BTME 3072
Robotics and Automation
Lecture 5

2nd Year

III Semester

Galgotias University

2020-21

Unit I: Introduction to Robotics

- Definition of a Robot –
- Basic Concepts –Robot configurations –
- **Types of Robot drives –**
- Basic robot motions –
- Point to point control –
- Continuous path control.

Objectives of the lecture

- Drive system and its requirements
- Brief explanation of the drive system

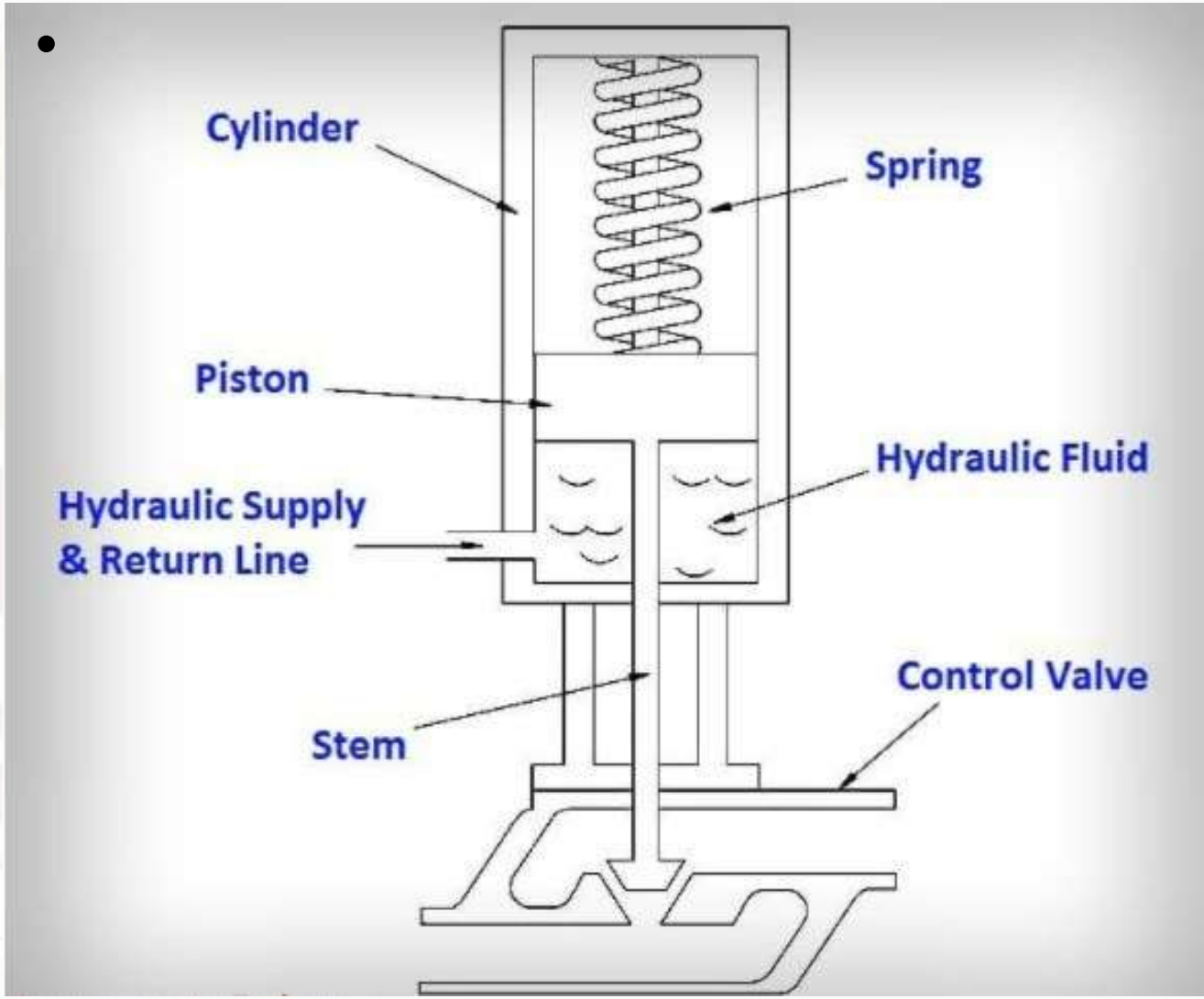
Major types of the drive system

- Hydraulic Actuators
- A common example of a hydraulic device is the braking system of a modern car, here only moderate force applied to the brake pedal produces a large enough force at the brake pads to stop the car.
- The underlying principle of all hydraulic systems is Pascal's Law, which states:-

If external pressure is applied to a confined fluid, the pressure is transferred without loss to all surfaces in contact with the fluid.

Hydraulic Actuators

- A **hydraulic actuator** consists of a cylinder or fluid motor that uses **hydraulic** power to facilitate mechanical operation.
- The mechanical motion gives an output in terms of linear, rotary or oscillatory motion.
- Because liquids are nearly impossible to compress, a **hydraulic actuator** can exert considerable force.



Hydraulic Actuators

- A liquid is confined in a cylinder between the two pistons A and B.
- If a force of 3kg is applied to B which has a surface area of 1 sq. cm.
- There will be a pressure in the liquid of 3 kg per sq. cm or 300 KPa.
- According to Pascal's law there is also a pressure on the surface of piston A. Piston A has a surface area of 20 sq. cm the force on piston A would therefore be 60 kg.
- It appears we have multiplied the input force 20 times. Now because the liquid is incompressible, then if piston B is moved through 20 cm then piston A will only move through 1 cm, therefore this can be summed up with the equation :

Force x Distance moved at input = Force x Distance moved at output

Advantages of Hydraulic Actuators

- Hydraulic actuators are rugged and suited for high force applications. They can produce forces 25 times greater than pneumatic cylinders of equal size. They also operate in pressures of up to 4,000 psi.
- A hydraulic actuator can hold force and torque constant without the pump supplying more fluid or pressure due to the incompressibility of fluids.
- Hydraulic actuators can have their pumps and motors located a considerable distance away with minimal loss of power.

Disadvantages of Hydraulic Actuators

- Hydraulics will leak fluid. Like pneumatic actuators, loss of fluid leads to less efficiency and cleanliness problems resulting in potential damage to surrounding components and areas.

- Hydraulic actuators require many complementary parts, including a fluid reservoir, motor, pump, release valves, and heat exchangers, along with noise reduction equipment.

Pneumatic drive system

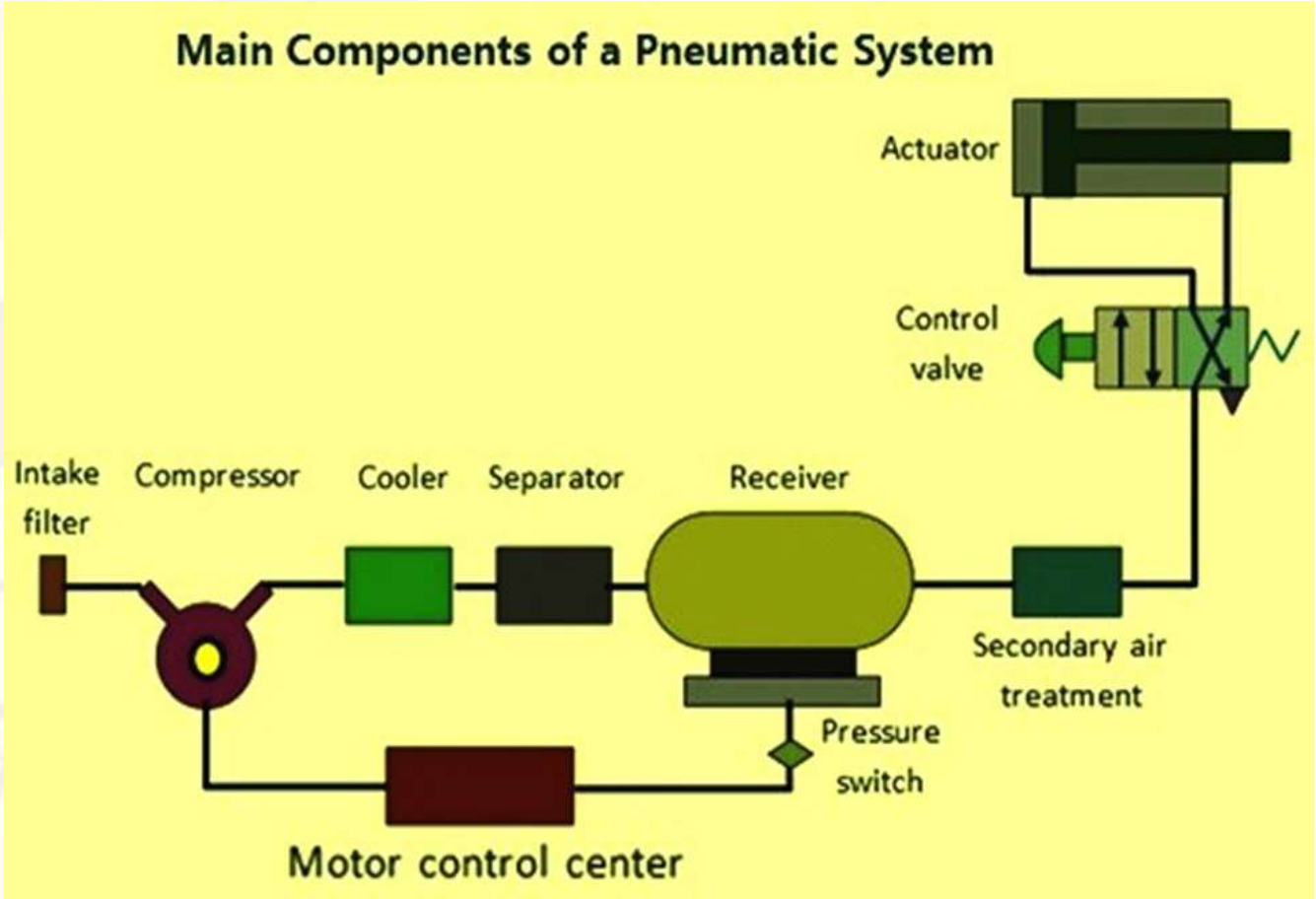
- A pneumatic system is a system that uses compressed air to transmit and control energy.
- Pneumatic systems are used extensively in various industries.
- Most pneumatic systems rely on a constant supply of compressed air to make them work. This is provided by an air compressor.
- The compressor sucks in air from the atmosphere and stores it in a high pressure tank called a receiver.
- This compressed air is then supplied to the system through a series of pipes and valves.

Main components of pneumatic system

- Air compressor converts the mechanical energy of an electric or combustion motor into the potential energy of compressed air.
- The types of compressors in the compressed air systems are
  - (i) piston or reciprocating compressors,
  - (ii) rotary compressors,
  - (iii) centrifugal compressors, and
  - (iv) axial flow compressors.
- Reciprocating compressors are
  - (i) single stage or double stage piston compressor, and
  - (ii) diaphragm compressor.
- Rotary compressors are
  - (i) sliding vane compressor, and
  - (ii) screw compressor.
- Air drying system can be
  - adsorption type,
  - absorption type,
  - refrigeration type, or the type that uses semi permeable membranes.
- Also an inline filter is provided to remove any contaminant particles present.
- This treatment is called primary air treatment.
- In the third stage which is the secondary air treatment process, further filtering is carried out.

components of pneumatic system

- The main components of air consuming system consist of
  - intake filter,
  - compressor,
  - air take off valve,
  - auto drain,
  - air service unit,
  - directional valve,
  - actuators, and
  - speed controllers.



Advantages of pneumatic systems

- High effectiveness – There is an unlimited supply of air in the atmosphere to produce compressed air.
- High durability and reliability – Pneumatic system components are extremely durable and cannot be damaged easily.
- Simple design – The designs of pneumatic system components are relatively simple. High adaptability to harsh environment – Compared to the elements of other systems, compressed air is less affected by high temperature, dust, and corrosive environment, etc. Hence they are more suitable for harsh environment.
- Safety aspects – Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosionEasy selection of speed and pressure.
- Environmental friendly – The operation of pneumatic systems do not produce pollutants.
- Economical – As the pneumatic system components are not expensive, the costs of pneumatic systems are quite low. Moreover, as pneumatic systems are very durable, the cost of maintenance is significantly lower than that of other systems.

Limitations of pneumatic systems

- Relatively low accuracy – As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air.
- Low loading – As the cylinders used in pneumatic systems are not very large, a pneumatic system cannot drive loads that are too heavy.
- Processing required before use – Compressed air must be processed before use to ensure the absence of water vapour or dust.
- Uneven moving speed – As air can easily be compressed, the moving speeds of the pistons are relatively uneven.
- Noise – Noise is usually produced when the compressed air is released from the pneumatic components.

Application of pneumatic systems

- pneumatic presses,
- pneumatic drills,
- operation of system valves for air, water or chemicals, unloading of hoppers and bins,
- machine tools,
- pneumatic rammers,
- lifting and moving of objects,
- spray painting,
- holding in jigs and fixtures,
- holding for brazing or welding,
- forming operations, riveting, operation of process equipment etc.

Summery

- Hydraulic drive system and its characteristics were discussed.
- Pneumatic drive system and working , advantages and limitations are discussed.

Questions

- Discuss the hydraulic drive system its working, advantages, disadvantages and application.
- Discuss the pneumatic drive system its working, advantages, disadvantages and application.

Text books

- Introduction to robotics mechanics and control by John J Craig
- Fundamentals of Robotic Mechanical Systems by Jorge Angeles
- Robot Operating System for Absolute Beginners: Robotics Programming Made Easy by Lentin Joseph
- Reference book
  - Robotic process automation
  - Robotic Process Automation For Dummies®, NICE Special Edition

Thank You !