SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Coimbatore-35

Department of Biomedical Engineering

Course Name: ROBOTICS AND AUTOMATION IN MEDICINE

III Year : VI Semester

TITLE: PNEUMATIC AND HYDRAULIC ACTUATORS

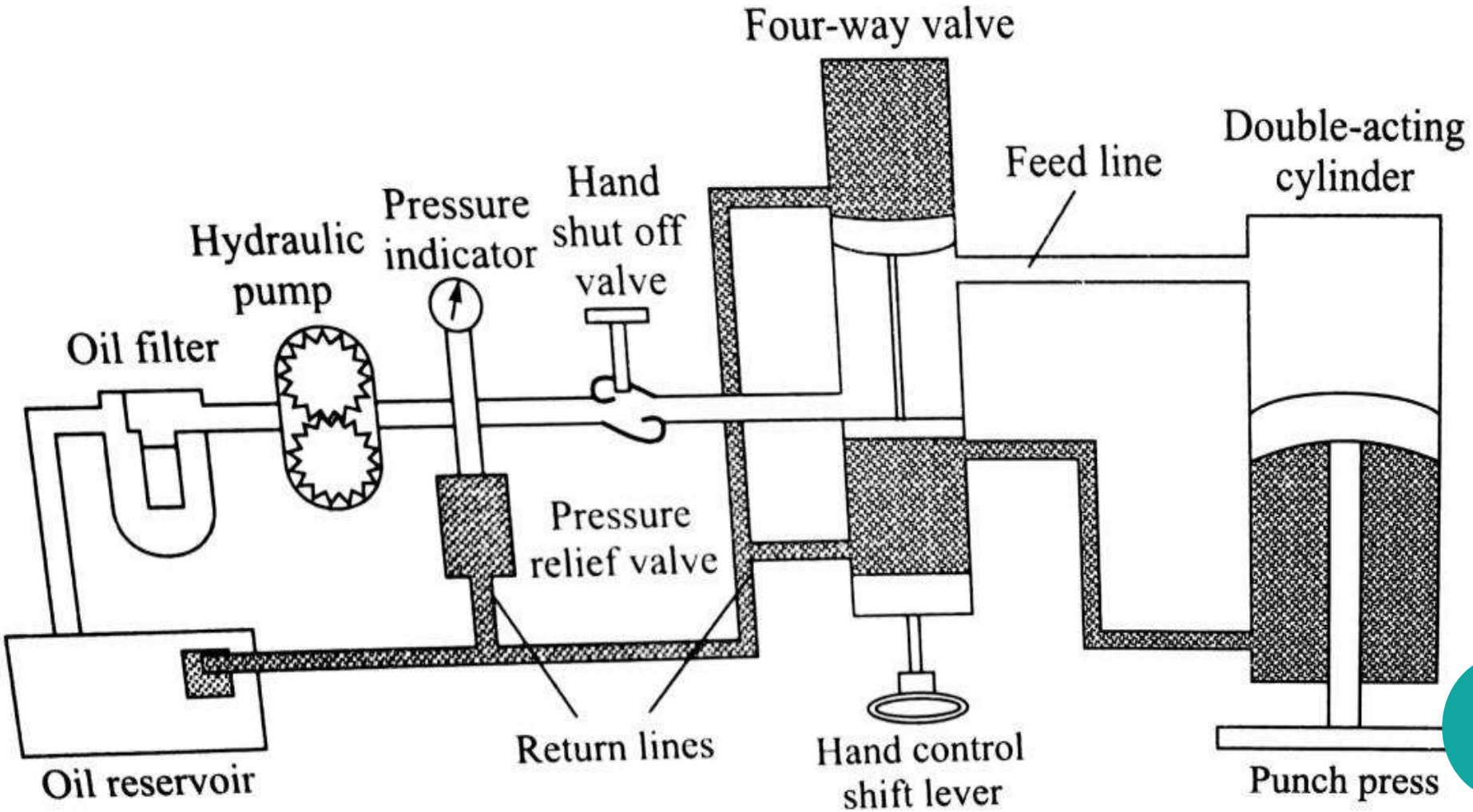
Actuators

- Actuators are devices which provide the actual ***motive force for the robot joints***
- Actuators are like the ***muscles*** of a human arm and hand
- The actuators are classified based on their source of power as:
  - Hydraulic Actuators
  - Pneumatic Actuators and
  - Electric Actuators

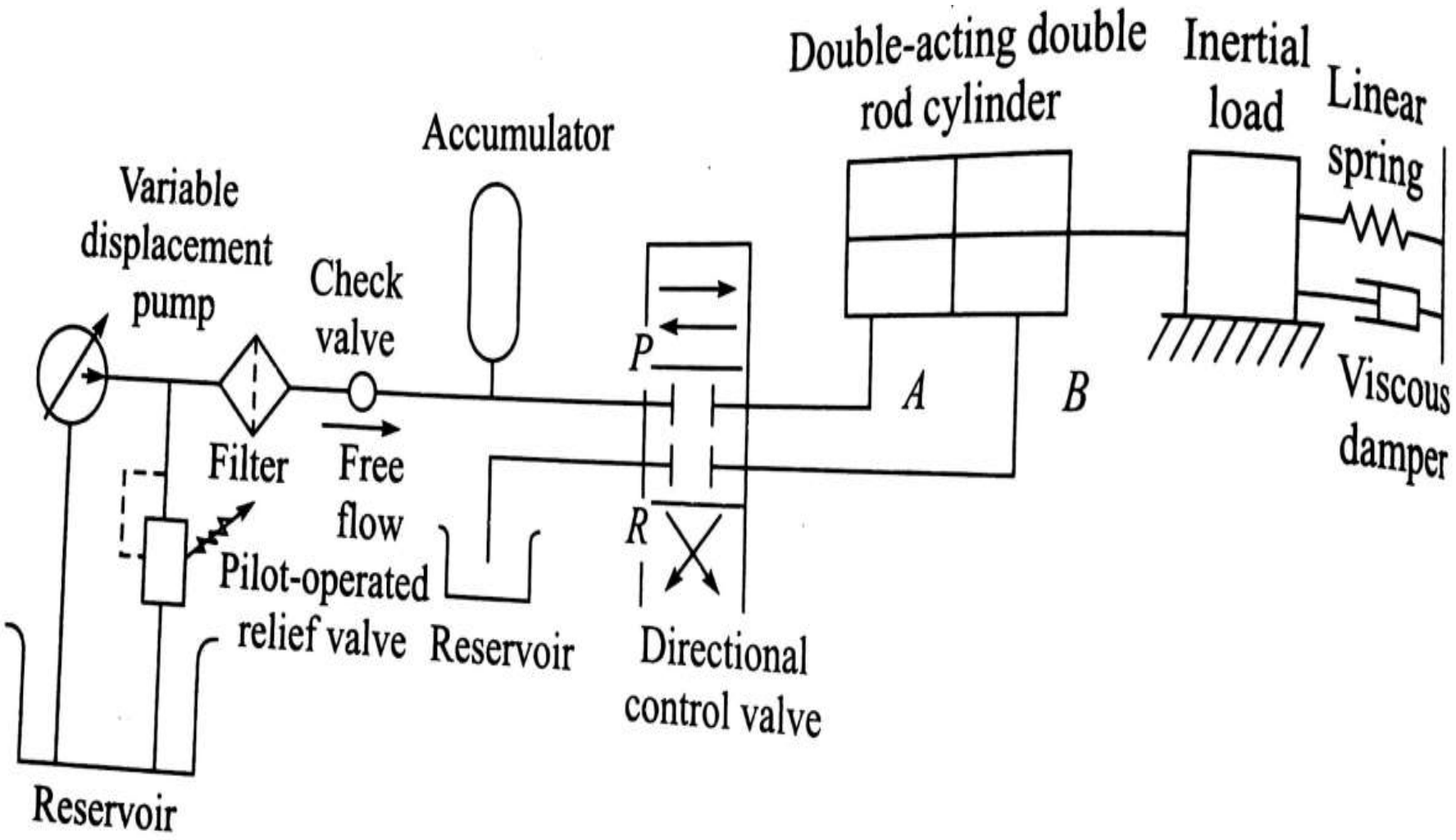
Hydraulic Actuators

- Hydraulic actuators are ***powered by pressurized oil***
- Hydraulic actuators are designed to operate at pressures of ***1000 to 3000 psi*** and are hence suitable for ***high power applic***ations

Hydraulic Actuators



Hydraulic Actuators



Hydraulic Actuators

- The oil (source of power for hydraulic actuators) is stored in a reservoir
- The oil is first filtered by an oil filter
- The filtered oil is sucked using a hydraulic pump
- Valves are used to control the flow of oil in the circuit. There is a four – way valve which allows the flow of oil in forward and reverse directions
- The flow of oil in the forward direction is via the feed line, and in the reverse direction it is via the return line
- The pressurized oil actuates a piston inside the cylinder, which causes the actuation of joints of a robot

Hydraulic Actuators

- An ***accumulator*** is a storage device which can be used when there is a sudden demand in power
- The inertial load, linear spring and viscous damper represent the mechanical system of robot
- An important attribute to be selected is the ***bulk modulus of the oil***
- If the ***bulk modulus of oil is high***, the ***robot is stiff***, ***quick responding*** and the ***pressure build up is fast***
- If the ***bulk modulus is low***, the ***robot is loose, slow responding*** and the ***pressure build up takes a lot of time***

Advantages

- ***High efficiency and high power-to-size ratio***
- ***Complete and accurate control*** over speed, position and direction of actuators are possible
- ***Large forces can be applied*** directly at desired locations
- ***Greater load carrying capacity*** than pneumatic and electric actuators
- ***No mechanical linkages*** are required
- ***Self-lubricating*** and ***non-corro***sive. (since oil is used)
- Can ***meet sudden demands in power*** (because o presence of accumulator)
- More ***capable of withstanding shock loads*** than the electric actuators

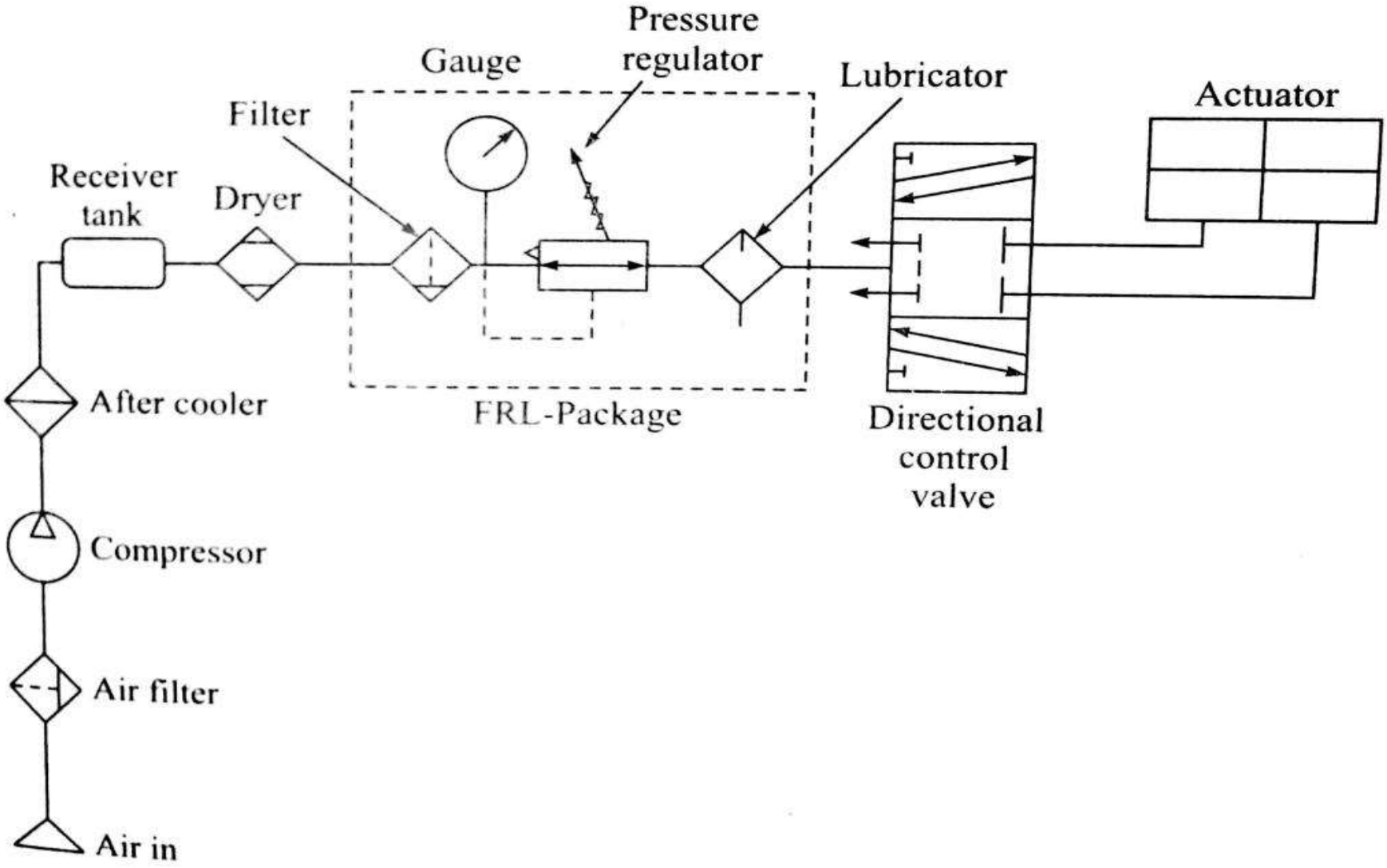
Disadvantages

- ***Leakages*** can occur, causing loss in performance and general contamination of working area
- ***Risk of fire*** is higher
- The power pack is ***noisy*** (70dB), if not protected by ***acoustic muffler***
- As the ***viscosity of oil changes with temperature***, the movement of robot gets affected (When temperature increases, viscosity decreases and hence movement increases. When temperature decreases, viscosity increases and hence movement decreases or becomes sluggish)
- For smaller robots, hydraulic actuators are not economically feasible

Pneumatic Actuators

- Pneumatic actuators are ***powered by compressed air***
- Pneumatic actuators are used for ***opening and closing motions of jaws*** in the gripper of the robot
- Pneumatic actuators operate at about ***100 psi*** and are ***not suitable for high power applications***

Pneumatic Actuators



Pneumatic Actuators

- The air which is the source of power for pneumatic actuators is first filtered for dust particles if any
- The filtered air is then compressed using a compressor
- The compressed clean air after passing through an after cooler is stored in the receiver tank
- The stored air is then passed through the drier for removal of moisture content, as moisture can damage the components of pneumatic system

Pneumatic Actuators

- The dry air then passes through a FRL (Filter – Regulator – lubricator) package, where it is filtered, regulated (controlled) and lubricated
- This air then passes through a direction control valve and then actuates the actuator component

Advantages

- Cheapest of all the actuators
- Easy to store and transmit compressed air
- Compressed air is clean, explosion proof and insensitive to temperature variations
- They are reliable and maintenance cost is low because of fewer moving parts
- Technology is very familiar one
- Very quick in action and response time is less, thus suitable for fast work cycles
- No mechanical transmission device is usually required
- No danger of explosion or electrocution
- Compact system
- Control is simple
- Interconnection between components is easy

Disadvantages

- Since air is compressible, precise control of speed and position is not easily obtainable
- Resetting the system will be slow if mechanical stops are used
- Not suitable for heavy loads
- If moisture penetrates the units, the components can get damaged.