Introduction

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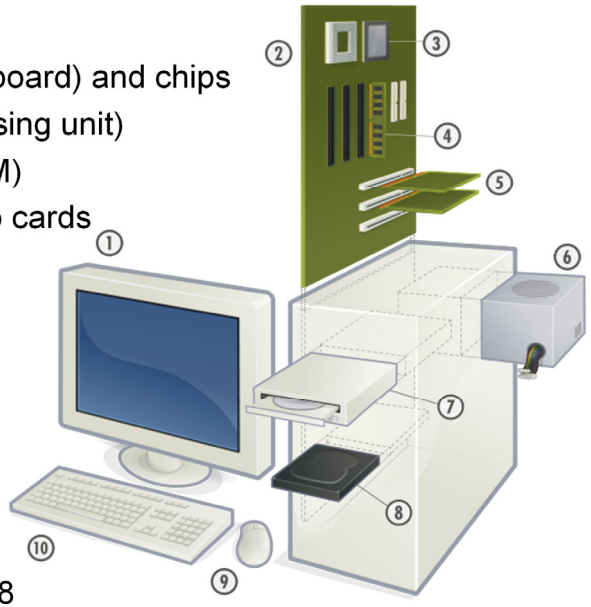
Some material from McGraw Hill

Logic Circuits

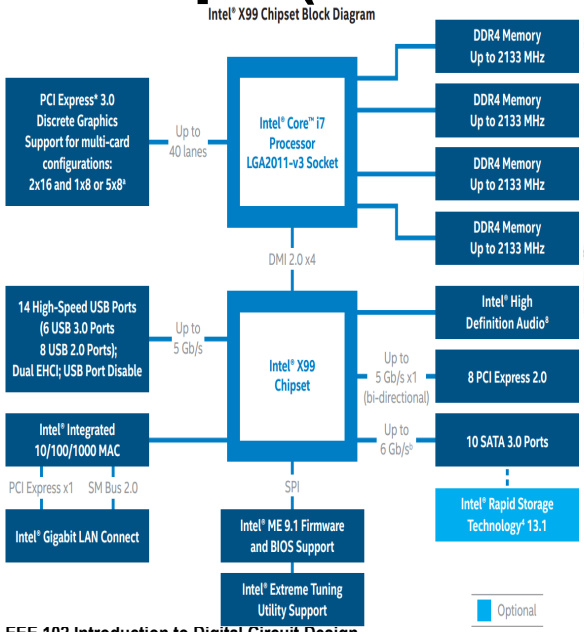
- **Logic circuits** are used to **build digital hardware** such as computers
- The name **digital** derives from the way in which information is represented in computers: **information is represented as electronic signals that correspond to digits of information**
- Until the 1960s logic circuits were constructed with discrete components: discrete electronics
- The **invention of integrated circuit in 1959 (Robert Noyce, Fairchild Semiconductor)** made it possible to place transistors and wires, and thus an entire circuit, on a single semiconductor chip
- In the beginning, these circuits had only a few transistors. But as the technology improved (technology scaling), the number of integrated transistors and wires became higher (Moore's Law): SSI to MSI to LSI to VLSI (to ULSI to GSI)

Desktop Computer Organization

- Components
  - (1) Monitor
  - (2) PCB (printed circuit board) and chips
  - (3) CPU (central processing unit)
  - (4) Main Memory (DRAM)
  - (5) Sound/network/video cards
  - (6) Power supply
  - (7) CD/DVD drive
  - (8) Hard drive
  - (9) Mouse
  - (10) Keyboard
- Component types
  - Processor: 3
  - Memory (storage): 4, 7, 8
  - Interconnection and input/output (I/O) devices: 1, 2, 5, 7, 9, 10



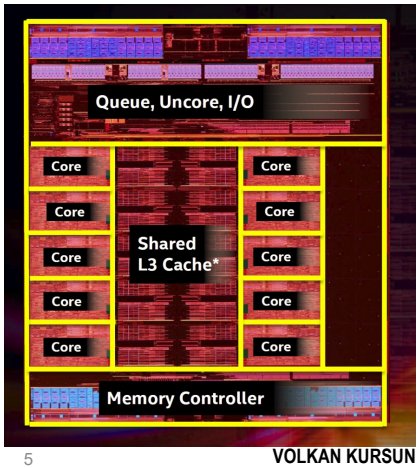
Desktop Computer Organization Example (Main PCB: Motherboard)



Central Processing Unit

- CPU in a desktop computer is a general-purpose processor
  - Designed to handle many different applications
- Is CPU the heart or the brain of a computer?
  - Implemented as an integrated circuit with many transistors
  - Example: Intel Core i7 has about 3.4 billion transistors

Intel Core i7 6950X Extreme Edition
14nm FinFET technology
3.4 billion transistors
10 cores
3.5GHz Max Turbo Frequency
10*256KiB L2 cache
25MiB L3 cache
140W

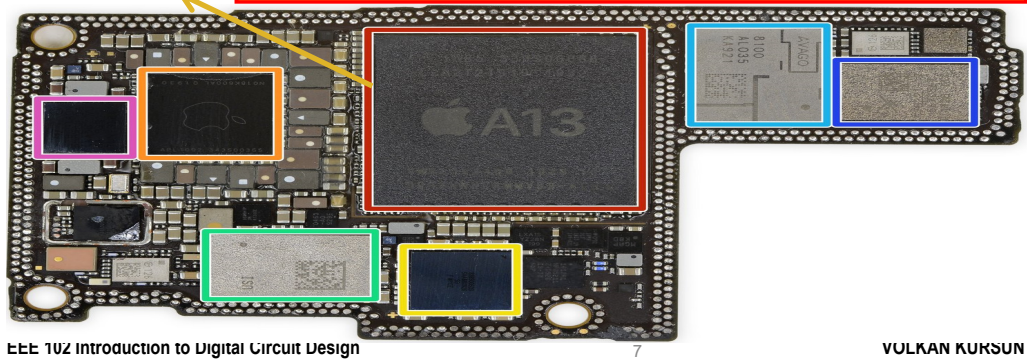


iPhone 11 ProMax Personal Mobile Device

Personal Mobile Computer Organization

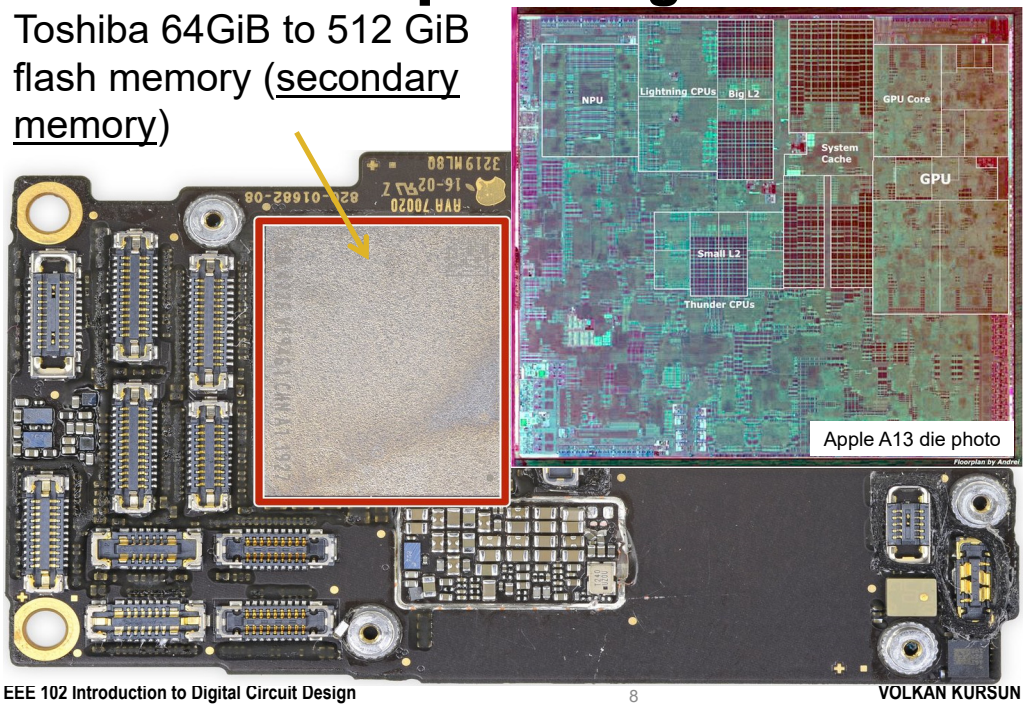
A13 SoC (TSMC 7nm FinFET technology, 8.5 billion transistors, ~98mm^2)

Hexa-core CPU 64-bit ARM ISA: 2 high-performance **cores** @ 2.66GHz + 4 energy-efficiency **cores** @ 1.73GHz
Integer ALUs: 6, **FP coprocessors**: 3
L1 instruction cache (per high-performance core): 128KiB
L1 data cache (per high-performance core): 128KiB
L2 cache (shared by high-performance cores): 8MiB
L1 instruction cache (per energy-efficiency core): 48KiB
L1 data cache (per energy-efficiency core): 48KiB
L2 cache (shared by energy-efficiency cores): 4MiB
System level cache (shared by all cores): 16MiB
4GiB LPDDR4X SK Hynix RAM (**main memory**) included in package



Mobile Computer Organization

Toshiba 64GiB to 512 GiB flash memory (secondary memory)



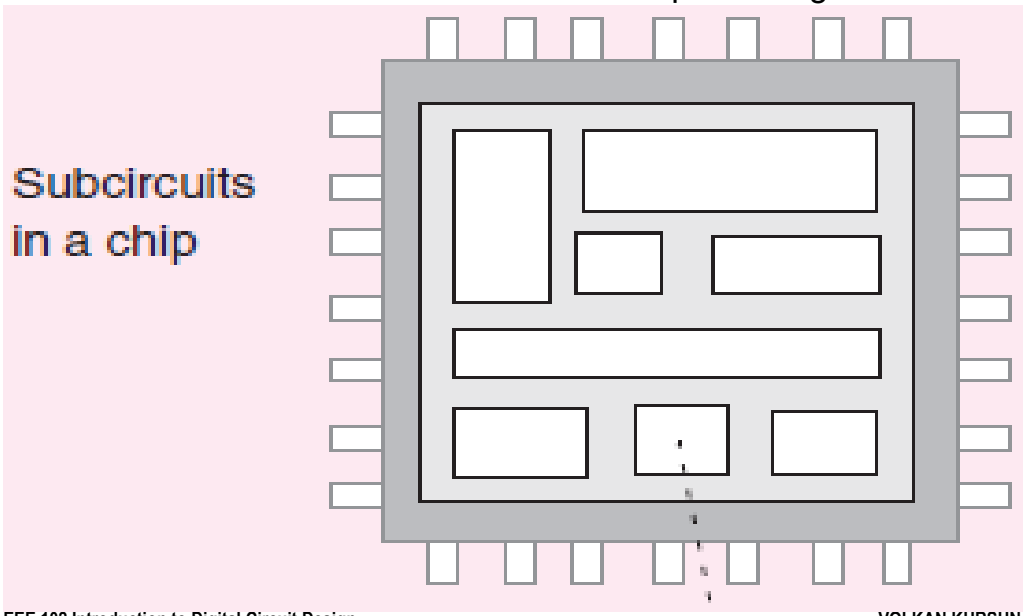
Integrated Circuits (IC) Technology

- Computers nowadays are much smaller, lighter, cheaper, faster, energy-efficient, reliable, and easier to use as compared to the early computers such as ENIAC

- All thanks to integrated electronics
  - Monolithic integration of many devices and wires on a small piece of silicon
  - Enhances reliability and speed
  - Lowers power consumption
  - Lowers volume, weight, and cost

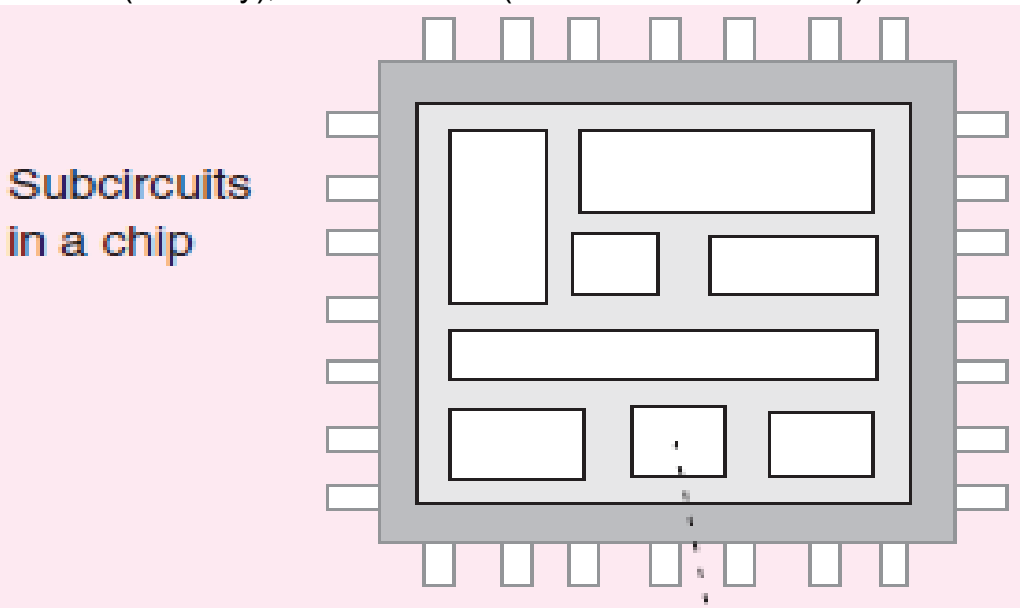
What is Inside a Chip?

- The chip is composed of a number of subcircuits (subsystems) which are interconnected to build the complete integrated circuit



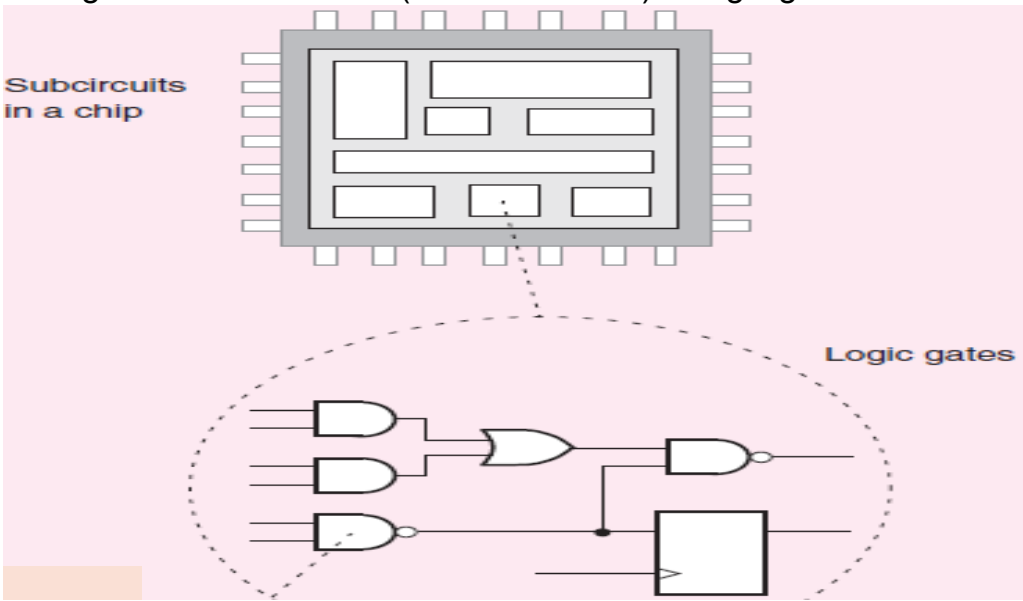
Subcircuits of a Chip

- Examples of subcircuits: arithmetic and logic units, data storage units (memory), and controller (control the flow of data)



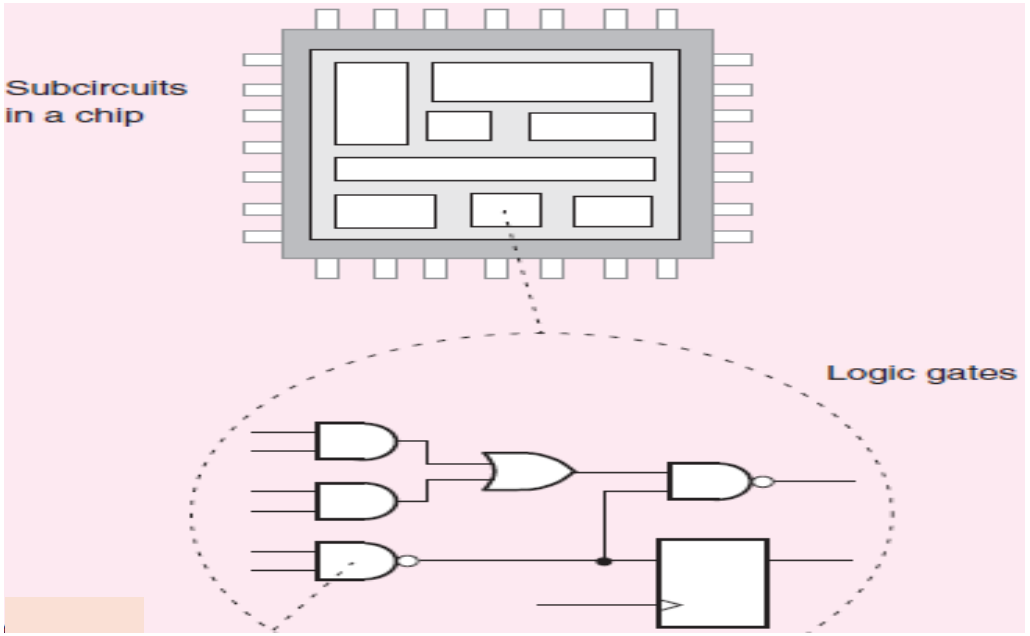
What is Inside the Subcircuits?

- Subcircuits are composed of logic circuits
- Logic circuit: a network (interconnection) of logic gates



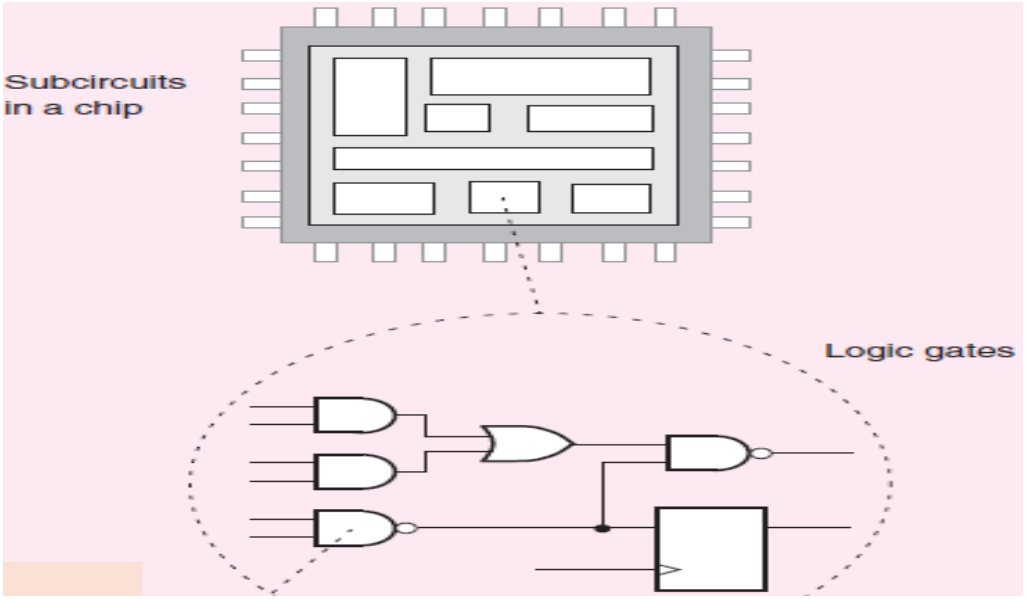
What Do Logic Gates Do?

- Each logic gate performs a basic logic function



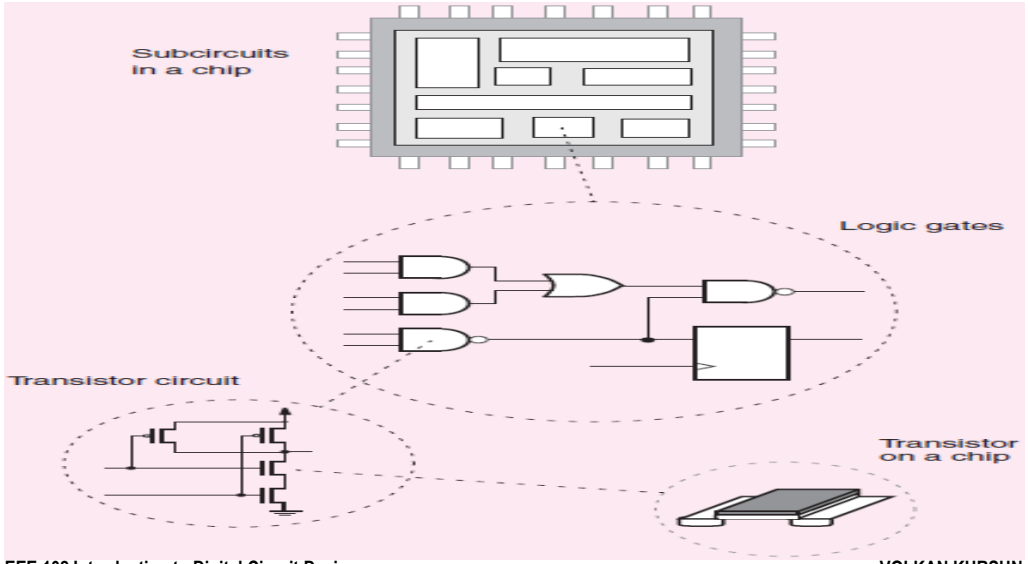
Networks of Logic Gates

- More complex operations are realized by connecting gates together and forming networks of logic gates



What is Inside A Logic Gate?

- Logic gates are built with transistors, which in turn are implemented by fabricating various layers of material on a silicon chip



What is EEE 102 All About?

- You will learn about basic logic gates and how to build networks of logic gates to realize complex functions

EEE 102: learn how to design networks of logic gates that perform important functions, such as adding, subtracting, counting, storing data, and controlling the processing of information