ROBOTICS

Definition

- Robotics is a branch of engineering and computer science that involves the conception, design, manufacture and operation of robots. The objective of the robotics field is to create intelligent machines that can assist humans in a variety of ways.

- Robotics can take on a number of forms. A robot might resemble a human or be in the form of a robotic application, such as robotic process automation, which simulates how humans engage with software to perform repetitive, rules-based tasks.

3 rules to be obeyed while constructing robots

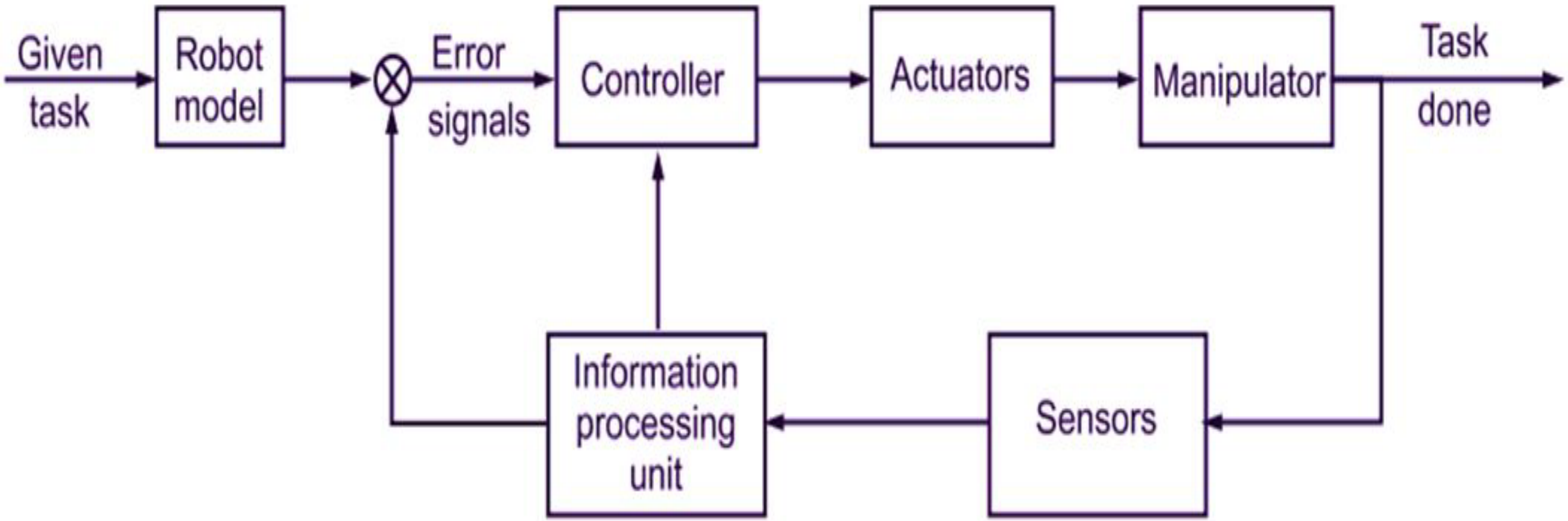
- Robots must never harm human beings.
- Robots must follow instructions from humans without violating rule 1.
- Robots must protect themselves without violating the other rules.

- Today, industrial robots, as well as many other types of robots, are used to perform repetitive tasks.
- They can take the form of a robotic arm, a collaborative robot (cobot), a robotic exoskeleton or traditional humanoid robots.
- Some applications for robotics include the following:

- **Home electronics.** Vacuum cleaners and lawnmowers can be programmed to automatically perform tasks without human intervention.
- **Home monitoring.** This includes specific types of robots that can monitor home energy usage or provide home security monitoring services, such as Amazon Astro.
- **Artificial intelligence (AI).** Robotics is widely used in AI and machine learning (ML) processes, specifically for object recognition, natural language processing, predictive maintenance and process automation.
- **Data science.** The field of data science relies on robotics to perform tasks including data cleaning, data automation, data analytics and anomaly detection.

- **Law enforcement and military.** Both law enforcement and the military rely heavily on robotics, as it can be used for surveillance and reconnaissance missions. Robotics is also used to improve soldier mobility on the battlefield.
- **Mechanical engineering.** Robotics is widely used in manufacturing operations, such as the inspection of pipelines for corrosion and testing the structural integrity of buildings.
- **Mechatronics.** Robotics aids in the development of smart factories, robotics-assisted surgery devices and autonomous vehicles.
- **Nanotechnology.** Robotics is extensively used in the manufacturing of microelectromechanical systems, which is a process used to create tiny integrated systems.
- **Bioengineering and healthcare.** Surgical robots, assistive robots, lab robots and telemedicine robots are all examples of robotics used in the fields of healthcare and bioengineering.

Block Diagram Representation

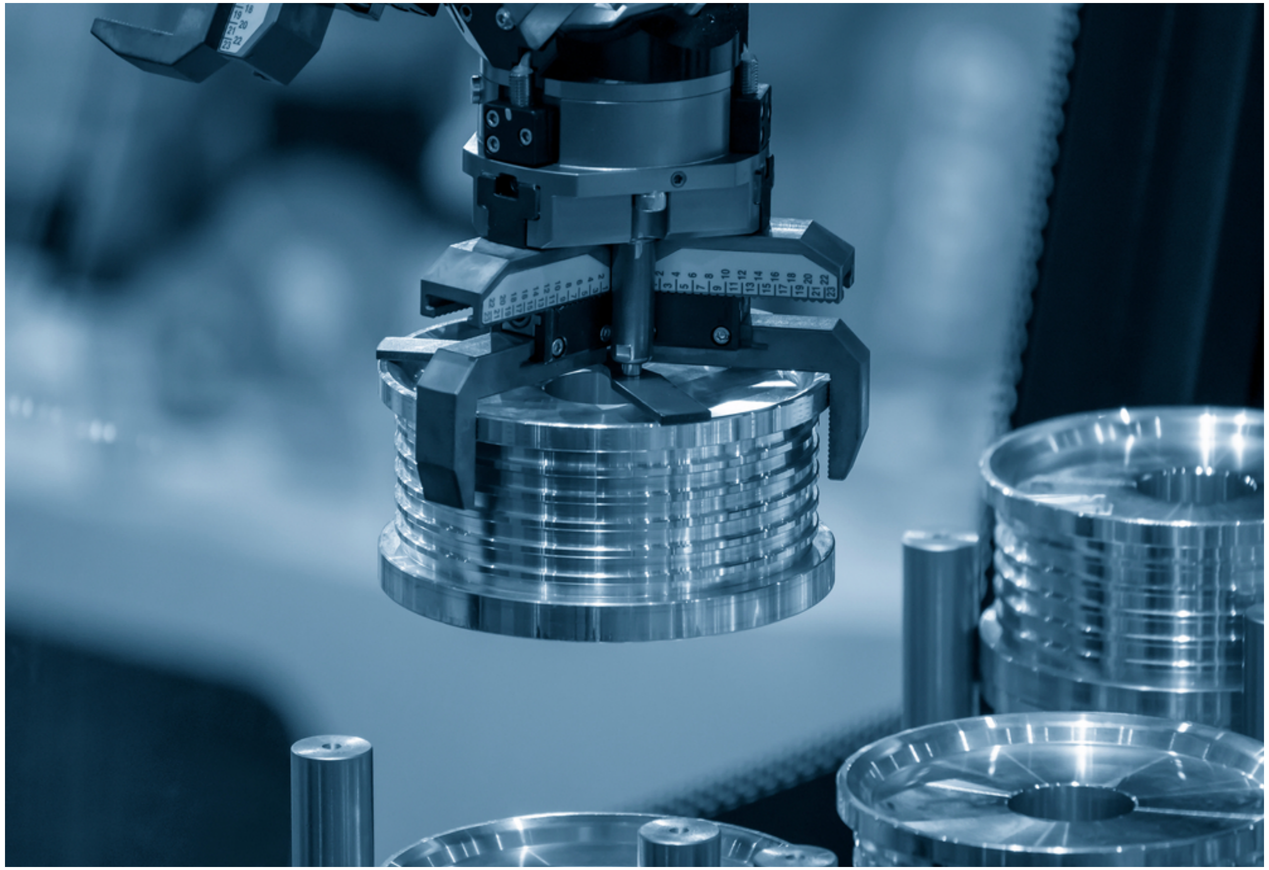


- Industrial robot has the basic parts like arm,sensor, actuator,controller etc. These subsystems communicate among themselves via interfaces whose function consists basically of decoding the transmitted information from one medium to another.

Components of Robot

- End effectors
- Sensors
- Manipulators
- Robot controller
- For mobile robots, the batteries
- for robots are the mount of a robot arm, and mounting systems to fasten sensors.
- The robot vision system.
- other smaller pieces and parts like LED displays and keypads.

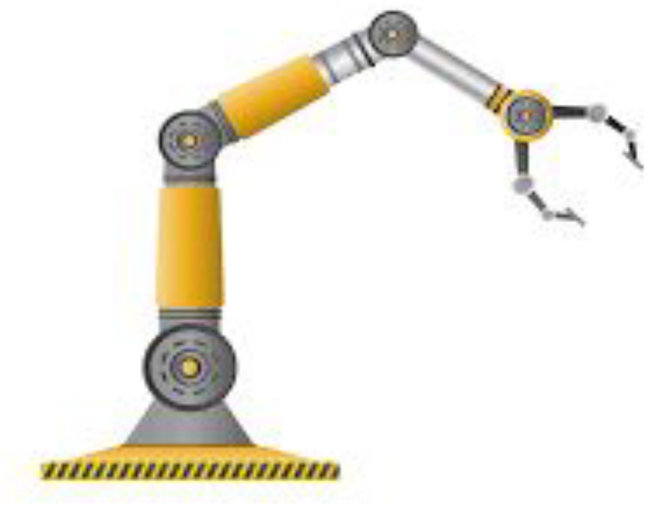
Robot End Effectors



- The end effector of a robotic arm is where the work happens. It’s where the contact between the robot and the workpiece happens. As with human beings, who use a very wide array of tools to get things done, so it is with robots.
- Robotic end effectors are also called “End of Arm Tooling” or EoAT. The EoAT is in effect the wrist, hand, and tool of the robot. End effectors can be anything from a welding tool to a vacuum cleaner.
- The EoAT could be a screwdriver or a rotating drill.
- If the robot is supposed to lift boxes ,For smaller boxes, a suction cup might be better.
- For larger boxes, it might be better to have a robot with two arms. The “hands” or grippers might be shaped like a sphere with knobs on them.
- For big and heavy boxes, it might be best to have prongs that can slip underneath the box and support it from below

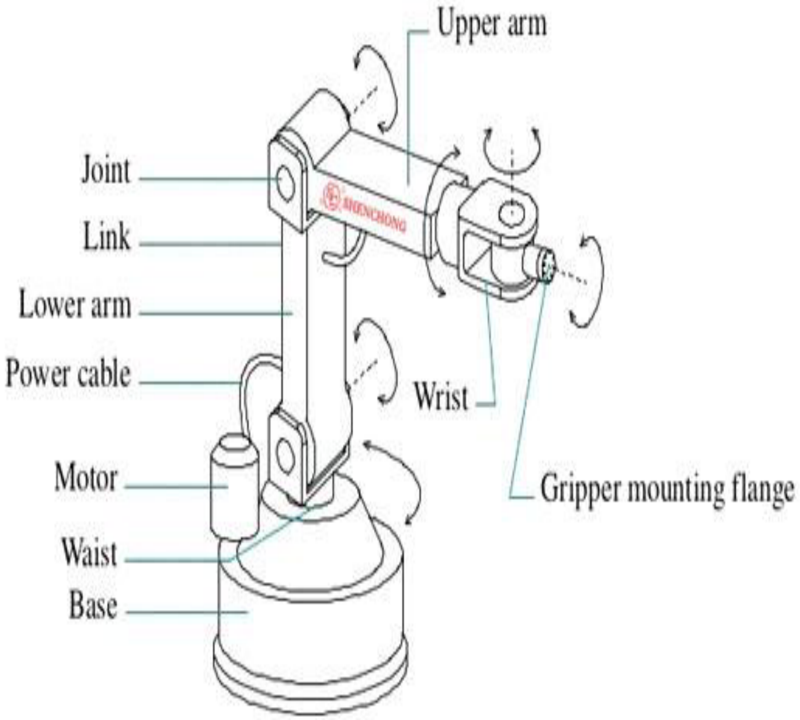
Robot Sensors

Robot Manipulators



The arm-like structure of an industrial robot is known as a robot manipulator. This component is responsible for completing the tasks the robot is programmed to perform. Also known as a robot arm, the manipulator mounts to the robot body and consists of multiple links and joints.

Links are rigid components that connect different sections of the robot arm. Their rigidity provides a solid structure, but joints are necessary for flexibility. As with the human body, robotic joints move in different ways, facilitating linear, rotary, and revolutionary motions. This allows the robot to perform the desired movements within its work envelope.



- Generally speaking, the manipulator is mainly composed of the following parts:
- - Hand or grasping mechanism: including fingers, force transmission mechanism, etc. It mainly plays the role of grasping and placing work
- - Transmission mechanism or arm: including wrist, arm, etc.It is mainly used to change the direction and position of objects.
- - Driving part: it is the power of the first two parts, so it is also called power source. There are four commonly used driving forms: hydraulic, pneumatic, electric and mechanical.
- - Control part: it is the command system of manipulator action. It controls the sequence (program), position and time (even speed and acceleration) of actions.
- - Other parts: such as machine body, walking mechanism, stroke detection device and sensing device, etc.

Robot Controllers

- There are three broad categories of robotic controllers:
  - **PLC** (Programmable Logic Controller),
  - **PAC** (Programmable Automation Controller),
  - **IPC** (Industrial Personal Computer).
- The PLC is the oldest technology and the lowest cost type of robot controller. It is used for simple applications that do not need complex motion control. The data logging ability of a PLC is also less capable than other types of robot controllers. The PLC will have fewer kinds of input/output devices.
- The PAC represents an updated version of the PLC. The PAC has more computing power and greater capability. There is a very broad range of applications for which a PAC is a good fit.
- The IPC has the greatest computing power, and it is also the most expensive type of robot controller. It can handle complex motions and can communicate via a wide variety of interfaces. The IPC can handle and store very large amounts of data.
- In deciding between different robot controllers, one important factor is software. Look for application-specific software packages. The application package will determine how easy it is to get up and running. It will also influence how much support you can expect for your particular needs.

Robotic Vision System

- A robotic vision system is a technology that enables a robot to “see.” These systems enable the machine to be able to identify, navigate, inspect or handle parts or tasks.
- A robotic vision system consists of one or more cameras connected to a computer. The computer contains a processing software program that helps the robot interpret what it sees. Then, the robot follows the program’s instructions—specified by the manufacturing facility’s staff—to complete the specified task.
- Additional elements, such as lighting, image sensors, communications devices or other components, can be incorporated to add to the machine’s overall capabilities.

- Robots can be used to handle a wide variety of tasks, such as:
- Product sorting
- Product assembly
- Measuring
- Depalletizing

Degree of Freedom

- A ‘Degree of Freedom’ (DoF) as it relates to robotic arms, is an independent joint that can provide freedom of movement for the manipulator, either in a rotational or translational (linear) sense.
- Every geometric axis that a joint can rotate around or extend along is counted as a Single Degree of Freedom.
- The two most common joints are:

- **Revolute Joint:** Providing one degree of rotational freedom
- **Prismatic Joint:** Providing one degree of linear freedom

- Each axis of a robot represents a degree of freedom or in simpler terms an independent motion. Each axis allows a robot to gain a degree of freedom, meaning it has increased functionality. The more axes a robot has, the more degrees of freedom it has which allows it access to greater amounts of space.

• 2 DOF

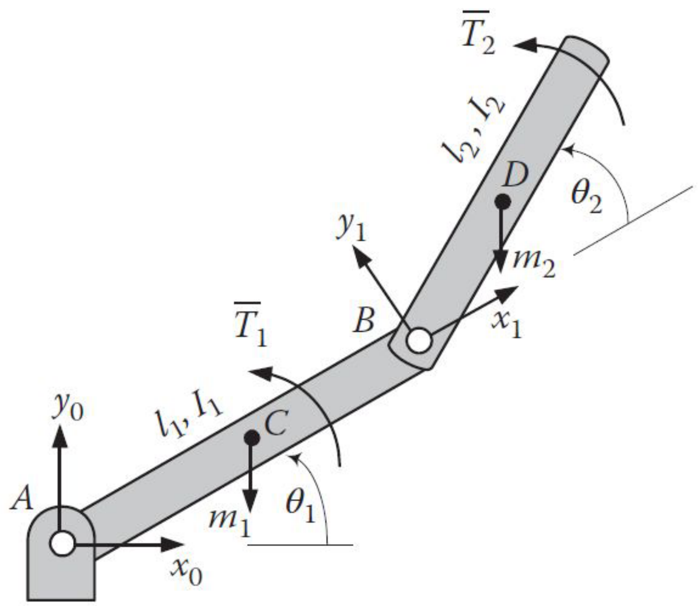
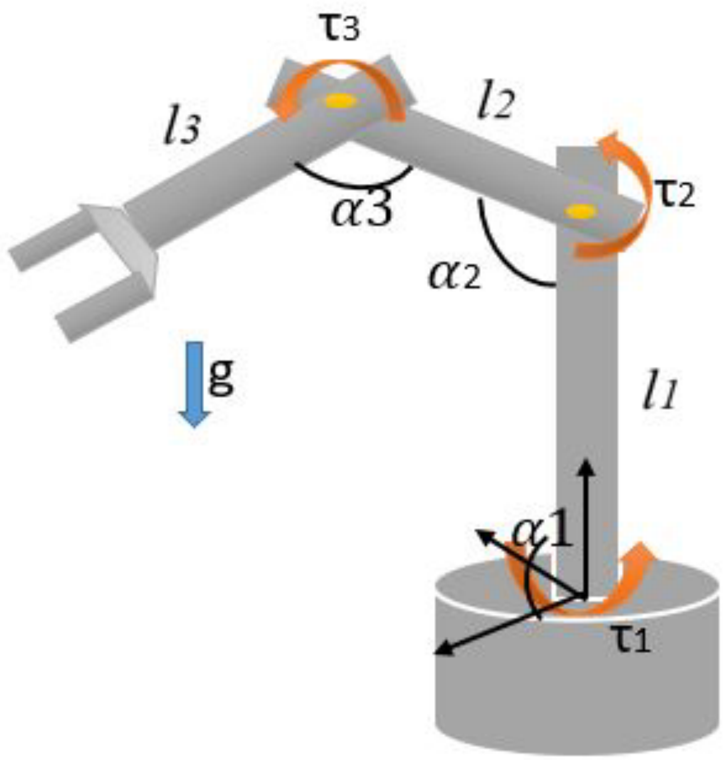
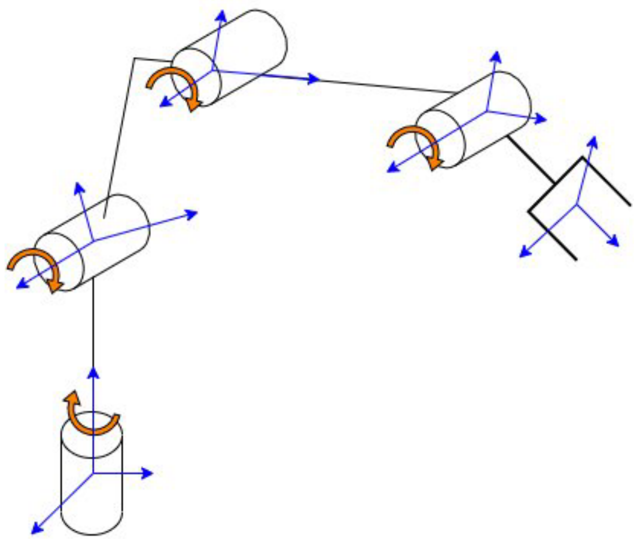


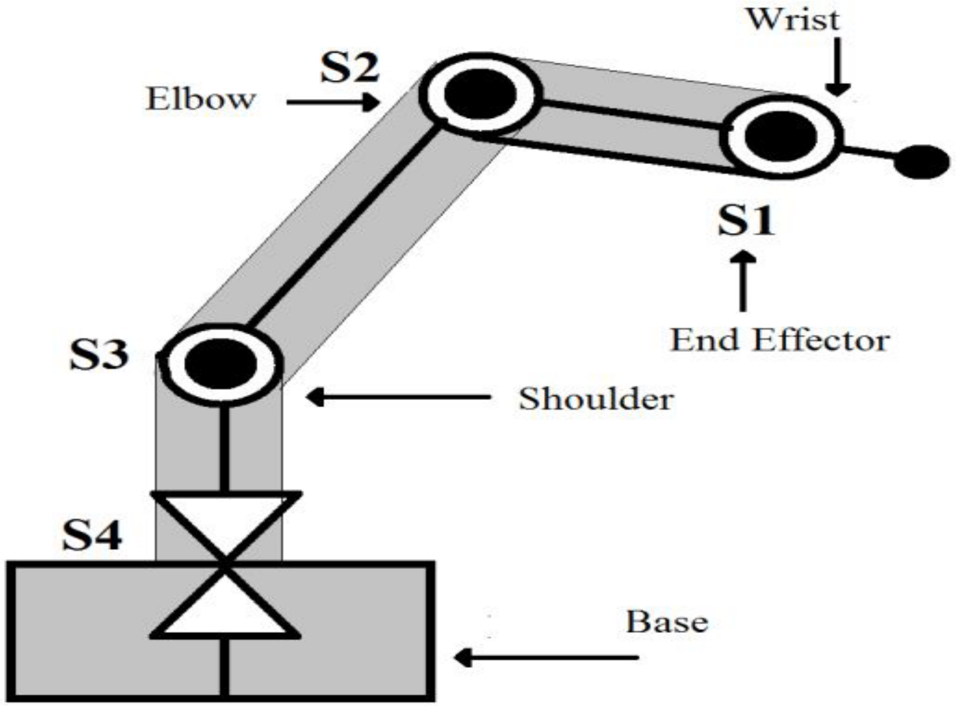
Figure 6.6 A 2-DOF robot arm.

- 3 DOF

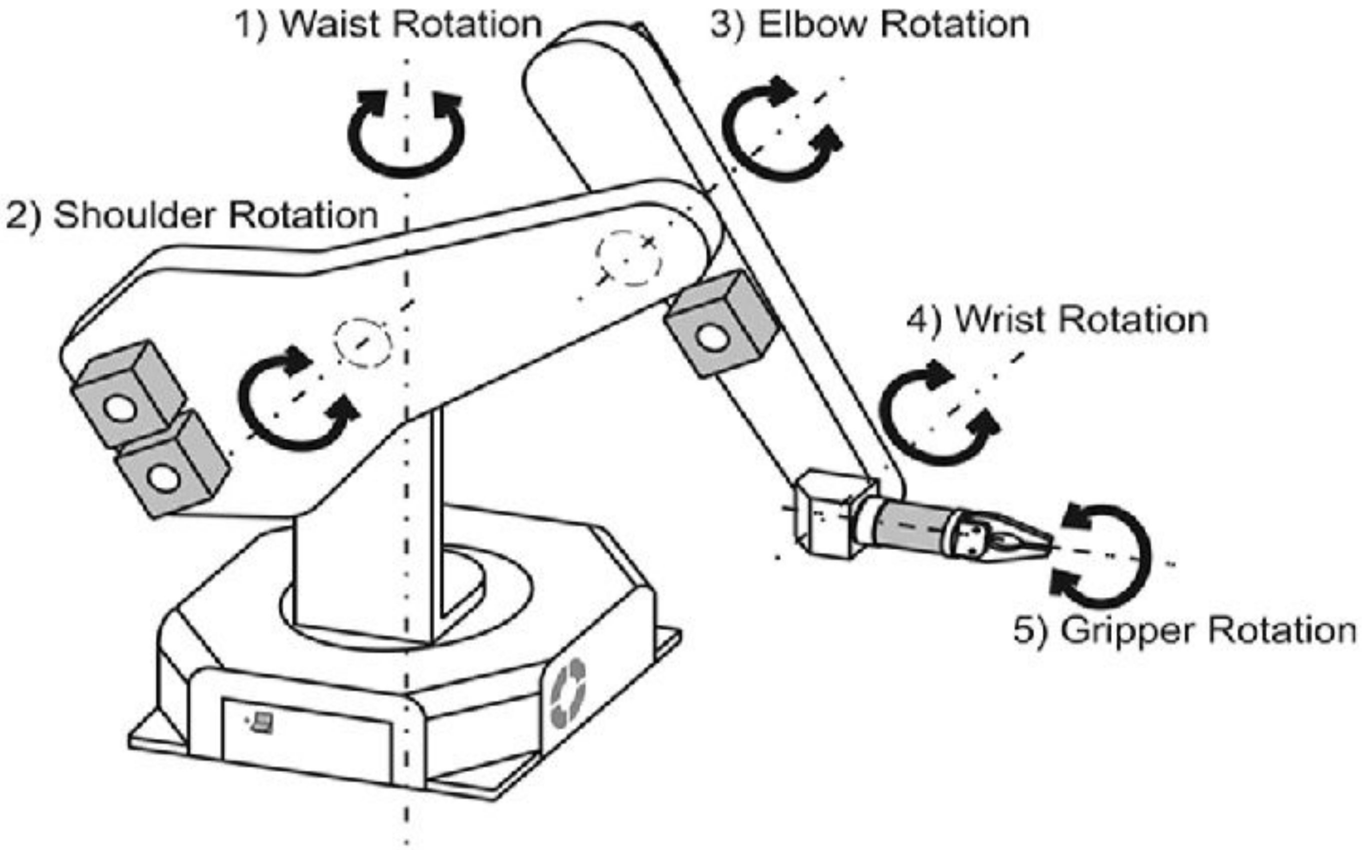


- 4 DOF

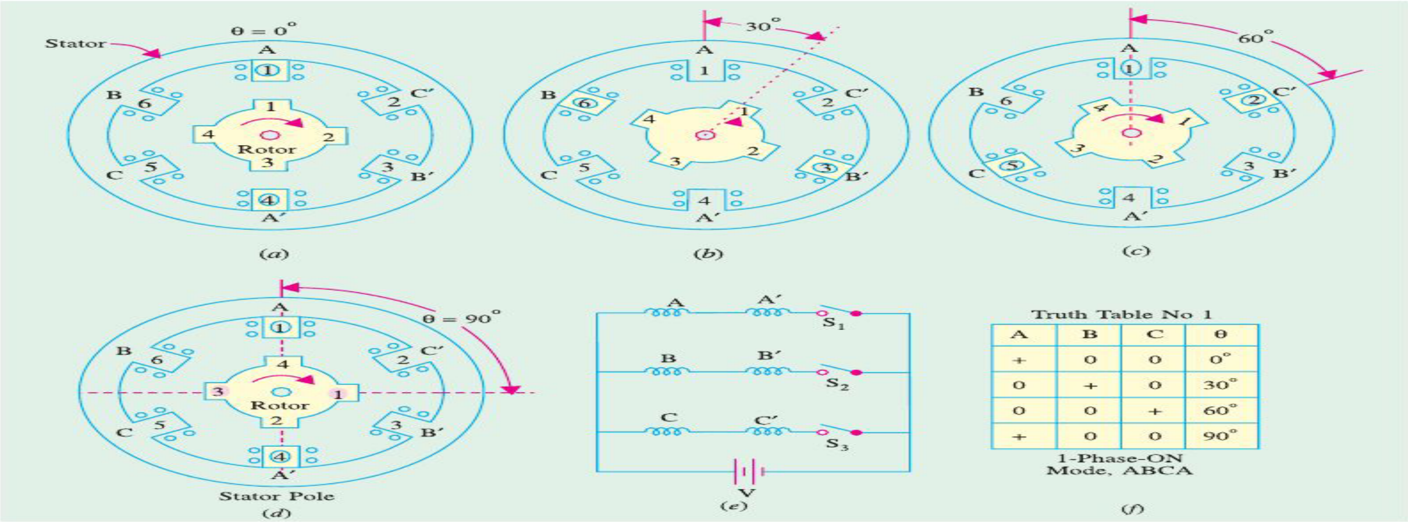




- 5DOF


1) Waist Rotation
3) Elbow Rotation
2) Shoulder Rotation
4) Wrist Rotation
5) Gripper Rotation

Motors



Truth Table No 1

A	B	C	θ
+	0	0	0°
0	+	0	30°
0	0	+	60°
+	0	0	90°

1-Phase-ON Mode, ABCA