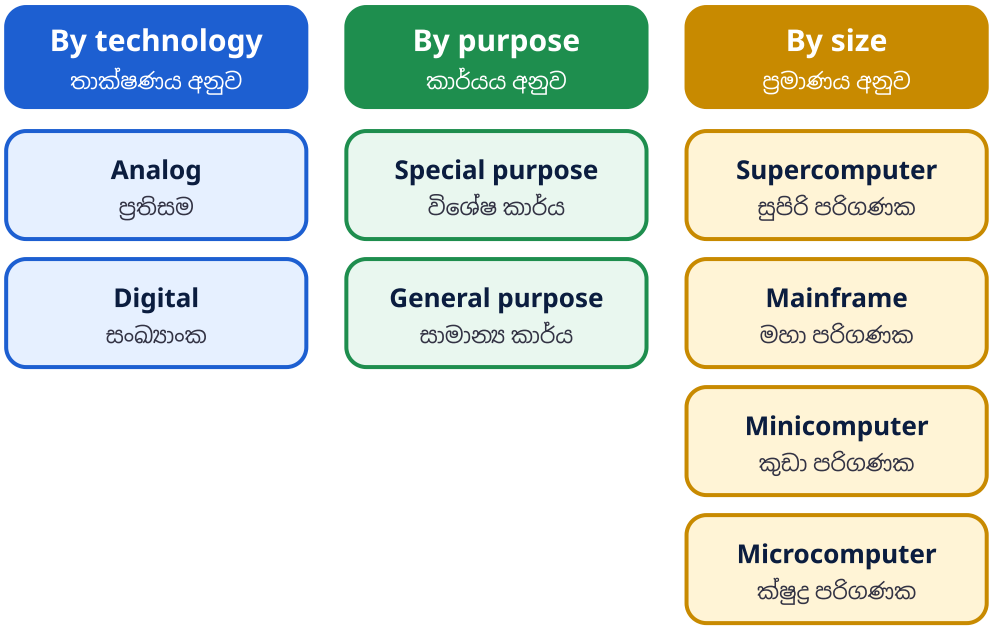
Moore's law (Gordon Moore, 1965): the number of transistors on a chip doubles about every two years.

🧱 **Worked example: Moore's law: the Intel 4004 (1971) had about 2,300 transistors. If the count doubles every 2 years, how many transistors would a chip have in 2011?**
Years = 2011 − 1971 = 40. Doublings = 40 ÷ 2 = 20. Count = 2,300 × 2^20 = 2,300 × 1,048,576 = **2,411,724,800** (about 2.4 billion). Real chips in 2011 had about 2.3 billion – the law worked well.

🧱 **Worked example: The Intel 4004 ran at 740 kHz. A modern core runs at 3.7 GHz. How many times faster is the clock?**
3.7 GHz = 3,700,000,000 Hz; 740 kHz = 740,000 Hz. 3,700,000,000 ÷ 740,000 = **5,000 times**.

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4. Classification of computers



Three ways to classify computers.

4.1 By technology: analog and digital

Feature	Analog computer	Digital computer
Data	Continuous values (voltage, pressure, temperature)	Discrete values – digits 0 and 1
Accuracy	Lower – an approximate reading	High – exact digits
Memory	Little or none	Large memory
Examples	Slide rule, analog speedometer, differential analyser	PC, laptop, smartphone

> 💡 A **hybrid computer** joins both: for example a hospital ICU monitor measures the heart (analog) and shows numbers and stores records (digital).

4.2 By purpose: special purpose and general purpose

- **Special purpose** – made for one job only, with a fixed program. Examples: washing machine controller, traffic light controller, ATM, car engine computer, digital camera.
- **General purpose** – can do many different jobs by loading different programs. Examples: desktop PC, laptop, smartphone.

4.3 By size: super, mainframe, mini and micro

Type	Size and power	Users	Uses
Supercomputer	Fastest; thousands of processors working in parallel	Research teams	Weather forecasting, climate, space, nuclear research, AI training

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Mainframe	Very large and reliable; huge storage	Hundreds or thousands at once	Banks, airlines, insurance, government records
Minicomputer (mid-range)	Smaller than a mainframe	Tens of users	A department, small business, factory control
Microcomputer	Small; one microprocessor	Usually one user	Desktop, laptop, smartphone, tablet, phablet

Mobile microcomputers: a **smartphone** is a phone with a full operating system and apps; a **tablet** is a flat touch-screen computer, usually 7 to 13 inches, often without phone calls; a **phablet** is a large smartphone (about 6 to 7 inches) – between a phone and a tablet.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* **ARM and Apple silicon.** In 2026 most phones, tablets and many laptops use **ARM** processors, which give good speed with low power. Apple's M-series chips (M1 in 2020, now M4 and newer) put the CPU, GPU, AI engine and memory in one package called a **system on a chip (SoC)**. **Quantum computers** are a new idea: they use **qubits** that can be 0 and 1 at the same time (superposition). Companies like IBM and Google have chips with over 100 qubits, but they are still experimental and need very cold temperatures.

Key Words

Abacus – An early hand-moved calculating aid with beads on rods.

Pascaline – A mechanical adding machine with gear wheels made by Pascal in 1642.

Analytical Engine – Babbage's planned machine with input, store, mill and output.

Electro-mechanical – Machines that use electric relays and motors to move mechanical parts.

Vacuum tube – The switching part of first generation computers.

Transistor – A small semiconductor switch used from the second generation.

Integrated circuit – Many transistors made together on one silicon chip.

Microprocessor – A complete CPU on a single chip.

Moore's law – Transistors on a chip double about every two years.

Analog computer – A computer that works with continuous values.

Digital computer – A computer that works with discrete digits 0 and 1.

Special purpose computer – A computer built for one fixed job.

Supercomputer – The fastest type, used for huge scientific calculations.

Mainframe – A large reliable computer serving thousands of users at once.

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Phablet – A large smartphone between a phone and a tablet in size.

Sample Q&A

1. Name two mechanical calculating aids and give one fact about each.

> **Answer:** Pascaline (1642, Blaise Pascal) – gear wheels that add and subtract. Analytical Engine (1837, Charles Babbage) – had input, store, mill and output, like a modern computer.

2. What is the main technology of each computer generation?

> **Answer:** 1st vacuum tubes; 2nd transistors; 3rd integrated circuits; 4th microprocessors (VLSI); 5th AI and parallel processing (ULSI).

3. Give three problems of first generation computers.

> **Answer:** They were very large, produced a lot of heat and used much electricity; vacuum tubes failed often; they could be programmed only in machine language.

4. Distinguish analog and digital computers.

> **Answer:** An analog computer works with continuous values such as voltage and gives approximate results. A digital computer works with discrete digits 0 and 1 and gives exact results.

5. Why is a washing machine controller a special purpose computer?

> **Answer:** It is built to do only one job – control washing – with a fixed program that the user cannot change.

6. Which type of computer would a bank use for all its accounts, and why?

> **Answer:** A mainframe, because it is very reliable, stores huge amounts of data and serves thousands of users and transactions at the same time.

MCQ

1. Which calculating aid was made by Blaise Pascal in 1642?

A. Napier’s bones
B. Abacus
C. Pascaline
D. ENIAC
E. Analytical Engine

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2. Who is called the “father of the computer”?

A. John Napier
B. Herman Hollerith
C. Blaise Pascal
D. Gordon Moore
E. Charles Babbage

3. Hollerith’s tabulating machine (1890) is an example of a:

A. Electro-mechanical machine
B. Fourth generation computer
C. Quantum computer
D. Fully electronic computer
E. Purely mechanical aid

4. Which generation used transistors as the main part?

A. Third
B. Fourth
C. Fifth
D. Second
E. First

5. The first microprocessor, the Intel 4004, was released in:

A. 1946
B. 1981
C. 1971
D. 1956
E. 1964

6. Integrated circuits are the main technology of the:

A. Second generation
B. Third generation
C. First generation
D. Mechanical era
E. Fifth generation

7. Using Moore’s law, 2,300 transistors in 1971 becomes about how many in 2011?

A. About 2.4 billion
B. About 2.4 million
C. About 92,000
D. About 24 billion
E. About 46,000

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8. Which is an analog device?

A. A calculator app
B. A laptop
C. A slide rule
D. A digital watch
E. A smartphone

9. A traffic light controller is best described as a:

A. Supercomputer
B. Mainframe
C. Analog slide rule
D. General purpose computer
E. Special purpose computer

10. Weather forecasting for a whole country needs a:

A. Tablet
B. Supercomputer
C. Minicomputer
D. Washing machine controller
E. Phablet

11. A smartphone with a 6.7-inch screen is often called a:

A. Mainframe
B. Analog computer
C. Plotter
D. Minicomputer
E. Phablet

12. Which statement about fourth generation computers is TRUE?

A. They began in 1946
B. They use only machine language
C. They have no operating system
D. The whole CPU is on one chip
E. They use vacuum tubes

13. Which term means: “An early hand-moved calculating aid with beads on rods”?

A. Transistor
B. Microprocessor
C. Analytical Engine
D. Abacus
E. Digital computer

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14. Which term means: “A mechanical adding machine with gear wheels made by Pascal in 1642”?

A. Pascaline
B. Special purpose computer
C. Moore’s law
D. Electro-mechanical
E. Integrated circuit

15. Which term means: “Babbage’s planned machine with input, store, mill and output”?

A. Analytical Engine
B. Vacuum tube
C. Analog computer
D. Supercomputer
E. Microprocessor

16. Which term means: “Machines that use electric relays and motors to move mechanical parts”?

A. Moore’s law
B. Transistor
C. Mainframe
D. Digital computer
E. Electro-mechanical

17. Which term means: “The switching part of first generation computers”?

A. Analog computer
B. Vacuum tube
C. Phablet
D. Special purpose computer
E. Integrated circuit

18. Which term means: “A small semiconductor switch used from the second generation”?

A. Abacus
B. Microprocessor
C. Transistor
D. Digital computer
E. Supercomputer

19. Which term means: “Many transistors made together on one silicon chip”?

A. Special purpose computer
B. Integrated circuit
C. Pascaline
D. Mainframe
E. Moore’s law

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20. Which term means: "A complete CPU on a single chip"?

A. Supercomputer
B. Phablet
C. Analytical Engine
D. Microprocessor
E. Analog computer

Structured Questions

1. (a) Name the main technology of the first three computer generations. (b) Give one advantage of each new generation over the one before. *(5 marks)*

> (a) 1st vacuum tubes; 2nd transistors; 3rd integrated circuits; (b) transistors were smaller, cooler and more reliable than tubes; ICs put many transistors on one chip, so computers became smaller and cheaper.

2. Arrange these in time order and name the type (mechanical, electro-mechanical or electronic): ENIAC, Pascaline, Harvard Mark I, Abacus. *(4 marks)*

> Abacus – mechanical (hand); Pascaline 1642 – mechanical; Harvard Mark I 1944 – electro-mechanical; ENIAC 1946 – electronic.

3. Use Moore's law to estimate the transistors on a chip in 2011 if the Intel 4004 of 1971 had 2,300. Show your working. *(3 marks)*

> 40 years ÷ 2 = 20 doublings; 2^20 = 1,048,576; 2,300 × 1,048,576 = 2,411,724,800 (about 2.4 billion).

4. (a) Distinguish special purpose and general purpose computers with one example each. (b) Is an analog speedometer digital or analog? Why? *(3 marks)*

> Special purpose – one fixed job, e.g. ATM; general purpose – many jobs with different programs, e.g. a PC; (b) analog – the needle shows a continuous value.

5. Suggest the most suitable computer type for each and give a reason: (a) a national bank (b) climate research (c) a student doing homework. *(3 marks)*

> (a) Mainframe – reliable, thousands of users at once; (b) supercomputer – fastest for huge calculations; (c) microcomputer such as a laptop or tablet – cheap, one user.

Summary

- Aids went from mechanical (abacus, Pascaline, Babbage) to electro-mechanical (Hollerith, Mark I) to electronic (ENIAC).

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- Generations: vacuum tubes → transistors → ICs → microprocessors → AI and parallel processing.
- Processors grew from the 4-bit Intel 4004 (1971) to 64-bit multi-core chips; Moore's law – transistors double every two years.
- By technology: analog (continuous) or digital (0 and 1).
- By purpose: special purpose (one job) or general purpose (many jobs).
- By size: super, mainframe, mini and micro – micro includes smartphones, tablets and phablets.

MCQ answer key – 2.1

1. **C** – Pascal's gear adding machine.
2. **E** – He designed the Analytical Engine.
3. **A** – Electric parts read punched cards.
4. **D** – 1956–1963.
5. **C** – It began the fourth generation.
6. **B** – 1964–1971, e.g. IBM System/360.
7. **A** – 20 doublings: 2,300 × 1,048,576.
8. **C** – Continuous scales.
9. **E** – One fixed job.
10. **B** – Huge calculations.
11. **E** – Phone + tablet.
12. **D** – Microprocessor = CPU on a chip.
13. **D** – Abacus – An early hand-moved calculating aid with beads on rods.
14. **A** – Pascaline – A mechanical adding machine with gear wheels made by Pascal in 1642.
15. **A** – Analytical Engine – Babbage's planned machine with input, store, mill and output.
16. **E** – Electro-mechanical – Machines that use electric relays and motors to move mechanical parts.
17. **B** – Vacuum tube – The switching part of first generation computers.
18. **C** – Transistor – A small semiconductor switch used from the second generation.
19. **B** – Integrated circuit – Many transistors made together on one silicon chip.
20. **D** – Microprocessor – A complete CPU on a single chip.

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