CSN-101 (Introduction to Computer Science and Engineering)

Lecture 6: Evolution of Computer Hardware, Moore's Law

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Piazza Class Room: https://piazza.com/iitr.ac.in/fall2019/csn101

[Access Code: csn101@2019]

Moodle Submission Site: https://moodle.iitr.ac.in/course/view.php?id=45

[Enrollment Key: csn101@2019]

Plan for Lecture Classes in CSN-101 (Autumn, 2019-2020)

Week	Lecture 1 (Monday 4-5 PM)	Lecture 2 (Friday 5-6 PM)
1	Evolution of Computer Hardware and Moore's Law, Software and Hardware in a Computer	Computer Structure and Components, Operating Systems
2	Computer Hardware: Block Diagrams, List of Components	Computer Hardware: List of Components, Working Principles in Brief, Organization of a Computer System
3	Linux OS	Linux OS
4	Writing Pseudo-codes for Algorithms to Solve Computational Problems	Writing Pseudo-codes for Algorithms to Solve Computational Problems
5	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms
6	C Programming	C Programming
7	Number Systems: Binary, Octal, Hexadecimal, Conversions among them	Number Systems: Binary, Octal, Hexadecimal, Conversions among them
8	Number Systems: Negative number representation, Fractional (Real) number representation	Boolean Logic: Boolean Logic Basics, De Morgan's Theorem, Logic Gates: AND, OR, NOT, NOR, NAND, XOR, XNOR, Truth-tables
9	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput
10	Different layers of networking, Network components, Type of networks	Network topologies, MAC, IP Addresses, DNS, URL
11	Different fields of CSE: Computer Architecture and Chip Design	Different fields of CSE: Data Structures, Algorithms and Programming Languages
12	Different fields of CSE: Database management	Different fields of CSE: Operating systems and System softwares
13	Different fields of CSE: Computer Networking, HPCs, Web technologies	Different Applications of CSE: Image Processing, CV, ML, DL
14	Different Applications of CSE: Data mining, Computaional Geometry, Cryptography, Information Security	Different Applications of CSE: Cyber-physical systems and IoTs

The Word - Computer

- The word "computer" was first recorded in 1613
- Originally used to describe a human who performed calculations or computations
- This definition remained same until the end of the 19th century, when the industrial revolution gave rise to machines whose primary purpose was calculating

Introduction

Today's Scenario:

personal computer > computer
(2017, $500) (1985, 1 million dollars)

Mainly in terms of:
1. Performance
2. Main memory
3. Disk storage

Introduction

Contd.

Reason???

- Advances in the technology used to build computers
- Innovation in computer design.

Introduction

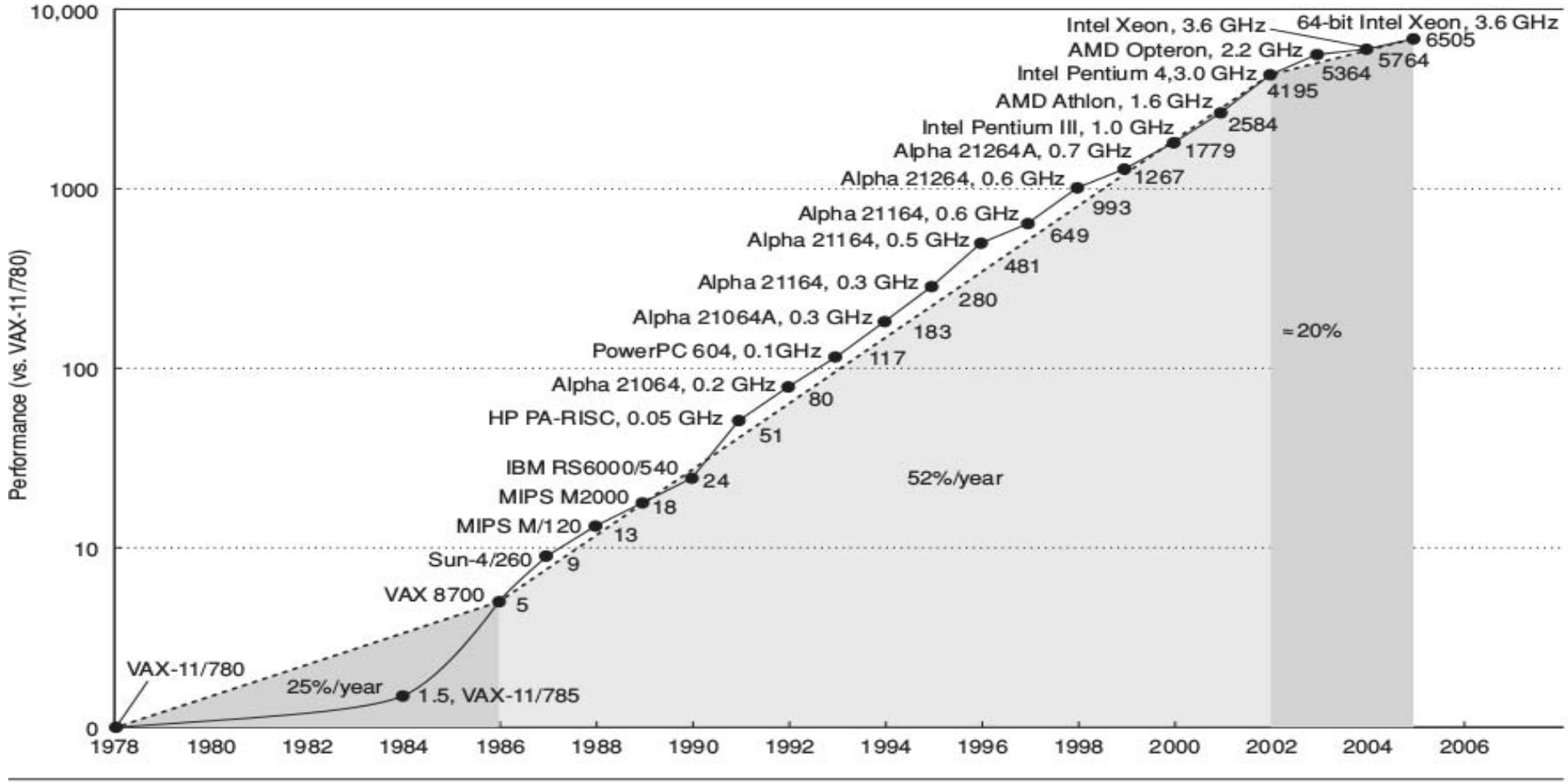
Contd.

Major Factors

- Emergence of the microprocessor (1970s)
- Improvements in IC technology

Introduction

Contd



Growth in processor performance since the mid-1980s. This chart plots performance relative to the VAX 11/780

Introduction

Contd..

- Since 2002, processor performance improvement dropped to about 20% per year
- Lead to the use of multiple processors per chip rather than via faster uniprocessors.
- Adoption of parallelism

Classes of Computers

- 1960s, large mainframes:

- Costing millions of dollars
- Stored in computer rooms with multiple operators overseeing their support
- Mainly for business data processing and large-scale scientific computing

Classes of Computers

contd

1970s, Minicomputers:

1) A smaller-sized computer

2) Focused on applications in scientific Laboratories

3) Mainly for business data processing and large-scale scientific computing

Classes of Computers

contd

- 1970s, Supercomputers:

  1) High-performance computers for Scientific computing

  2) Pioneered innovations that later trickled down to less expensive computer classes

- 1980s, Desktop computers:

  1) Based on microprocessors

  2) In form of both personal computers and workstations

Classes of Computers

contd

- 1990s:
  1) Internet and the World Wide Web

  2) First successful handheld computing devices: Personal Digital Assistant (PDA)

  3) emergence of high-performance digital consumer electronics: video games to set-top boxes.

- Extraordinary popularity of cell phones has been obvious since 2000

Classes of Computers

contd.

Feature	Desktop	Server	Embedded
Price of system	$500–$5000	$5000–$5,000,000	$10–$100,000 (including network routers at the high end)
Price of microprocessor module	$50–$500 (per processor)	$200–$10,000 (per processor)	$0.01–$100 (per processor)
Critical system design issues	Price-performance, graphics performance	Throughput, availability, scalability	Price, power consumption, application-specific performance

A summary of the three mainstream computing classes and their system characteristics.

Desktop Computing

- Largest market in dollar terms
- Low-end systems selling under $500
- Heavily configured workstations in range of $5000
- driven to optimize price performance.
- Highest-performance microprocessors and cost-reduced microprocessors

Servers

- To provide larger-scale and more reliable file and computing services
- Backbone of large-scale enterprise computing
- Dependability is critical: may be operated
  seven days a week, 24 hours a day
- Scalability is must: should accommodate increase in demand

Servers

contd.

- Efficient throughput: transactions per minute or Web pages served per second
- Overall efficiency: determined by how many requests can be handled in a unit Time
- Responsiveness to an individual request remains equally important

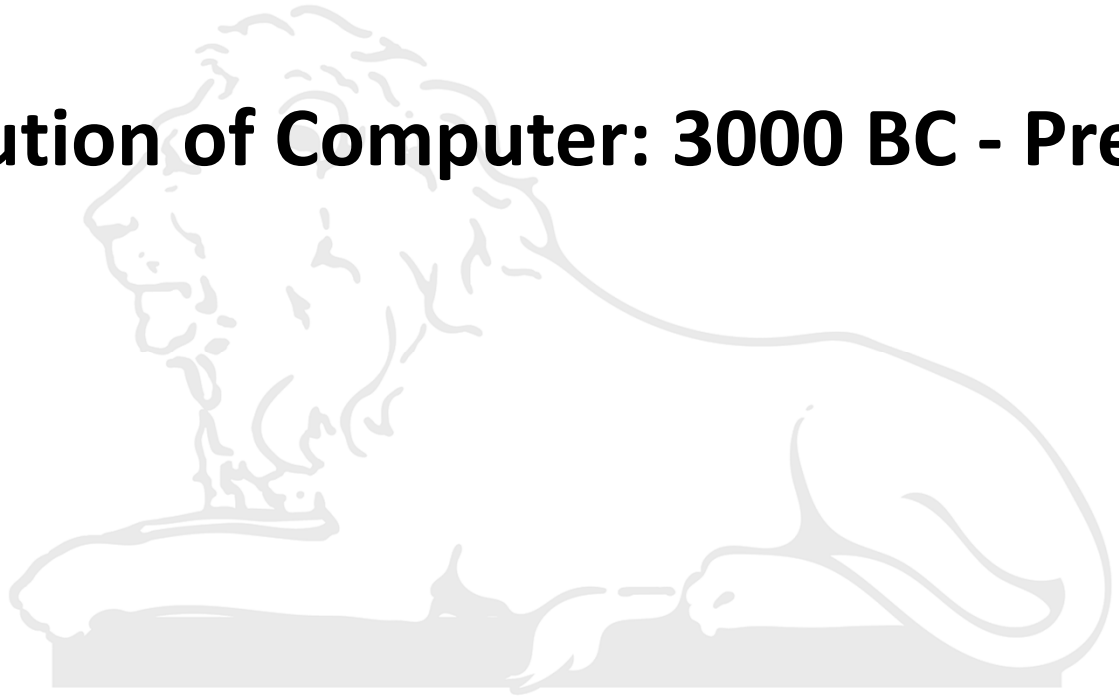
Embedded Computers

- Fastest growing portion of the computer market
- Devices include: microwaves, most washing machines, most printers, most networking switches, cell phones and smart cards, video games etc.
- Primary goal is meeting the performance need at a minimum price

Embedded Computers contd

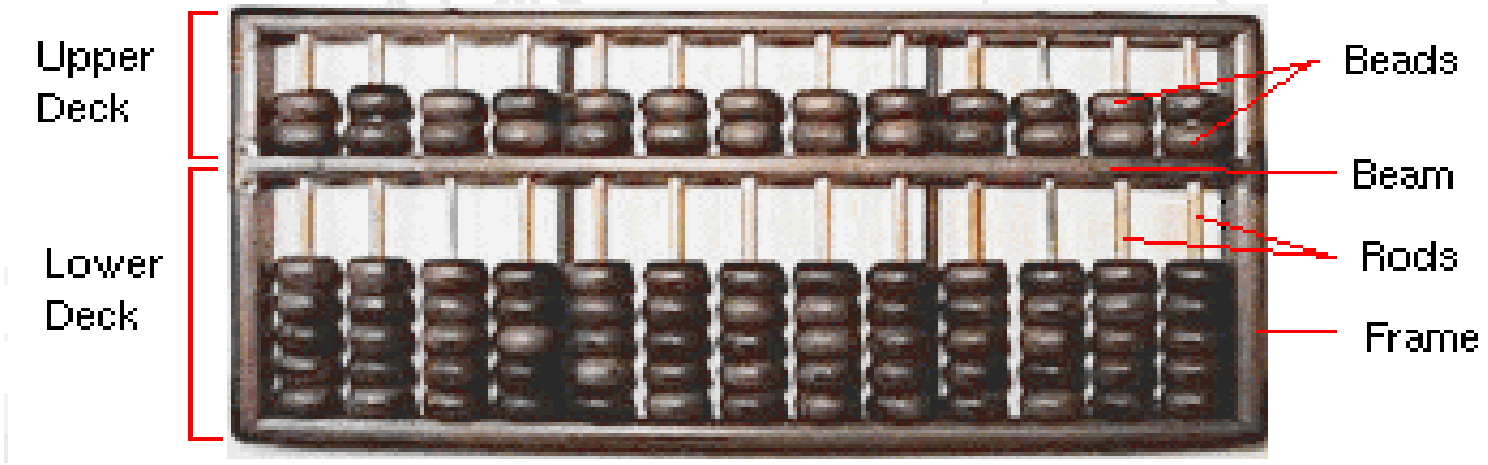
- Need to minimize memory and power
- Performance requirement is often real-time Execution
- Memory can be a substantial portion of the system cost

Evolution of Computer: 3000 BC - Present



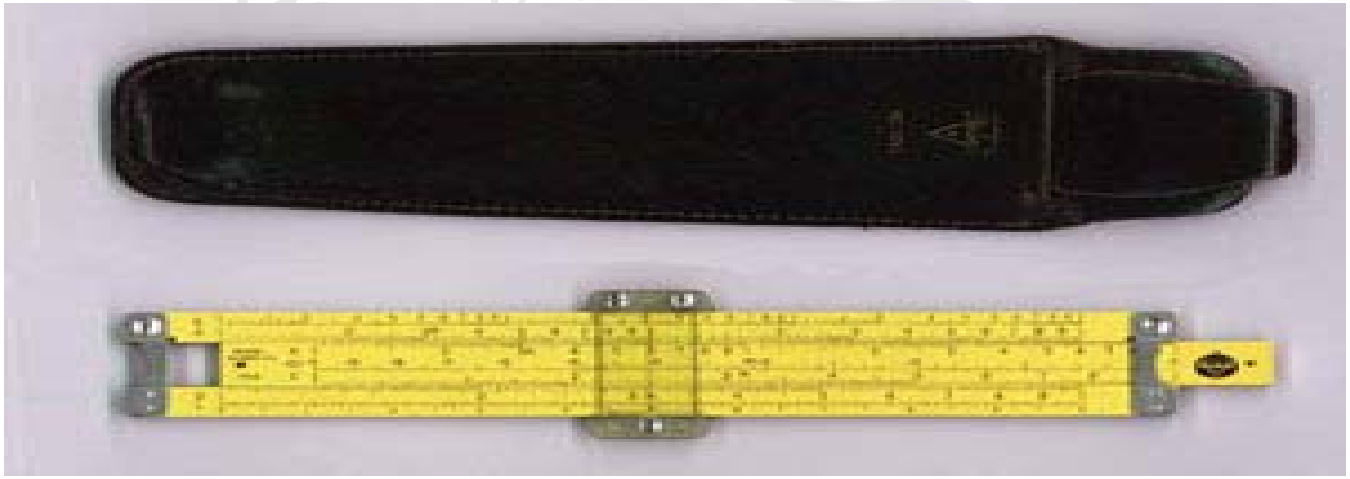
The Abacus

- Abacus also called as **counting frame**, is a calculating tool
- Used in Europe, China and Russia, centuries before the adoption of the written Hindu-Arabic numerical system
- Constructed as a bamboo frame with beads on rods



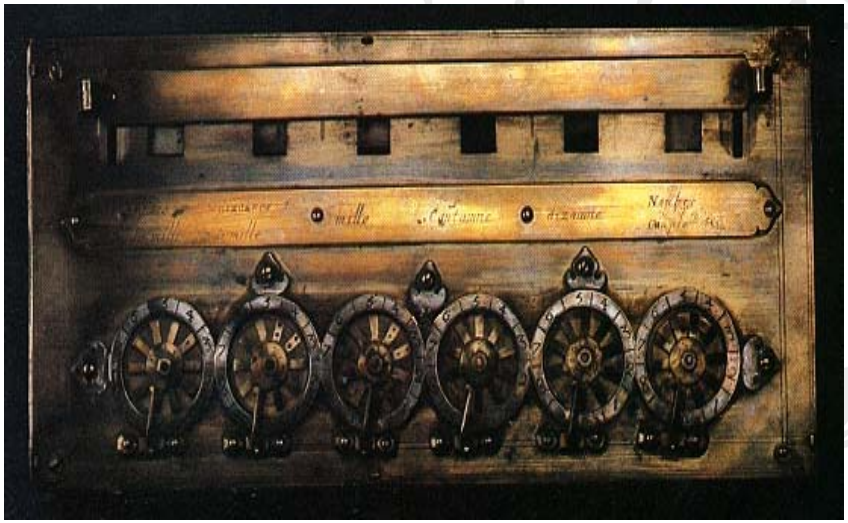
Slide Rule

- Slide Rule 1630
- Based on Napier's rules for logarithms
- Used until 1970s

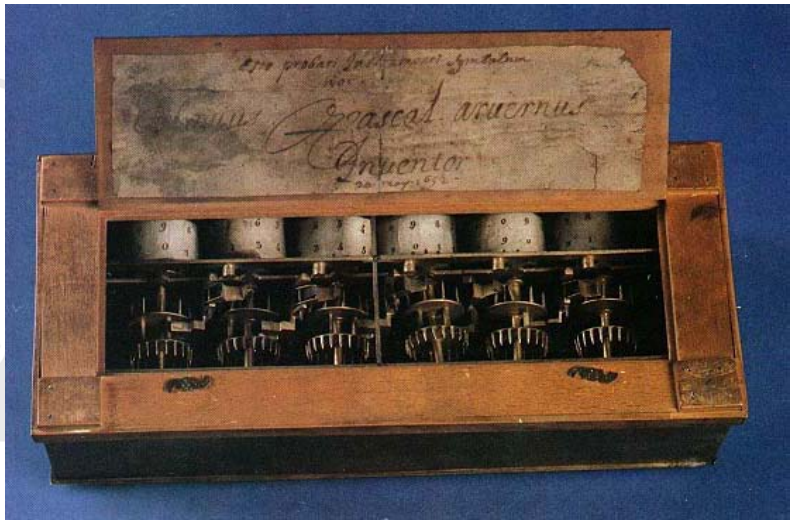


The Pascaline

- Invented by Blaise Pascal, circa 1642



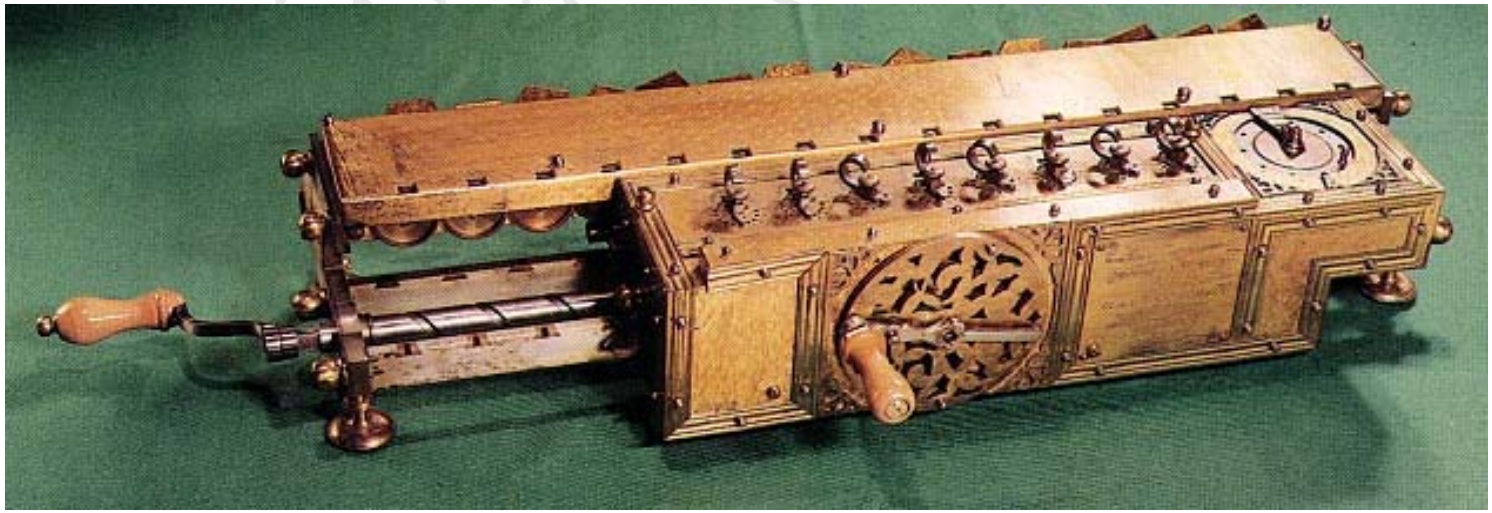
Front View



Inside Pascaline

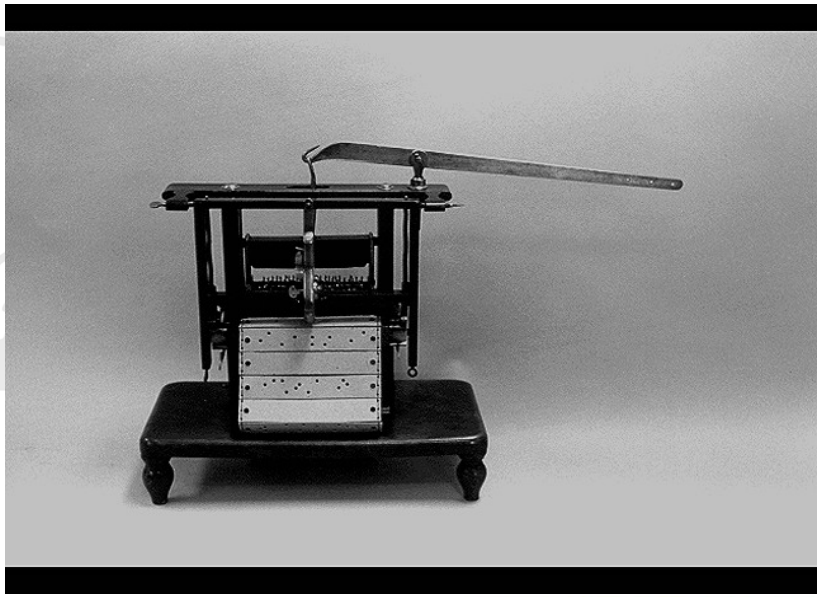
The Reckoner

- Gottfried Wilhelm Leibniz, circa 1700
- Build a four-function (addition, subtraction, multiplication, and division) calculator, called as ***stepped reckoner***



Jacquard Loom - 1801

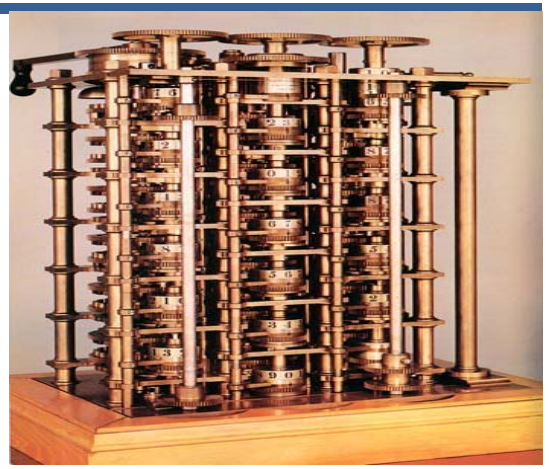
- Used metal cards with punched holes to guide weaving process
- 1st stored program - metal cards
- 1st computer manufacturing



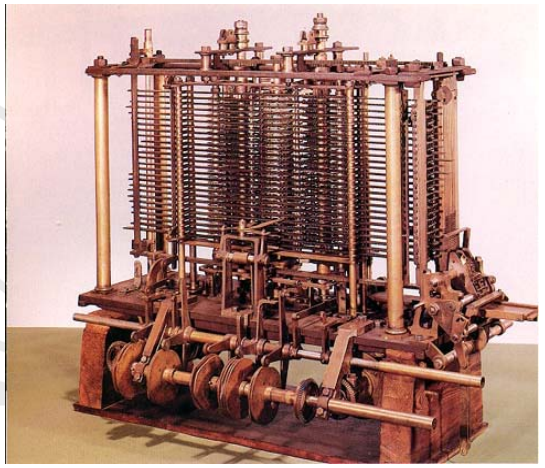
First mechanical computer or automatic computing engine

Charles Babbage:1792-1871

- Difference Engine 1822
  - 1st automatic computing machine
  - was capable of computing several sets of numbers
  - huge calculator - steam driven machine the size of a room

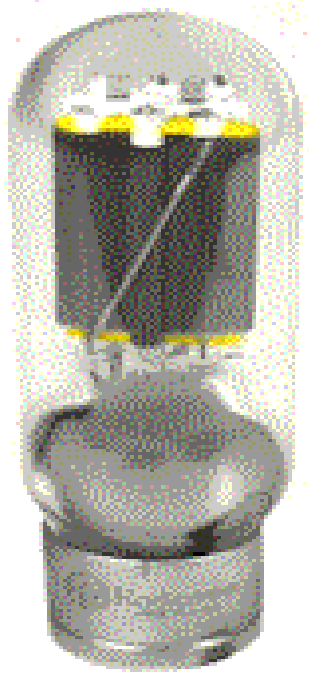


- Analytical Engine 1833
  - 1st general mechanical computer
  - large as a house and powered by 6 steam engines
  - Contained:
    - ALU
    - Basic flow control
    - Punch card (inspired by the Jacquard Loom)
    - Integrated memory



Vacuum Tubes - 1930 - 1950s

- **First Generation Electronic Computers** used Vacuum Tubes
- Vacuum tubes are glass tubes with circuits inside
- Vacuum tubes have no air inside of them, which protects the circuitry



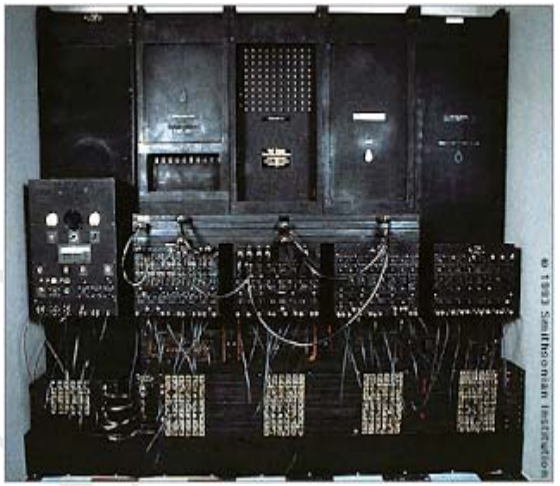
First Generation - 1930 - 1950s

- The first electronic computer was designed at Iowa State between 1939-1942
- Vacuum tube technology
- Unreliable
- Supported machine language only
- Very costly
- Generated a lot of heat
- Slow input and output devices
- Huge size
- Need of AC
- Non-portable
- Consumed a lot of electricity

ENIAC - 1946

- ENIAC (***E****lectronic* ***N****umerical* ***I****ntegrator* ***A****nd* ***C****omputer)*
- Considered to be the first operational electronic digital computer in the United States

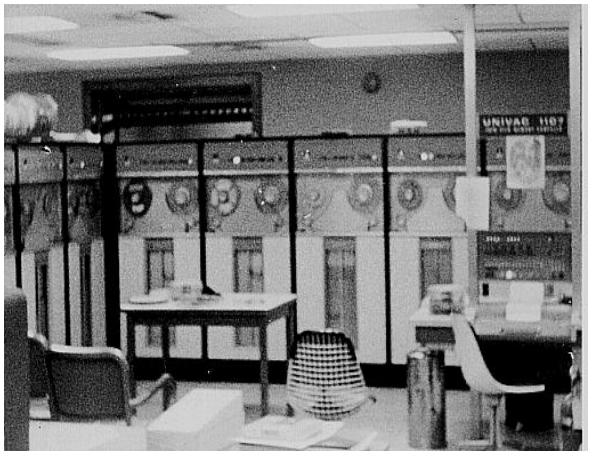
- Components:
  - 18000 vacuum tubes,
  - 7200 crystal diodes,
  - 1500 relays,
  - 70000 resistors,
  - 10000 capacitors and
  - around 5 million hand-soldered joints.



- Weighed nearly 30 tons and consumed 160 kW of power

UNIVAC - 1951

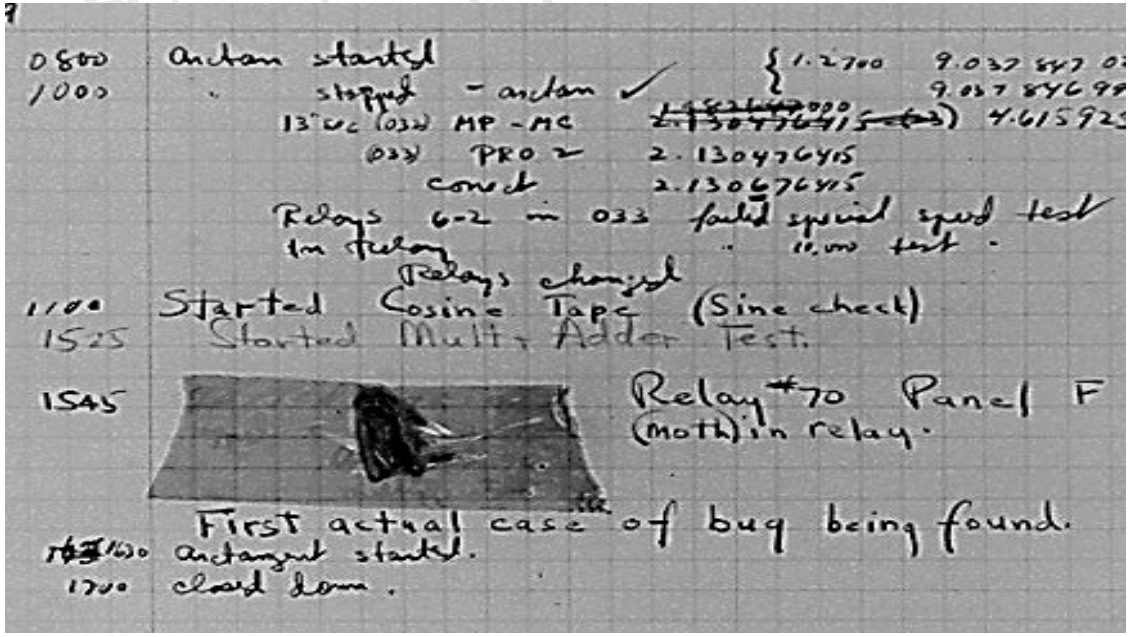
- UNIVAC (**UNIV**ersal **A**utomatic **C**omputer)
- 1st fully electronic **digital** computer built in the U.S
- Created at the University of Pennsylvania
- "a big pocket calculator"
- until 1970 was standard computer, but very expensive
- contained 18,000 vacuum tubes



- Grace Hopper programmed UNIVAC
- Recipient of Computer Science's first "Man of the Year Award"

First Computer Bug - 1945

- Grace Hopper found the 1st computer “bug”: a moth stuck in a relay responsible for a malfunction
- The word "bug" had been used to describe a defect since then
- Hopper worked to eliminate program faults called it debugging” a computer



First Computer Bug

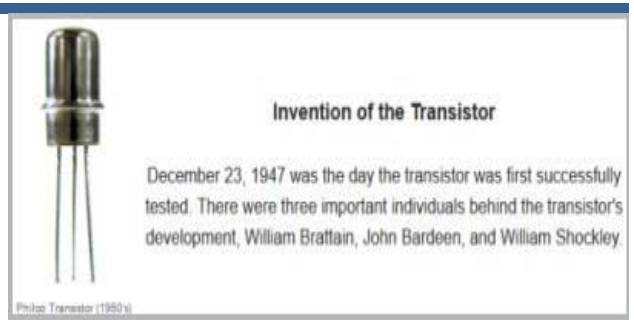
Second Generation – 1965-1963

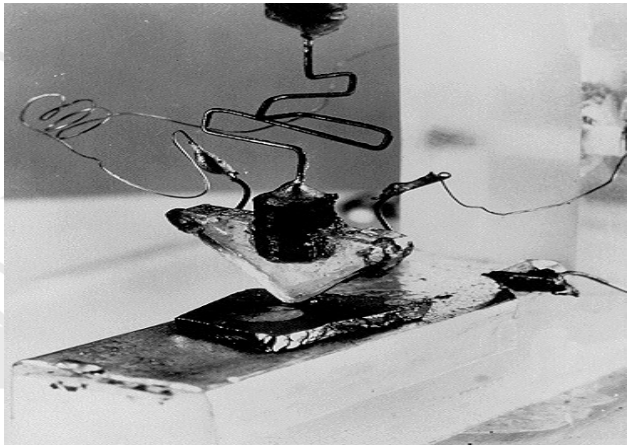
- 1956 – Computers began to incorporate ***Transistors***
- Replaced vacuum tubes with Transistors
- Smaller size, less heat generation, less electricity consumption as compared to first generation
- Faster than first generation computers
- Still very costly
- AC required
- Supported machine and assembly languages

- Some computers of this generation :
  - IBM 1620, IBM 7094, CDC 1604, CDC 3600, ATLAS

Transistor

- Invented at Bell Labs in 1947 by three scientists
- 1956 – Computers began to incorporate ***Transistors***
- Replaced vacuum tubes with Transistors
- won a Nobel prize
- on-off switch
- A small device made up of semiconductor material like germanium and silicon





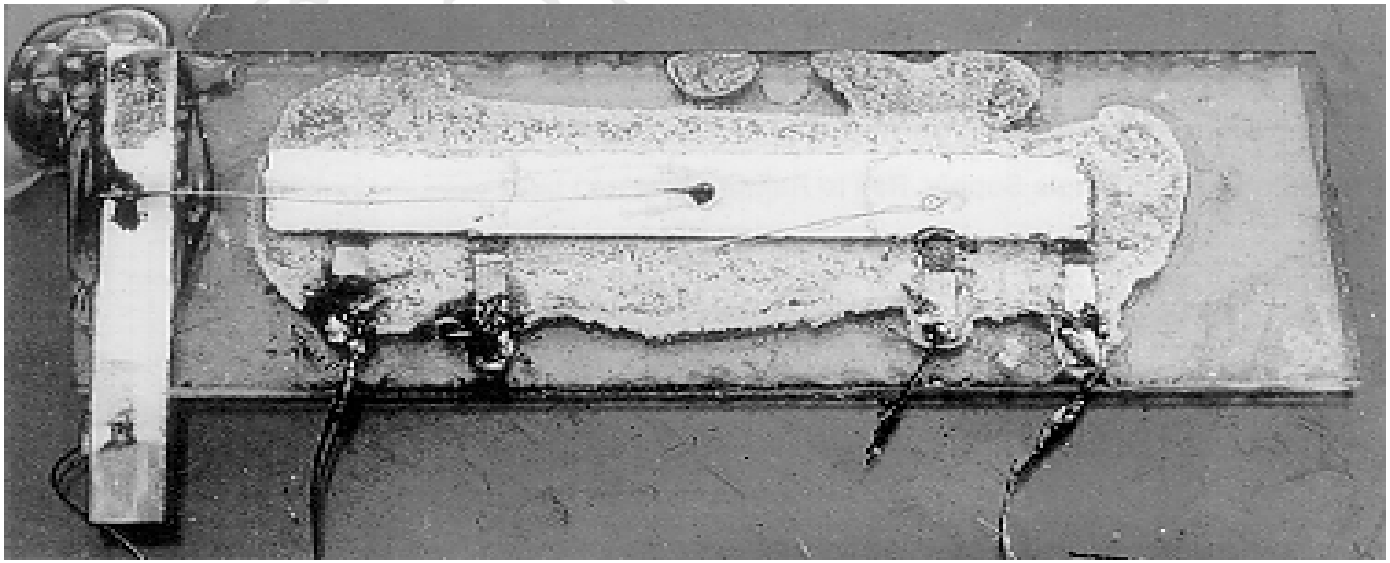
Third Generation – 1964-1971

- Integrated Circuit
- Operating System
- Smaller size
- Generated less heat
- Faster
- Lesser maintenance
- Costly

- Some computers of this generation were:
  - IBM-360 series, Honeywell-6000 series, PDP (Personal Data Processor), IBM-370/168, TDC-316

Integrated Circuits

- In 1958, Jack St. Clair Kilby of Texas Instruments demonstrated the first integrated circuit
- Integrated Circuits are transistors, resistors, and capacitors integrated together into a single



The first working integrated circuit by Jack Kilby. It contains a single transistor and supporting components on a slice of germanium and measures 1/16 by 7/16 inches (1.6 x 11.1 mm)

Continued to Next Class…