

# ΕΙΣΑΓΩΓΗ ΣΤΗΝ ΜΗΧΑΤΡΟΝΙΚΗ

## Ύλη του μαθήματος

Μηχατρονική-Ορισμός-Εφαρμογές. Μικροελεγκτές AVR. Βασικά Ηλεκτρικά Κυκλώματα και Εξαρτήματα. Βασικά Ηλεκτρονικά Κυκλώματα και Εξαρτήματα. Συστήματα ανάπτυξης ενσωματωμένων συστημάτων ανοικτού υλικού/λογισμικού Arduino/Αρχιτεκτονική και προγραμματισμός. Σειριακή είσοδος έξοδος. Ψηφιακή και αναλογική είσοδος έξοδος. Ρελέ ηλεκτρομηχανικά και στερεάς κατάστασης. Οπτοηλεκτρονικά εξαρτήματα. DIAC, TRIAC. Μετατροπείς A/D & D/A. Αισθητήρες (sensors) & Ενεργοποιητές (actuators). DC motors, Servo motors, Stepper motors. Σύστημα ανοικτού λογισμικού Raspberry Pi. Σχεδιασμός συστημάτων Μηχατρονικής.

## **Mechanical engineering**

**Mechanical engineering** is the discipline that applies engineering, physics, engineering mathematics, and materials science principles to design, analyze, manufacture, and maintain mechanical systems. It is one of the oldest and broadest of the engineering disciplines. The mechanical engineering field requires an understanding of core areas including mechanics, dynamics, thermodynamics, materials science, structural analysis, and electricity.

Mechanical engineering that involves the **design, production, and operation of machinery.**

## **Electrical engineering**

**Electrical engineering** is an engineering discipline that generally deals with the study and application of electricity, electronics, and electromagnetism. This field first became an identifiable occupation in the later half of the 19th century after commercialization of the electric telegraph, the telephone, and electric power distribution and use. Subsequently, broadcasting and recording media made electronics part of daily life. The invention of the transistor, and later the integrated circuit, brought down the cost of electronics to the point they can be used in almost any household object.

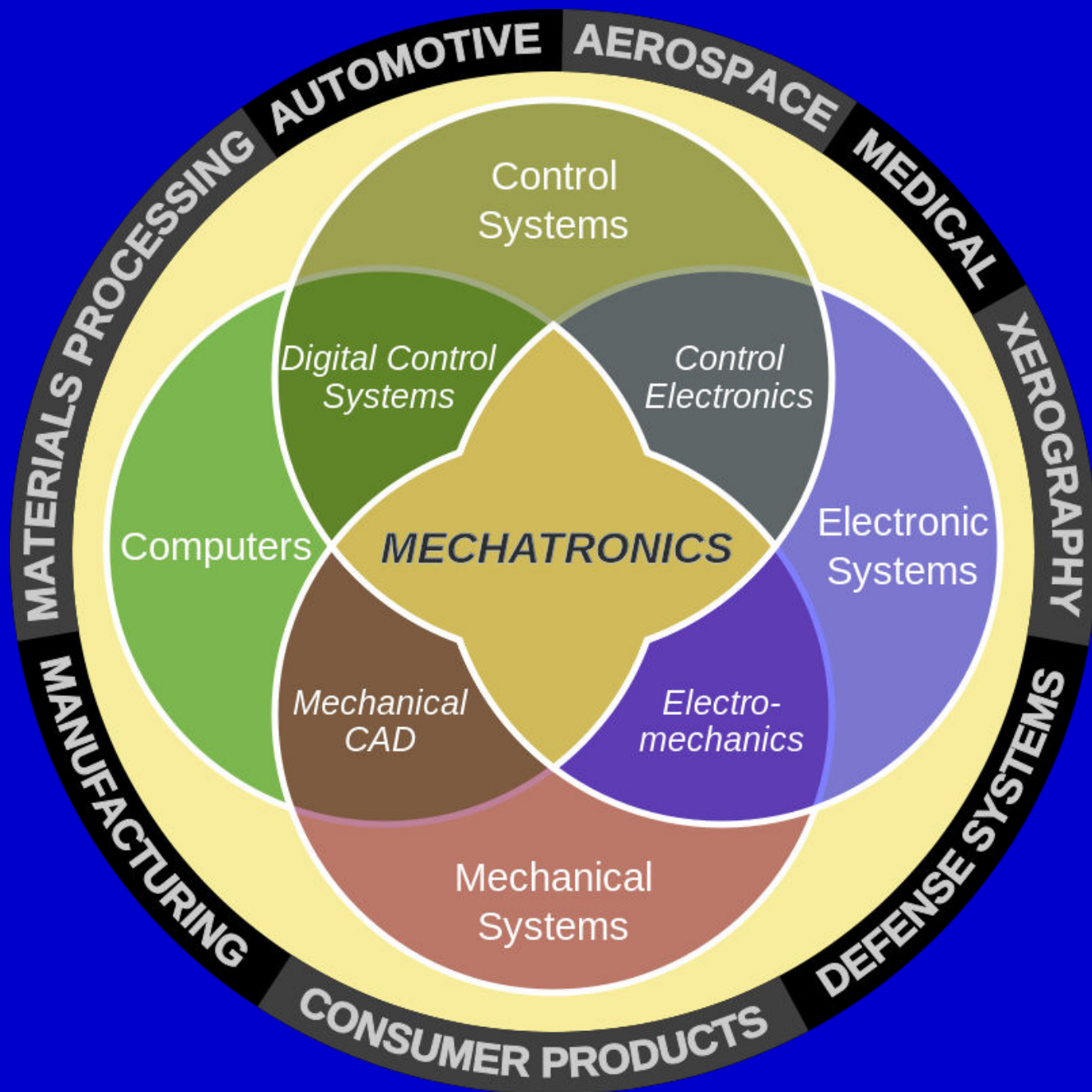
## Computer engineering

**Computer engineering** that integrates several fields of computer science and electronics engineering required to develop computer hardware and software. Computer engineers usually have training in electronic/electrical engineering, software design, and hardware–software integration. Computer engineering not only focuses on how computer systems themselves work, but also how they integrate into the larger picture.

Computer engineers are also suited for robotics research, which relies heavily on using digital systems to control and monitor electrical systems like motors, communications, and sensors.

## **Mechatronics**

**Mechatronics** is a multidisciplinary field of engineering that includes a combination of mechanical engineering, electronics, computer engineering. Mechatronics' aim is a design process that unifies these subfields. Originally, mechatronics just included the combination of mechanics and electronics, therefore the word is a combination of **mechanics** and **electronics**; however, as technical systems have become more and more complex the definition has been broadened to include more technical areas.



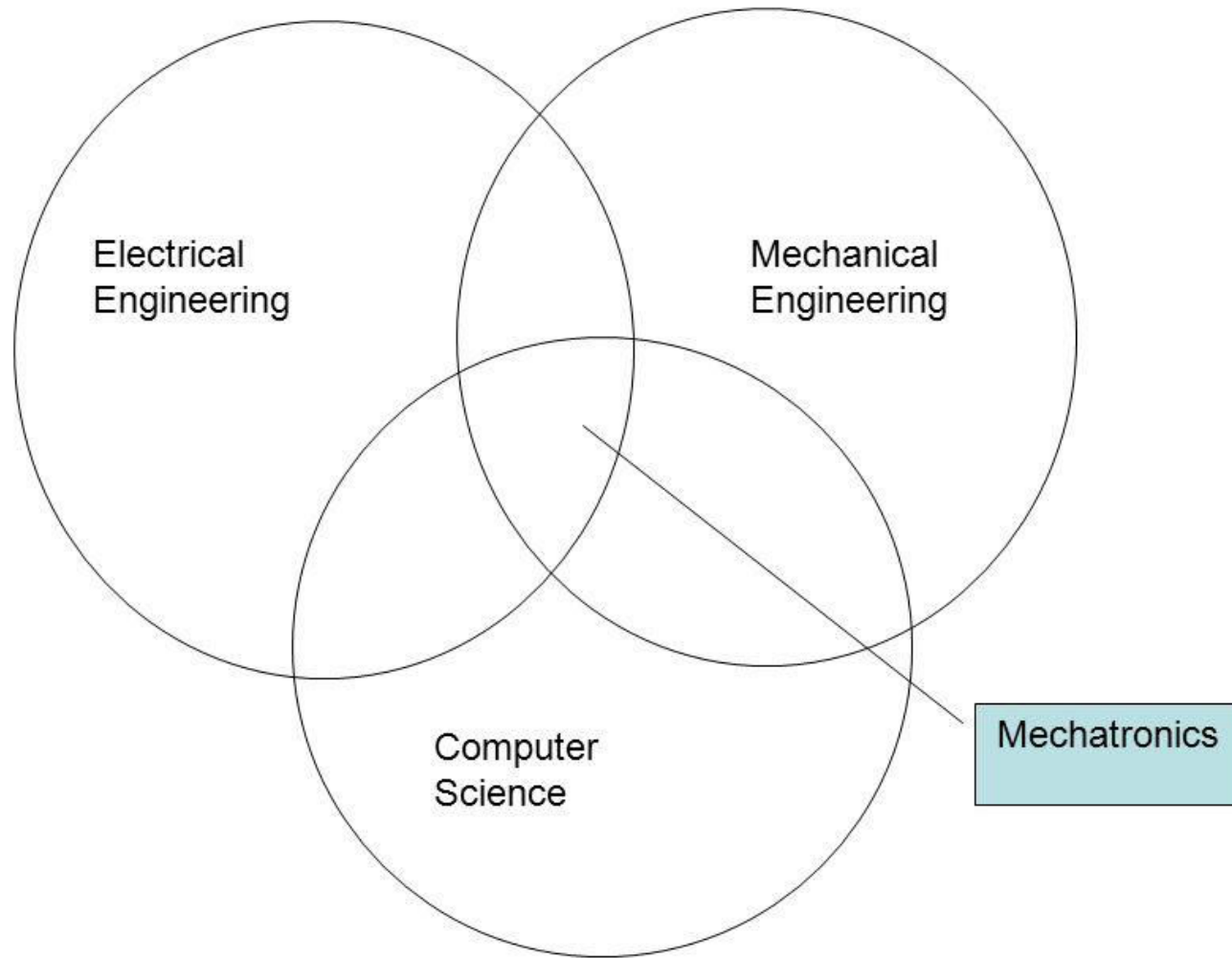
## Mechatronics

Mechatronics - integration of 3 engineering fields

- Mechanical engineering
- Electrical and/or electronic engineering
- Computer science

Word 'mechatronics' - by engineers at Yaskawa Electric Company

# Mechatronics

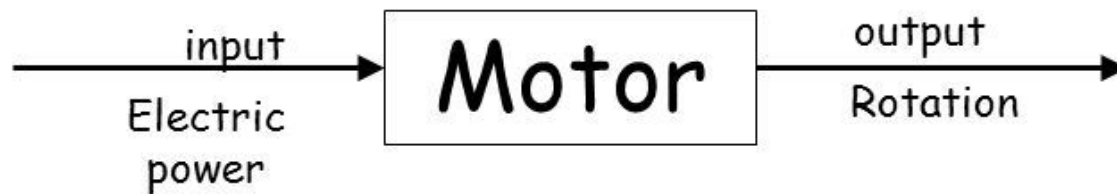


Mechatronics engineer is trained for:

- Design mechanical components of a product
- Design electrical components - actuator, sensor, amplifier, control logic
- Design computer hardware and software to control product real time

# Systems

- Mechatronics involves many systems
- System - a box with input and output



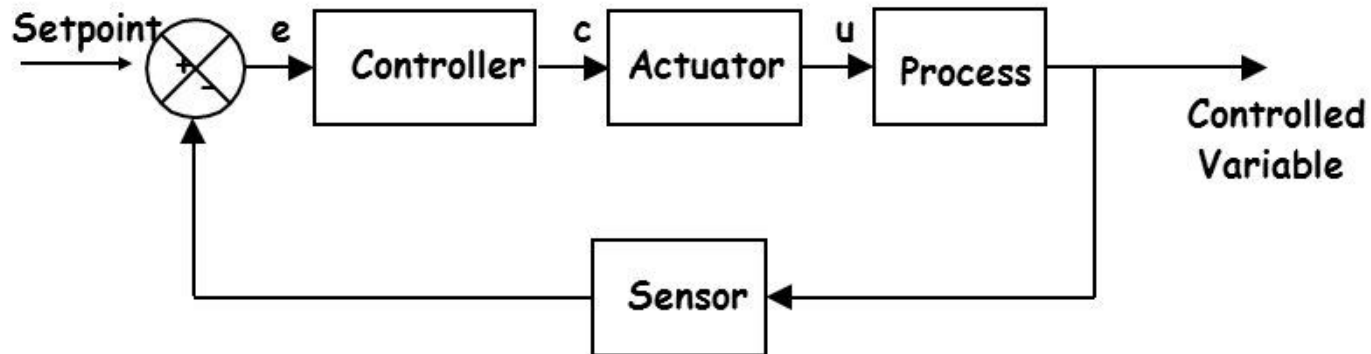
# Measurement and instrumentation system

- Components - sensor, signal conditioner, display

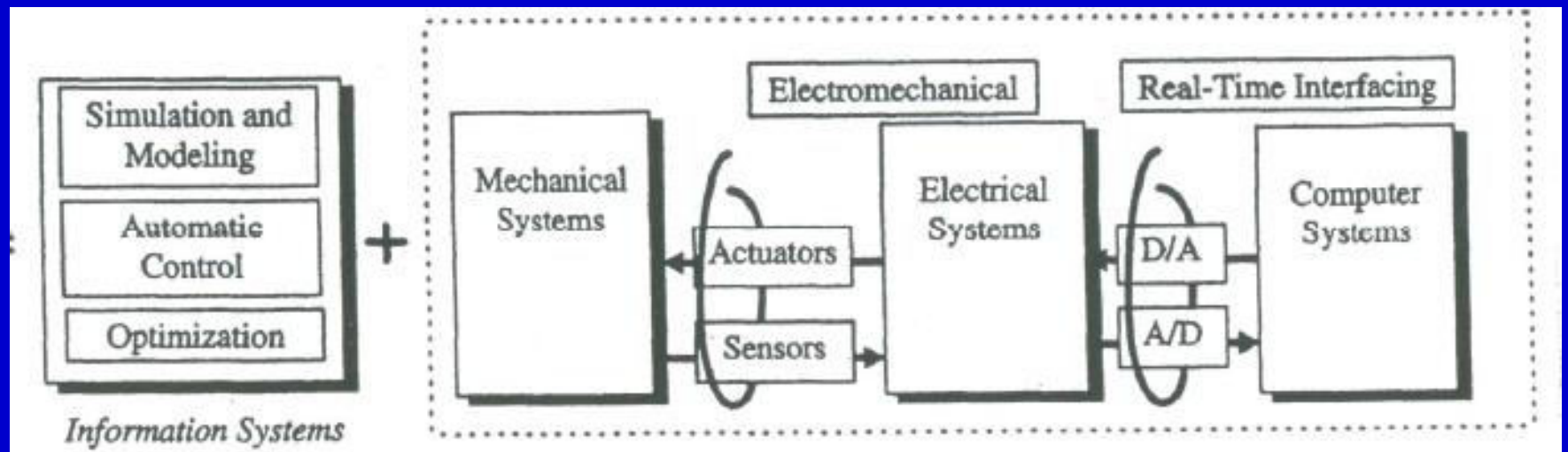


# Control system

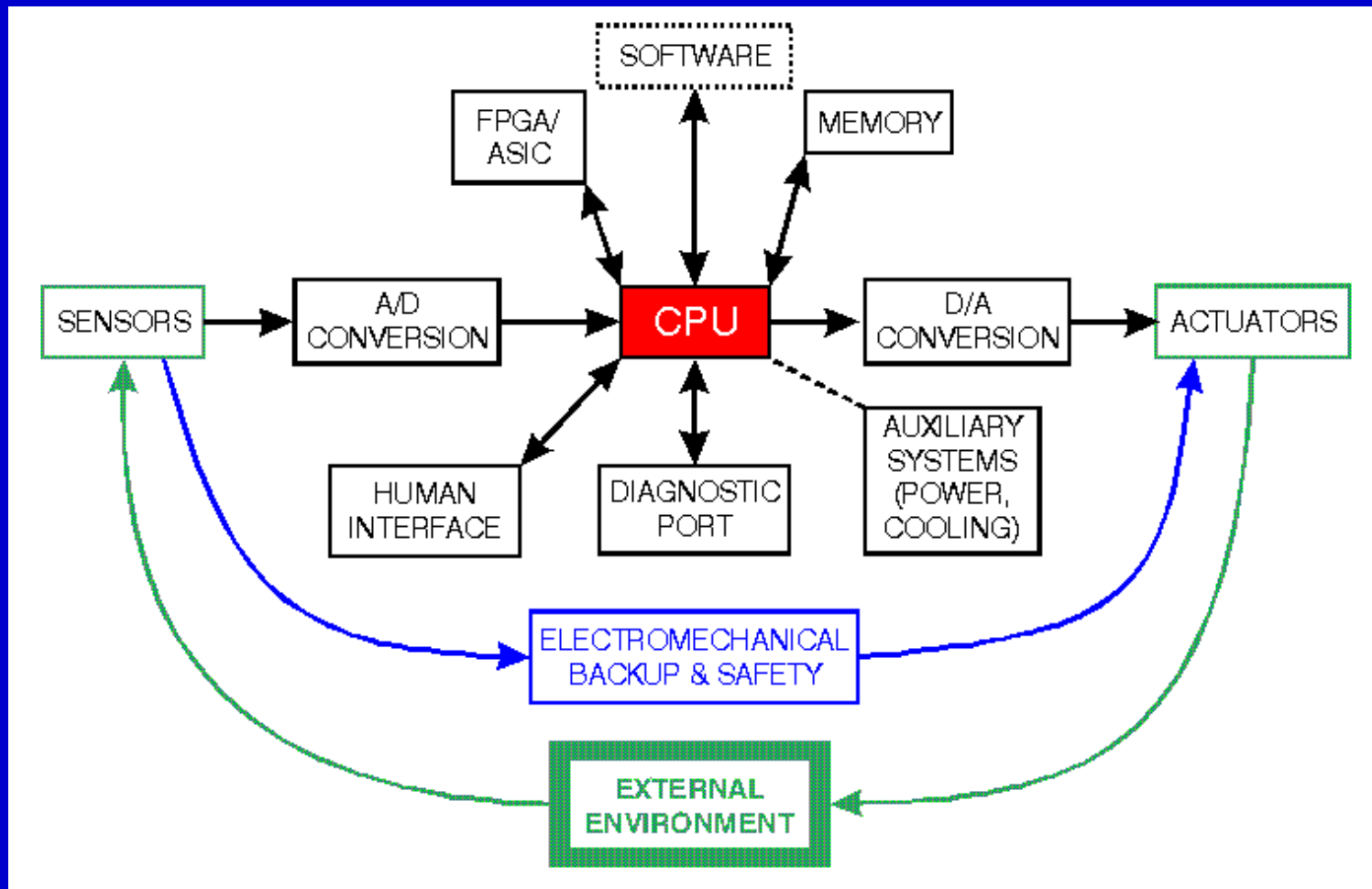
- Maintain the output of system to the required input value



# Mechatronic system



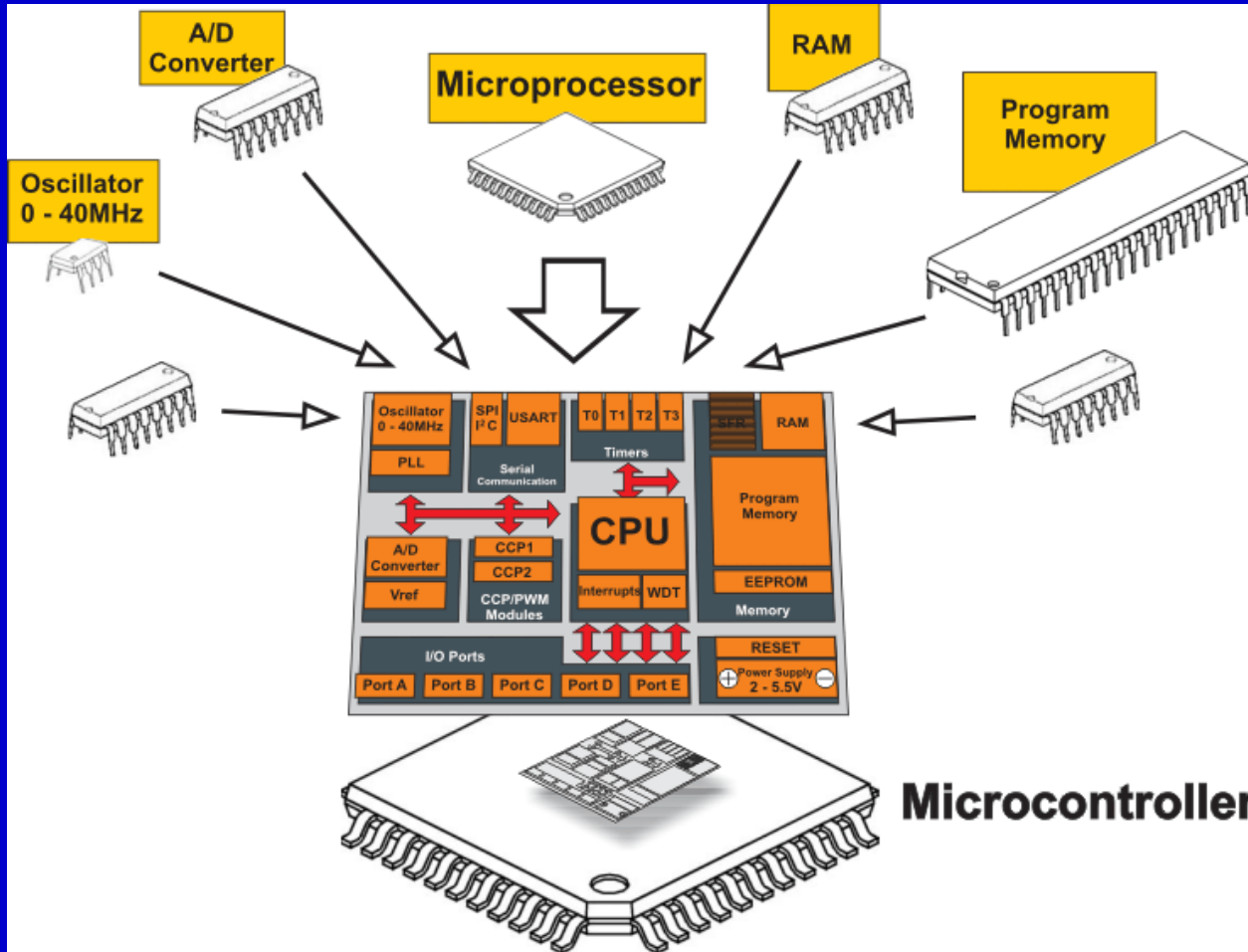
## Αρχιτεκτονική Μηχατρονικών Συστημάτων



# Microprocessor-based controllers

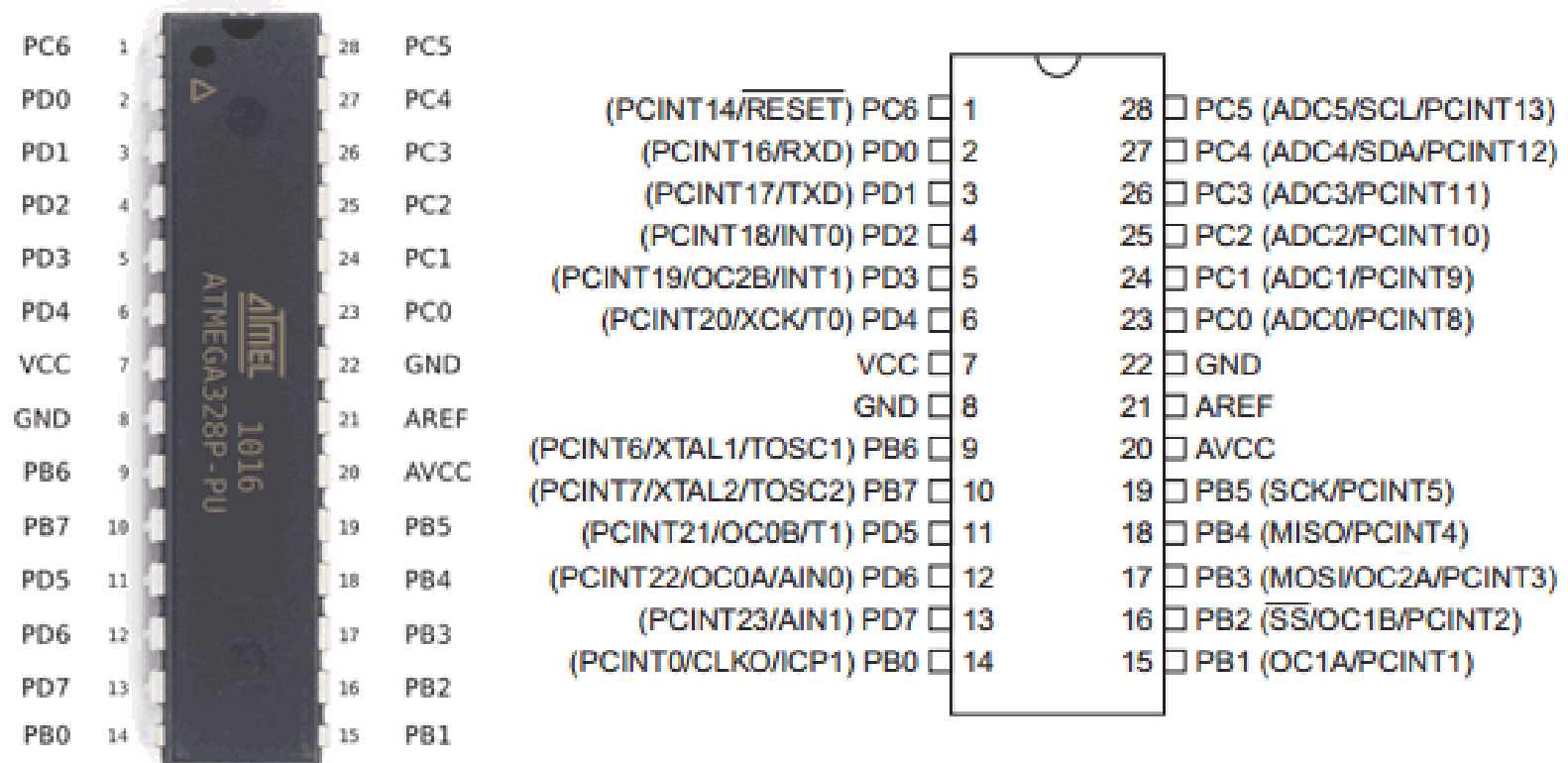
- Microprocessors - replacing mechanical cam-operated controllers
- To carry out control function
- Advantages - variety of programs
- Embedded microcontroller - microprocessor integrated in a chip to perform certain task (PIC, ATMEL, etc.)
- Adaptable form - programmable logic controller (PLC)

# Microcontroller

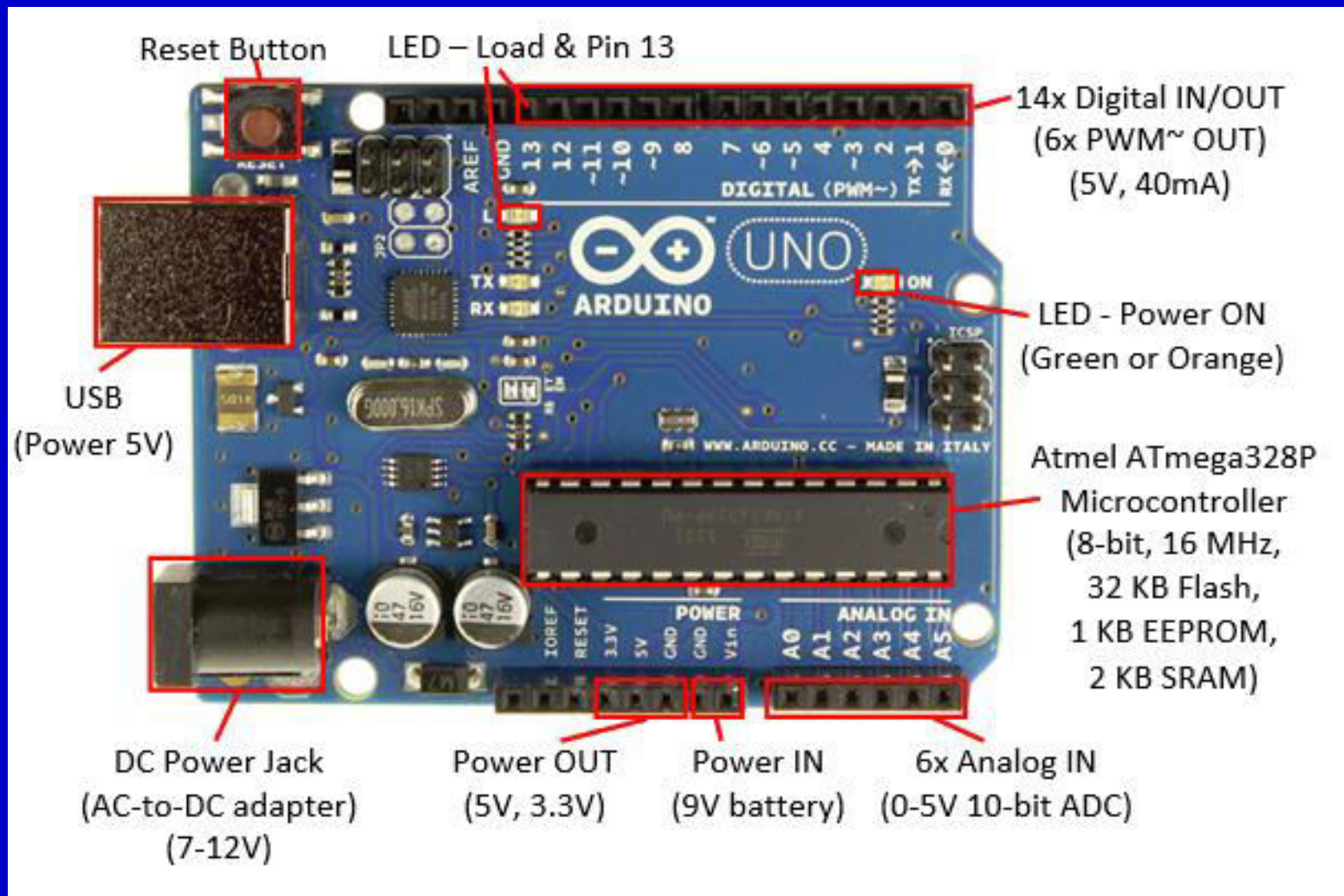


# Μικροελεγκτής AVR ATmega328P

ATmega328P pin mapping



# Σύστημα ανάπτυξης Arduino βασισμένο στον μικροελεγκτή ATMEL AVR



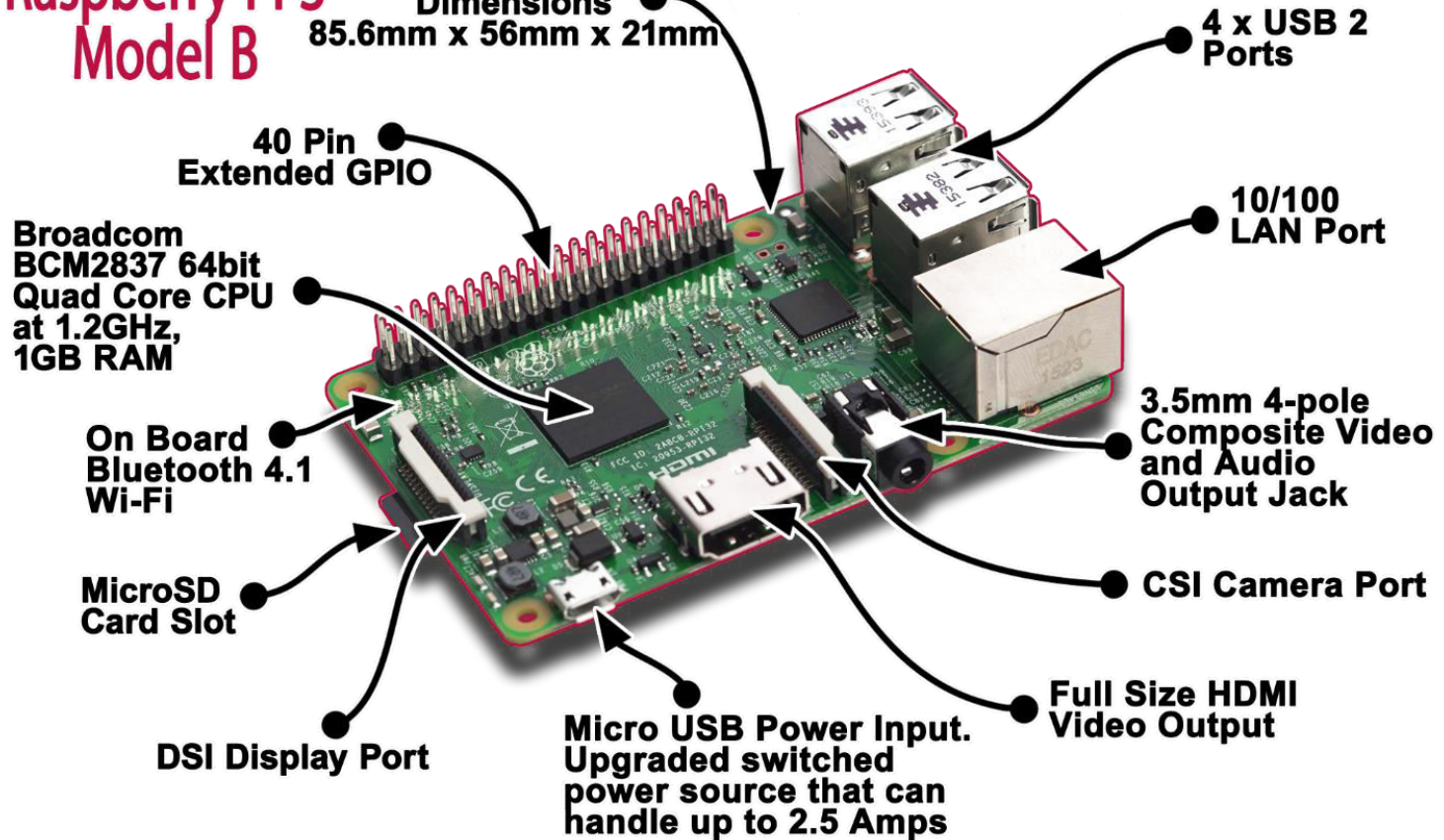
## Raspberry Pi

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools.

The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, VideoCore IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 1 GB. It does not include a built-in hard disk or solid-state drive, but it uses an SD card for booting and persistent storage.

# Raspberry Pi 3 Model B

**Dimensions**  
85.6mm x 56mm x 21mm



## Τεχνικά χαρακτηριστικά του Raspberry Pi 3

**SoC:** Broadcom BCM2837

**CPU:** 4× ARM Cortex-A53, 1.2GHz

**GPU:** Broadcom VideoCore IV

**RAM:** 1GB LPDDR2 (900 MHz)

**Networking:** 10/100 Ethernet, 2.4GHz 802.11n wireless

**Bluetooth:** Bluetooth 4.1 Classic, Bluetooth Low Energy

**Storage:** microSD

**GPIO:** 40-pin header, populated

**Ports:** HDMI, 3.5 mm analogue audio-video jack, 4×USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

# GPIO

The image shows a Raspberry Pi 3 Model B V1.2 board with a 40-pin GPIO header. A table to the right of the board provides a detailed list of the pins, their functions, and their electrical characteristics. The pins are color-coded: red for 3.3V and 5V, black for GND, and yellow for various GPIO pins. The table is organized into two columns of pin numbers (1-2 and 3-40) and a central column of functions.

Pin No.		
1	2	<b>3.3V</b>
3	4	<b>5V</b>
5	6	<b>5V</b>
7	8	<b>GND</b>
9	10	<b>GND</b>
11	12	<b>GND</b>
13	14	<b>GND</b>
15	16	<b>GND</b>
17	18	<b>3.3V</b>
19	20	<b>GND</b>
21	22	<b>GND</b>
23	24	<b>GND</b>
25	26	<b>GND</b>
27	28	<b>DNC</b>
29	30	<b>GND</b>
31	32	<b>GND</b>
33	34	<b>GND</b>
35	36	<b>GND</b>
37	38	<b>GND</b>
39	40	<b>GND</b>



## Sensors

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A sensor is a transducer that converts a physical stimulus from one form into a more useful form to measure the stimulus

- Two basic categories:
  1. Analog
  2. Discrete
    - Binary
    - Digital (e.g., pulse counter)



Ultrasonic  
(distance)



Light  
(light intensity)



Sound  
(db pressure)



Touch



## Other Sensors

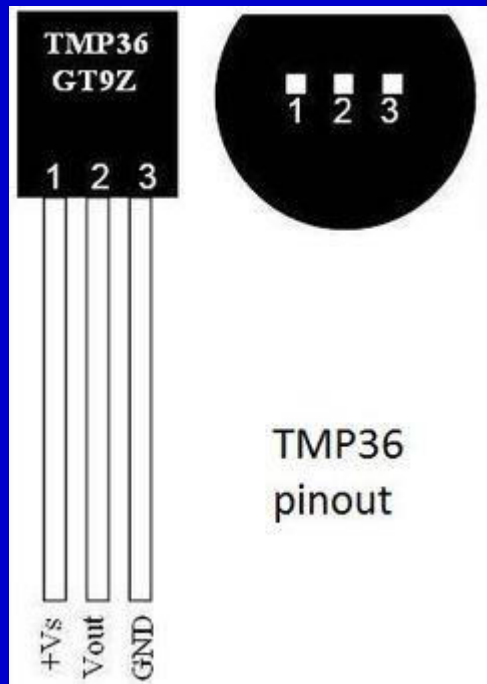
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- Temperature
- RFID
- Barcode
- Proximity
- Vision
- Gyroscope
- Compass
- Tilt/Acceleration
- Etc.



**Radio-Frequency Identification (RFID)** uses electromagnetic fields to automatically identify and track tags attached to objects.

## Αισθητήρας θερμοκρασίας TMP36



- Low Voltage Operation (+2.7 V to +5.5 V)
- Calibrated Directly in °C
- 10 mV/8°C Scale Factor (20 mV/8°C on TMP37)
- ±2°C Accuracy Over Temperature (typ)
- ±0.5°C Linearity (typ)
- Stable with Large Capacitive Loads
- Specified -40 °C to +125 °C, Operation to +150 °C
- Less than 50 µA Quiescent Current



## Actuators

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Hardware devices that convert a controller command signal into a change in a physical parameter

- The change is usually mechanical (e.g., position or velocity)
- An actuator is also a transducer because it changes one type of physical quantity into some alternative form
- An actuator is usually activated by a low-level command signal, so an amplifier may be required to provide sufficient power to drive the actuator



## Types of Actuators

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### 1. Electrical actuators

- Electric motors
  - DC servomotors
  - AC motors
  - Stepper motors
- Solenoids



### 1. Hydraulic actuators

- Use hydraulic fluid to amplify the controlled command signal

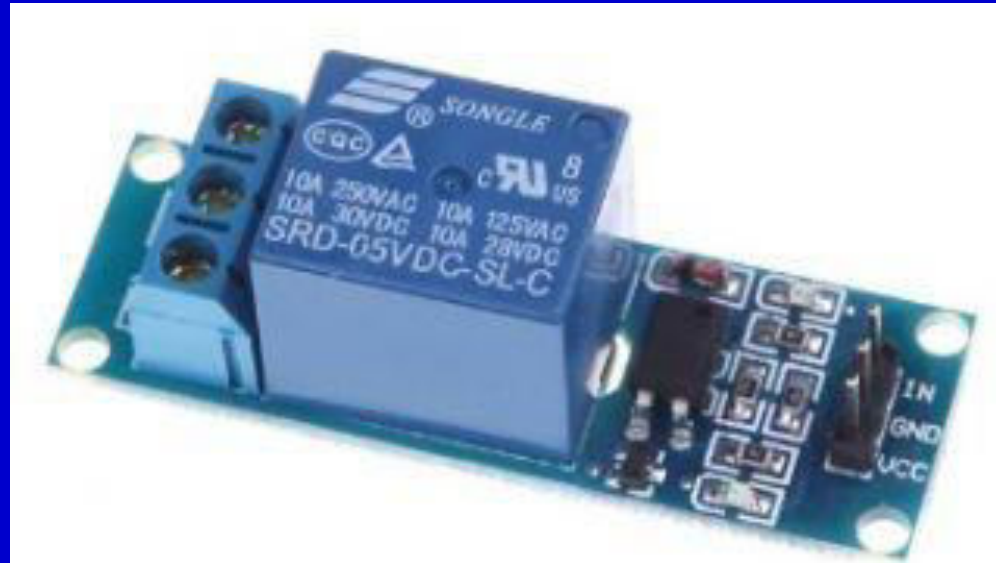


### 1. Pneumatic actuators

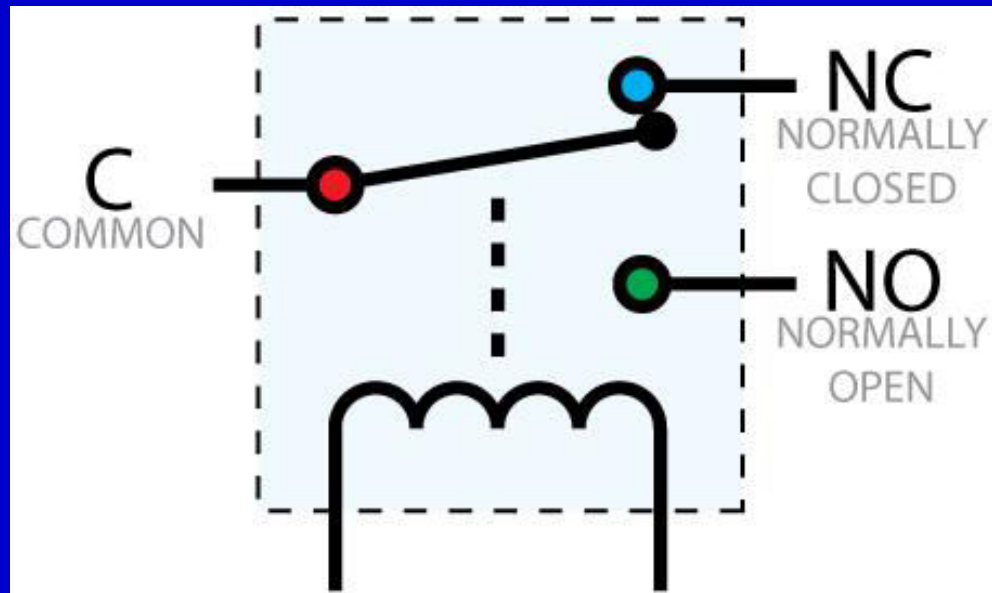
- Use compressed air as the driving force



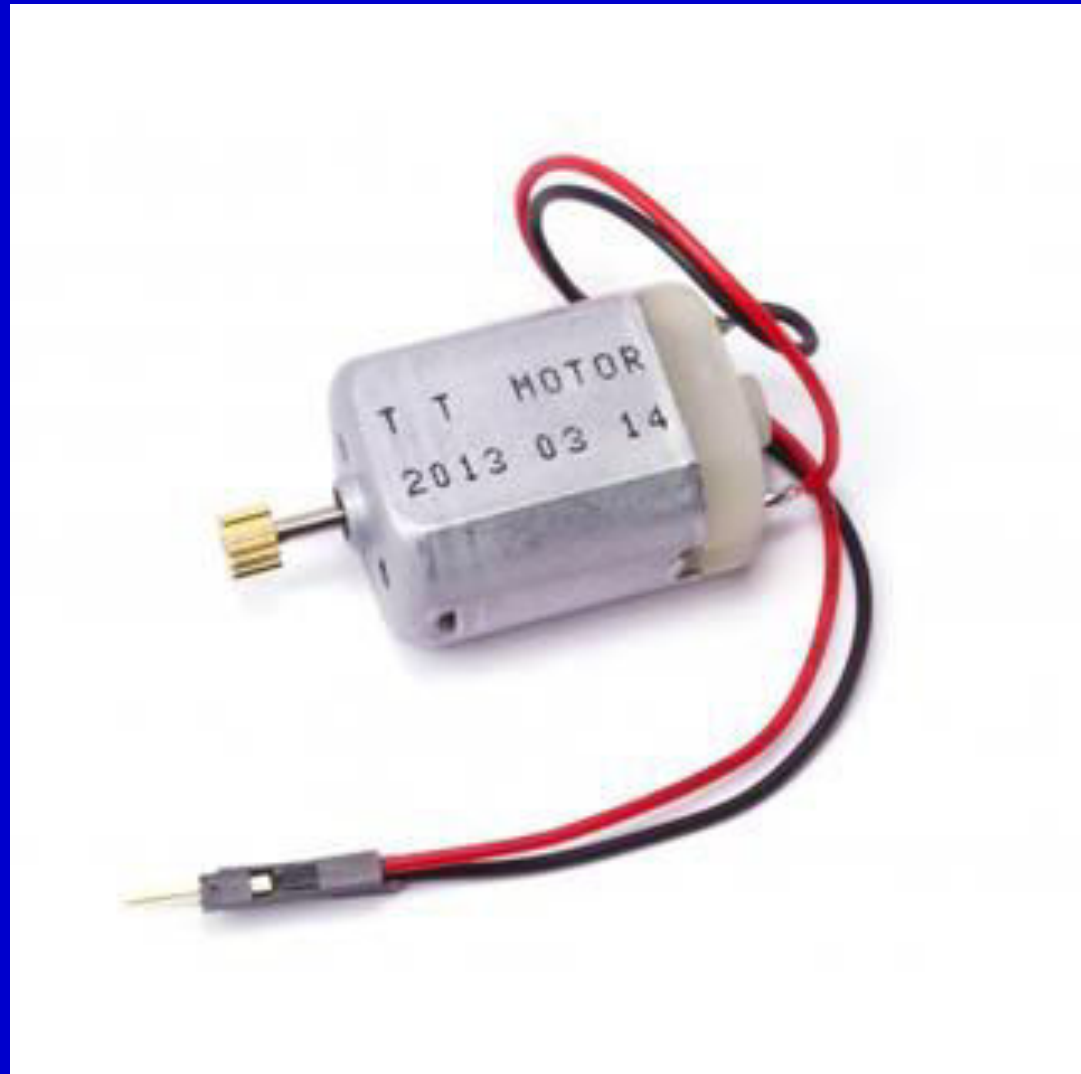
# Relay



## Conventional relay



## DC motor



## DC motor 6/9V

Item	Specification
Rated Voltage	6V DC
No load speed	12000±15%rpm
No load current	≤280mA
Operating voltage	1.5-6.5V DC
Starting Torque	≥250g.cm(according to ourself developed blade)
starting current	≤5A
Insulation Resistance	above 10Ω between the case and the terminal

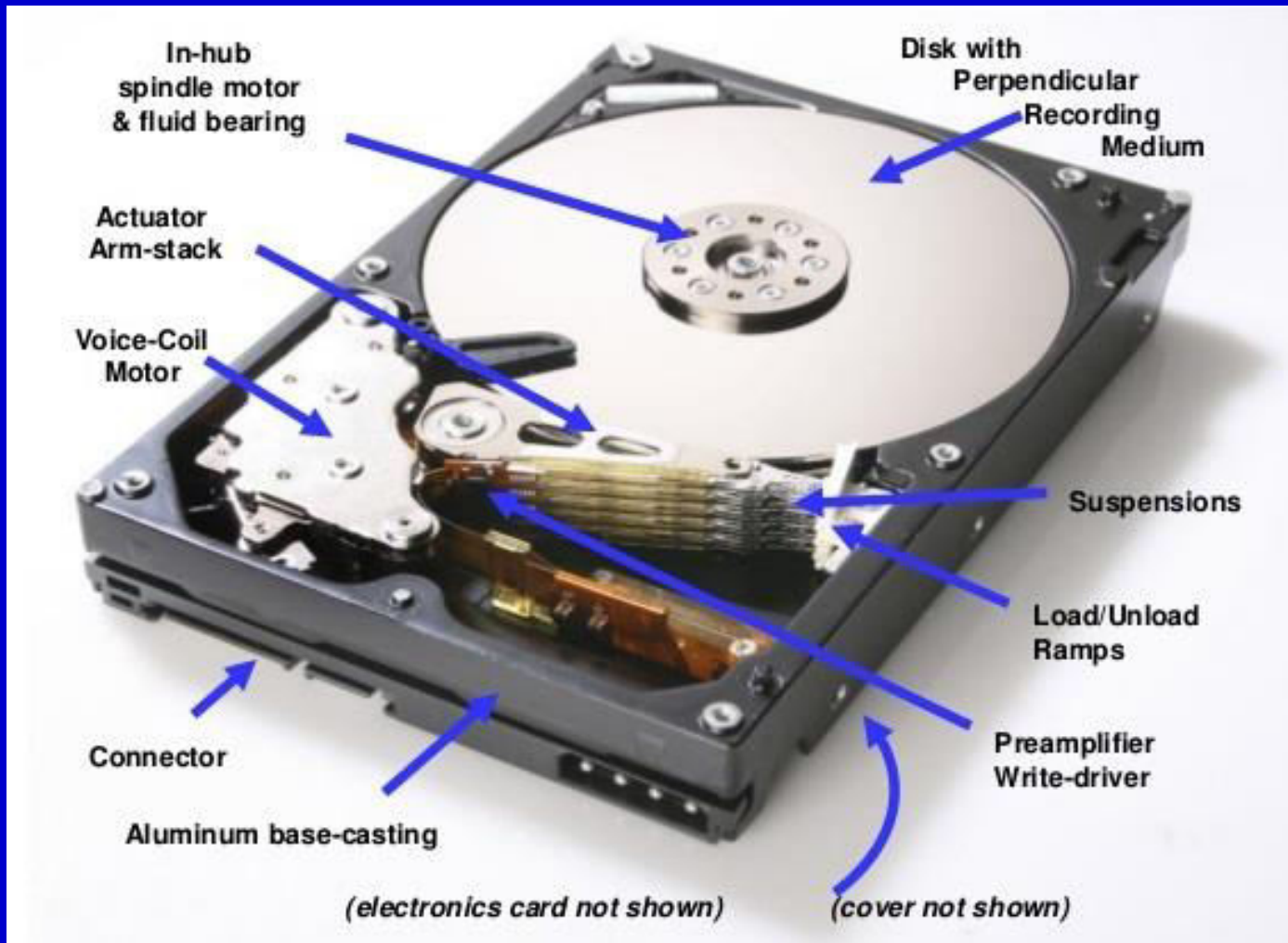
# Applications of Mechatronic System

- **Household**
  - Refrigerator
  - Washing machine
  - Microwave
- **Automotive**
  - Power steering
  - Air conditioner
- **Shop floor**
  - Tool monitoring system
  - Automated guided vehicle
  - Conveyor system
  - Bottle filling plant.

## **Mechatronics Applications**

- Smart consumer products: home security, camera, microwave oven, toaster, dish washer, laundry washer-dryer, climate control units, etc.
- Medical: implant-devices, assisted surgery, haptic, etc.
- Defense: unmanned air, ground, and underwater vehicles, smart munitions, jet engines, etc.
- Manufacturing: robotics, machines, processes, etc.
- Automotive: climate control, antilock brake, active suspension, cruise control, air bags, engine management, safety, etc.
- Network-centric, distributed systems: distributed robotics, tele-robotics, intelligent highways, etc.

## Hard disk internals



## **Automation**

**Automation** or **automatic control** is the technology by which a process or procedure is performed without human assistance. Automation is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Some processes have been completely automated.

## **Robotics**

**Robotics** deals with the design, construction, operation, and use of **robots**, as well as computer systems for their control, sensory feedback, and information processing. These technologies are used to develop machines that can substitute for humans and replicate human actions.

**Robotics** is an interdisciplinary branch of engineering and science that includes **mechanical engineering, electronics engineering, computer science**, and others.

# Robotics

