

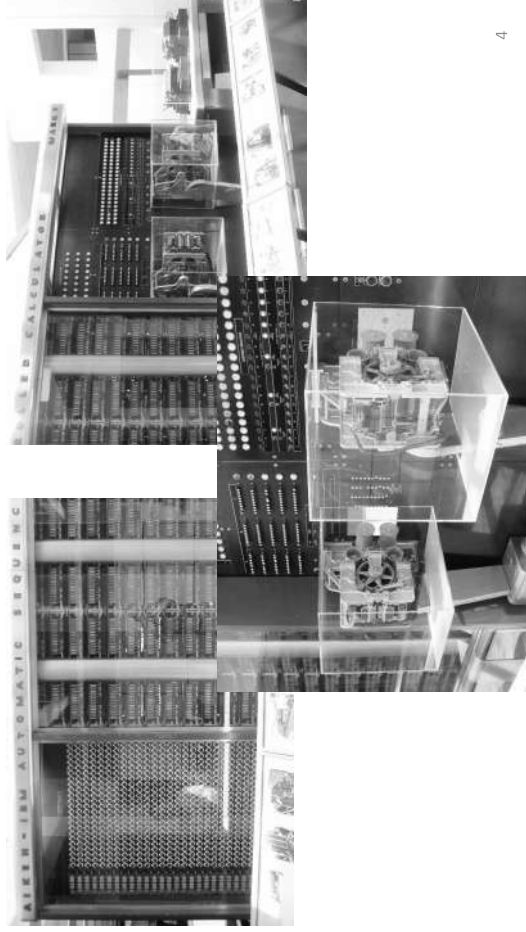
Course introduction

- **Objective 1:** Know the basic composition of computers and the characteristic of Von•Neumann computer.
- **Objective 2 :** Grasp the expressions of fixed-point and floating-point in the computer, operating principles of basic computing and hardware implementation.
- **Objective 3 :** Master order formats and common addressing modes in the instruction system.
- **Objective 4 :** Master the working principle and design methods of the single-cycle data path and control components, and the implementation theory of combinatorial logic and micro-program control.
- **Objective 5 :** Master the operating principle and composition structure of memory hierarchy.
- **Objective 6 :** Master the characteristics of the basic I/O device, the operating principle of the system and the classification of the bus.

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Mark I (Harvard) – IBM (ASCC) Automatic Sequence Controlled Calculator

- “the beginning of the era of the modern computer” and “the real dawn of the computer age”.



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Principles of Computer Organization

Course introduction

- Credit hours: 48
- Credit: 3
- Grading
 - Attendance 10%
 - Homework 20%
 - Final exam 70%

• Textbooks/Materials

- 《计算机组成原理》（第四版），蒋本珊编著，清华大学出版社，2019年出版
- 计算机组成与设计：硬件/软件接口（原书第5版•ARM版），[美]戴维A.帕特森，[美]约翰 L. 著，机械工业出版社，ISBN: 9787111668350



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Electronic Computers -- Generation 1

- Dominant technologies(主导技术, 核心技术):
 - Processors: Vacuum tubes
 - Memory: Acoustic delay line(声波延迟线), magnetic drum(磁鼓)
- Special-purpose system
 - John Atanasoff's experimental machine
 - Colossus , (decrypt the German Enigma cipher)
 - Hoffman's computer (decrypt the Japanese Enigma cipher)
- Programmable systems
 - ENIAC I-IV
- Store-program systems
 - Experimental projects: EDVAC,
 - Commercial products: UNIVAC I, IBM701, 704(fp hardware)

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ENIAC-I 1st electronic general-purpose computer

- Electronic Numerical Integrator(积分器) And Computer
 - J. Presper Eckert and John Mauchly
 - University of Pennsylvania
 - Trajectory tables for weapons
 - Started 1943, Finished 1946, Used until 1955
- ENIAC-I details
 - Decimal (not binary)
 - 20 accumulators of 10 digits
 - Programmed manually by switches
 - 18,000 vacuum tubes
 - 30 tons
 - 15,000 square feet
 - 140 kW power consumption
 - 5,000 additions per second



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Mark I (Harvard) ASCC (IBM)

- 765,000 components and 500 miles (800 km) of wire with three million connections
- Volume of 51 feet (16 m) in length, eight feet (2.4 m) in height, and two feet (~61 cm) deep.
- Weight of about 10,000 pounds (4500 kg).
- The basic calculating units had to be synchronized mechanically, so they were run by a 50-foot (~15.5 m) shaft(轴) driven by a five-horsepower(马力) (4 kW) electric motor
- The industry's largest electromechanical(机电的) calculator

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Generations of Computer

- Generation 1: 1946-1957
 - Vacuum tube (真空管)
- Generation 2: 1958-1964
 - Transistor(晶体管) -
- Generation 3: 1965-1970
 - Small scale integration(集成, 一体化), Up to 100 devices on a chip(芯片)
 - Medium scale integration , 100-3,000 devices on a chip
- Generation 4: 1971-
 - Large scale integration , 3000 - 100000 devices on a chip
 - Very large scale integration , 100,000 - 100,000,000 devices on a chip, 1978-
 - Ultra large scale integration, Over 100,000,000 devices on a chip

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Electronic Computers -- Generation 2

• Dominant technologies

- Processors: Discrete transistors (分立元器件)
 - Replaced vacuum tubes
 - Smaller & Cheaper
 - Less heat dissipation
 - Solid State device
 - Made from Silicon (Sand)
 - Invented 1947 at Bell Labs
 - William Shockley et al.
- Memory: Magnetic cores

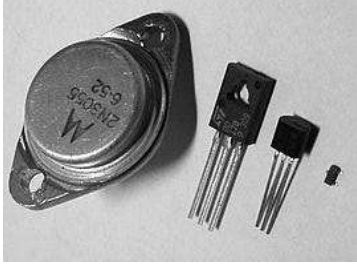
• General-purpose computers

- IBM System/360
- Minicomputers: Digital Equipment PDP-8

• Supercomputers

- Control Data 6600
 - Innovations: Load-store architecture, pipeline

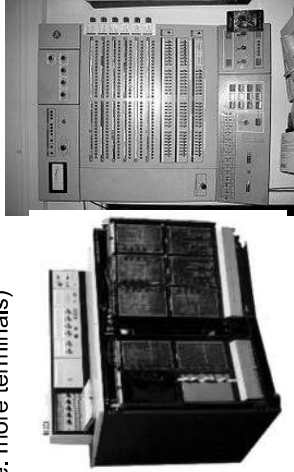
Assorted discrete transistors.
TO-3, TO-126, TO-92, SOT-23



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IBM 360 series

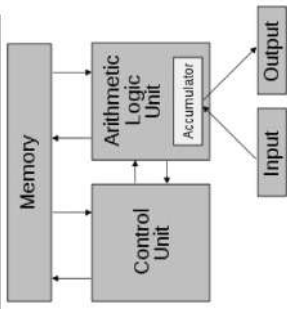
- 1964
- Replaced (& not compatible with) 7000 series
- First planned “family” of computers
 - Similar or identical instruction sets
 - Similar or identical O/S
 - Increasing speed
 - Increasing number of I/O ports (i.e. more terminals)
 - Increased memory size
 - Increased cost
- Multiplexed switch structure (多路复用的交换结构)



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Von Neumann/Turing

- “universal computing machine”, 1936, Alan Turing
- EDVAC 1944 (Eckert and Mauchly)
- First Draft of a Report on the EDVAC 1945, Von Neumann
 - Stored Program concept
 - Main memory storing programs and data
 - ALU operating on binary data
 - Control unit interpreting instructions from memory and executing
 - Input and output equipment operated by control unit



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1st Commercial Computers

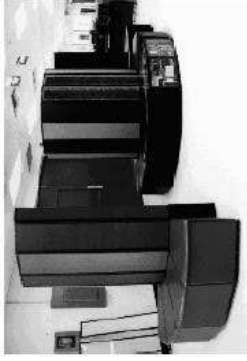
- 1947 - Eckert-Mauchly Computer Corporation
- UNIVAC I (Universal Automatic Computer)
- US Bureau of Census 1950 calculations
- Became part of Sperry-Rand Corporation
- Late 1950s - UNIVAC II
 - Faster
 - More memory



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Electronic Computers -- Generation 4

- Dominant technologies
 - Processors: Custom LSI or VLSI modules on PC board
 - Memory: SRAM, DRAM
- General-purpose computers
 - IBM 3xxx, 43xx series
 - Minicomputers: VAX8400
- Mini-supercomputers:
 - Convex C-1, C-2, C-3
- Vector supercomputers
 - Cray-2, Cray X-MP, Cray Y-MP
 - Fujitsu, Hitachi, NEC



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Electronic Computers -- Generation 4

- Dominant technologies
 - Processors: Mass-produced microprocessors
 - Memory: SRAM, DRAM
 - Compilers
- RISC processors
 - PA-RISC (Hewlett Packard)
 - SPARC (Sun Microsystems)
 - Alpha (Digital Equipment)
 - PowerPC (Apple, Motorola, IBM)
 - Motorola 88000
 - i860, i960 (Intel)
 - MIPS (Silicon Graphics) : 1981, John LeRoy Hennessy
 - ARM: 1983/1985, Roger Wilson 和 Steve Furber
 - RISC-V: 2010, David A. Patterson
- CISC processors:
 - 80x86, Pentium, Pentium Pro, Pentium II & III (Intel)

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DEC PDP-8

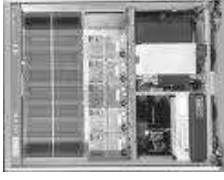
- 1964
- First minicomputer
- Did not need air conditioned room
- Small enough to sit on a lab bench
- \$16,000
 - \$100k+ for IBM 360
- Embedded applications & OEM (Original Equipment Manufacturer)
- BUS STRUCTURE



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Electronic Computers -- Generation 3

- Dominant technologies:
 - Processors: Integrated circuits (集成电路)
 - Memory:
 - Early: Magnetic cores
 - Later: Integrated circuits (SRAM, DRAM)
- General-purpose computers
 - Minicomputers: PDP-11, VAX11-780
 - IBM system/370
- Supercomputer s
 - Control Data 7600
 - Cray-1



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