ECE 3120
Computer Systems

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Today:

- Basic Concepts
  - Computer Organization
  - Hardware
    - Processor
    - Memory
    - Input Devices
    - Output Devices
Computer Concepts

- **Computer:**
  - **Hardware:**
    - Processor: “brain”, CPU
      - Datapath: registers and ALU
      - Control unit: hardware instruction logic.
    - Memory: place to store software programs and data
    - I/O devices: enter data/programs into the computer/display outputs
  - **Software:** programs
    - A program is a set of instructions that the computer hardware can execute.
Computer Organization

Figure 1.1 Computer Organization
Processor (Central Processing Unit)

- **Datapath:**
  - Register file: a register is a storage location within the CPU.
  - Arithmetic Logic Unit (ALU): perform all the arithmetic computations and logic evaluations.

- **Control Unit:**
  - Decodes and monitors the execution of instructions and coordinate the operations. The system clock synchronizes the activities of the CPU, which are measured by clock cycles (GHz).
  - Maintain 2 registers:
    - PC: keeps track of the address of the next instruction to be executed
    - Status Register: flags the instruction execution result
Memory

- Semiconductor memory, magnetic, optical memory.
- Semiconductor memory:
  - Random access memory (RAM): volatile
    - Dynamic RAM (DRAM): periodic refresh operations to maintain the stored information. Every a few milliseconds to over a hundred ms.
    - Static RAM (SRAM): no need to refresh. More transistors are used to hold one bit information.
  - Read-only memory (ROM): nonvolatile.
    - MROM: mask-programed ROM, programmed when being manufactured.
    - PROM: programmable ROM, one-time programmable ROM using PROM programmer/burner by end users.
    - EPROM: erasable PROM, strong ultraviolate light erasable in bulk.
    - EEPROM: electrically EPROM, erased by electrical signals and reprogrammed. Individual location.
    - Flash memory: take advantages of EPROM and EEPROM
I/O devices

- **Input device**
  - Allow users to enter data/programs into the computer so that computation can be performed.
  - Examples:

- **Output device**
  - Display results of computation so that users can read them and equipment can be controlled.
  - Examples:
Microprocessor

- A processor implemented on a single integrated circuit (IC). Peripheral chips are needed to construct a product. A microcomputer is a computer that uses a microprocessor as its CPU (such as today’s desktop).

Classifications: word length (number of bits that a microprocessor can manipulate in one operation).
- 4-bit (intel 4004, 1971), 8-bit, 16-bit, 32-bit, 64-bit.

Limitations:
- Requires external memory to execute programs;
- Peripheral chips are needed to interface with I/O devices
- Glue logic (decoders, buffers) is needed to interconnect external memory and peripheral interface chips with the microprocessor.
A microcontroller is a computer implemented on a single VLSI chip. It contains everything a microprocessor contains plus some more components, such as:

- Memory
- Timer
- ADC, DAC
- DMA controller
- Parallel I/O interface (parallel ports)
- Asynchronous serial I/O interface, synchronous serial I/O interface
- DSP features.
Features of 68HCS12 microcontroller

- 16-bit CPU
- 64 KB memory space (also supports expanded memory up to 1 MB through a 16-KB window)
- 0 KB to 4KB of EEPROM
- 2 KB to 14 KB of on-chip SRAM
- 32 KB to 512 KB flash memory
- Sophisticated timer functions that include: input capture, output compare, pulse accumulators, real-time interrupt, and COP timer
- Serial communication interfaces: SCI, SPI, CAN, BDLC
- Background debug mode (BDM)
- 10-bit A/D converter
- Instructions for supporting fuzzy logic function
Motivation for studying Microcontrollers!!

- Application for Microcontrollers – Embedded Systems

- A product that uses one or more microcontrollers as controller(s). Also called embedded products.

- End users are interested in the functionality of the product, not the microcontroller itself.

- Cell phones, home security systems, and modern automobiles are examples of embedded products.