Peripheral devices, 
Input/output devices

- **Peripheral** is a device that is connected to a host computer, but not part of it. It expands the host’s capabilities but does not form part of the core computer architecture. It is often, but not always, partially or completely dependent on the host.
- A peripheral is generally defined as any auxiliary device such as a computer mouse, keyboard, hard drive, etc. that connects to and works with the computer in some way.
- Other examples of peripherals are expansion cards, graphics cards, computer printers, image scanners, tape drives, microphones, webcams, and digital cameras.
- Many new devices such as smartphones and tablet computers have interfaces which allow them to be used as a peripheral by a full computer, though they are not host-dependent as other peripheral devices are.
- According to the most technical definition, the only pieces of a computer NOT considered to be peripherals are the central processing unit, power supply, motherboard, and computer case.
- Usually, the word peripheral is used to refer to a device external to the computer case, like a scanner, but the devices located inside the computer case are also technically peripherals. Devices that exist outside the computer case are called external peripherals, or auxiliary components.
- Devices that are inside the case such as internal hard drives or CD-ROM drives are also peripherals in technical terms and are called internal peripherals, but may not be recognized as peripherals by laypeople.
External I/O devices

• External devices are needed as a means of communication to the outside world (both input and output – I/O)
• Types
  – Human readable – communication with user (monitor, printer, keyboard, mouse)
  – Machine readable – communication with equipment (hard drive, CDROM/DVD, sensors, and actuators)
  – Communication – communication with remote computers/devices (Can be any of the first two or a network interface card or modem)

Peripheral devices in PC computer

There are three different types of peripherals:
1. Input, which provide input to the computer from the user (mice, keyboards, sound card, USB, Ethernet port, etc.)
2. Output, which provide output to the user from the computer (monitors, printers, sound card, USB port, Ethernet port, etc.)
3. Storage, which store data (hard drives, flash drives, CD/DVD/Blue-Ray drives, disk drives, card reader, etc.)
External input/output devices in PC

- Keyboard
- Mic
- Mouse
- Scanner
- Webcam

- Monitor
- Printers
- Speakers
- Data Projector

ROM & RAM

Main memory

Input

Processor

Output

Backing Storage

Control Unit

- Hard disk
- Floppy disk
- USB pen
- CD-RW
- DVD-RW

External input/output devices in PC

http://www.bbc.co.uk/education/guides/zxgkxnb/revision

Erasmus 2015/2016, WIEK, PK
**Internal input/output devices in PC**

- Real Time Clock (RTC)
- Parallel port (LPT)
- Serial ports (PS/2, USB, COM, FireWire, Ethernet)
- timers

![Diagram of internal input/output devices in PC](Erasmus 2015/2016, WIEiK, PK)

**Microcontroller for embedded system**

- A **microcontroller** (sometimes abbreviated μC, uC or MCU) is a small computer on a single integrated circuit containing a processor core (8, 16, 32 or 64-bit), memory, and programmable input/output peripherals.
- Program memory in the form of NOR flash is also included on chip, as well as a typically small amount of RAM.
- Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.
- Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems.
- By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

![Diagram of microcontroller for embedded system](Erasmus 2015/2016, WIEiK, PK)
Microcontroller for embedded system

- A microcontroller can be considered a self-contained system with a processor, memory and peripherals and can be used as an embedded system.
- The majority of microcontrollers in use today are embedded in other machinery, such as automobiles, telephones, appliances, and peripherals for computer systems.
- While some embedded systems are very sophisticated, many have minimal requirements for memory and program length, with no operating system, and low software complexity.
- Typical input and output devices include switches, relays, solenoids, LEDs, small or custom LCD displays, radio frequency devices, and sensors for data such as temperature, humidity, light level etc.
- Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction devices of any kind.

Microcontroller for embedded system

- Microcontrollers are useful to the extent that they communicate with other devices, such as sensors, motors, switches, keypads, displays, memory and even other micro-controllers.
- Many interface methods have been developed over the years to solve the complex problem of balancing circuit design criteria such as features, cost, size, weight, power consumption, reliability, availability, manufacturability.
- Many microcontroller designs typically mix multiple interfacing methods. In a very simplistic form, a micro-controller system can be viewed as a system that reads from (monitors) inputs, performs processing and writes to (controls) outputs.
Input/output devices in microcontrollers

External input/output devices for microcontroller

Internal Input/output devices in microcontrollers

- Microcontroller systems provide multiple forms of input and output signals to allow application software to control an external "real-world" system.
- Discrete digital I/O provides a single bit of data (on, or off).
- Analog signals, representing a continuously variable range such as temperature or pressure, can also be inputs and outputs for microcontrollers.
- The input/output circuits usually do not provide enough current to directly operate such devices as lamps or motors, so solid-state relays are operated by the microcontroller digital outputs, and inputs are isolated by signal conditioning level-shifting and protection circuits.

There are three types of internal peripherals in microcontroller:
- Digital input/output devices
- Analog/Digital/Analog input/output devices
- Analog input/output devices
Digital Input/Output devices in microcontrollers

**Internal Digital input/output devices:**
- parallel I/O ports, (8, 16 or 32-bit) – basic input/output devices
- serial ports, serial communications interfaces, (UART, SPI, I2C, USB, CAN, ...)
- timers, event counters, frequency prescaler (divider)
- PWM generators, (Pulse Width Modulation),
- watchdog timer,
- RTC clock (Real Time Clock),
- Programmable logic array (PLA),
- LCD controller (alphanumeric, graphics, monochrome, color),
- Touch screen controller,

Analog/Digital/Analog Input/Output devices in microcontrollers

—One or more analog inputs, with an analog multiplexer and common analog to digital converter (ADC), are found in microcontrollers.
—Analog outputs may use a digital-to-analog converter (DAC), or on some microcontrollers may be controlled by pulse-width modulation (PWM).

**Internal Analog/Digital/Analog input/output devices:**
- Analog comparator (a comparator is a device that compares two voltages and switches its output to indicate which is larger.) (comparator has two analog input and one digital output)
- Supply Voltage Supervisor (SVS) circuits are used to monitor the supply voltage to embedded and other micro-controller systems for under voltage conditions.
- Multichannel Analog Digital Converter (ADC)
- Digital Analog Converter (DAC)
Analog Input/Output devices in microcontrollers

Internal Analog input/output devices:
- on-chip voltage reference for ADC, DAC, analog comparator,
- on-chip temperature sensor,
- differential or single-ended programmable (gain) amplifier for ADC,
- operational amplifier
- current sources for external sensors.