

Chapter 4

Faradays law

$$V = - \frac{d\Phi}{dt} = G U$$

→ Lenz's law

Transduction constant
 $= \frac{V}{m}$

Velocity

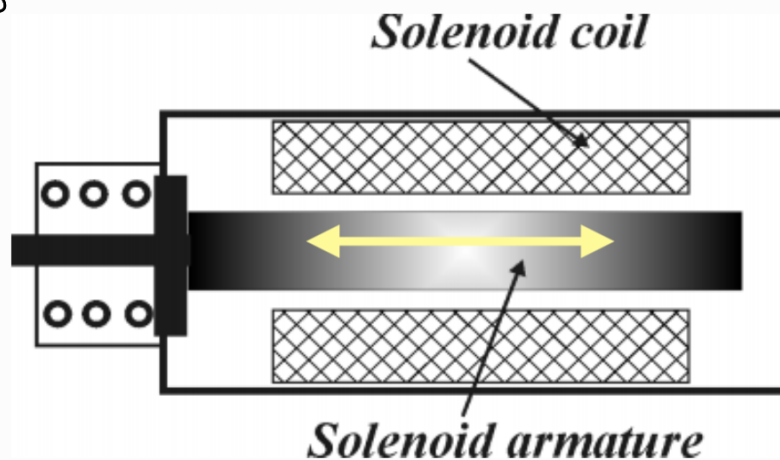
Forces in the magnetic field

$$F = I (L \times B)$$

← length
← current
← النسبة

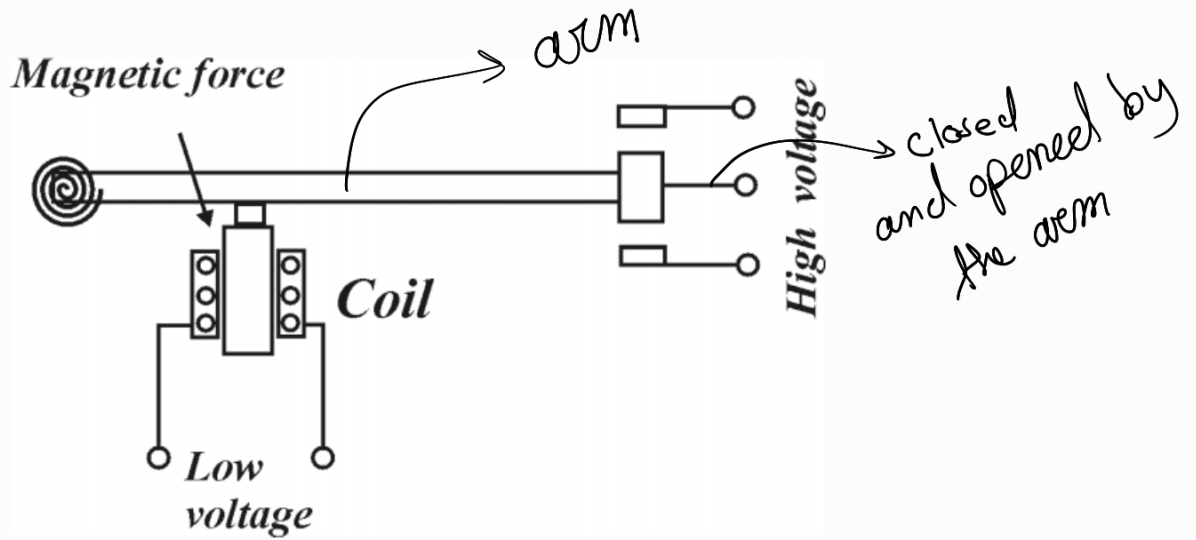
Solenoids and relays

Solenoids



Electromagnetic energy → linear motion

Relays

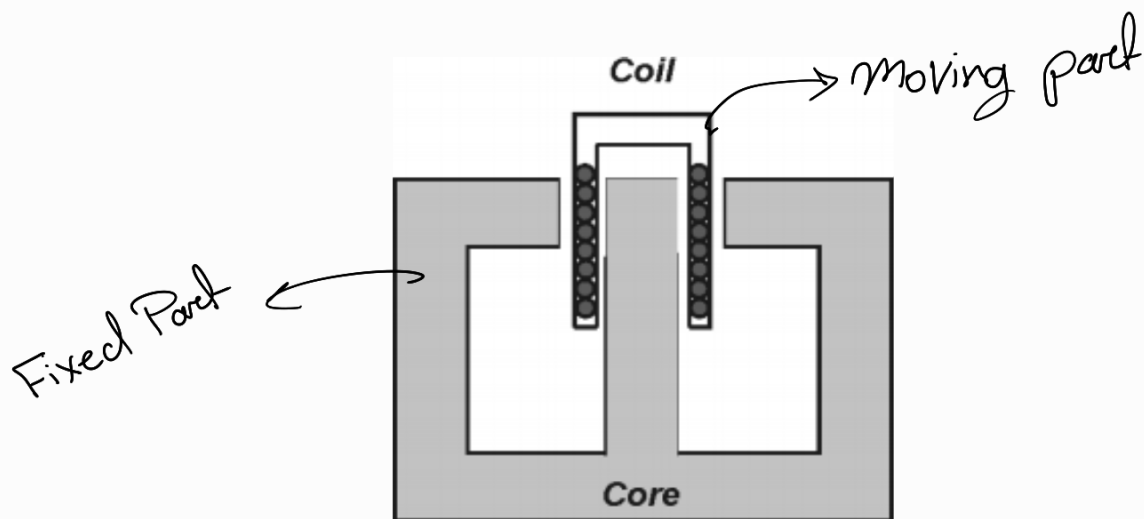


Types :

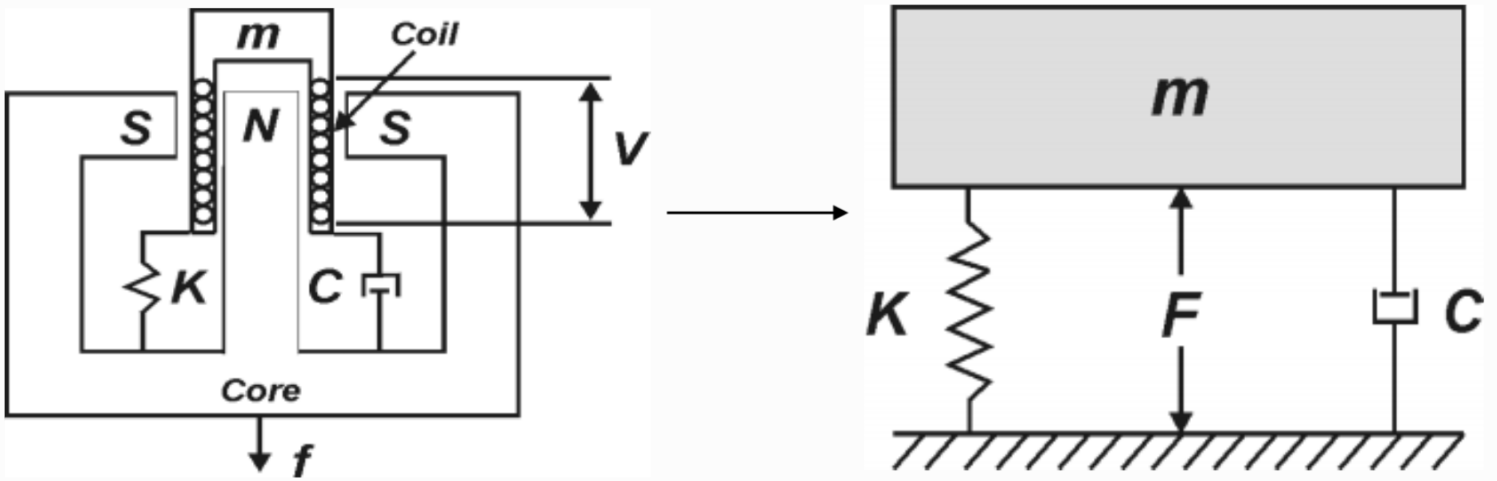
- NO → disconnected until relay is energized
- NC → connected until relay is energized
- CO → Controls two circuits → NO & NC

Voice coil linear actuator

- The coil itself moves
- used for precise displacements but- for short strokes



Voice coil linear actuator modeling



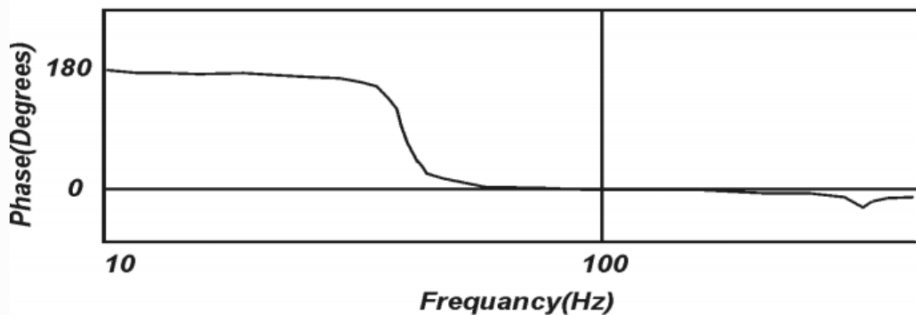
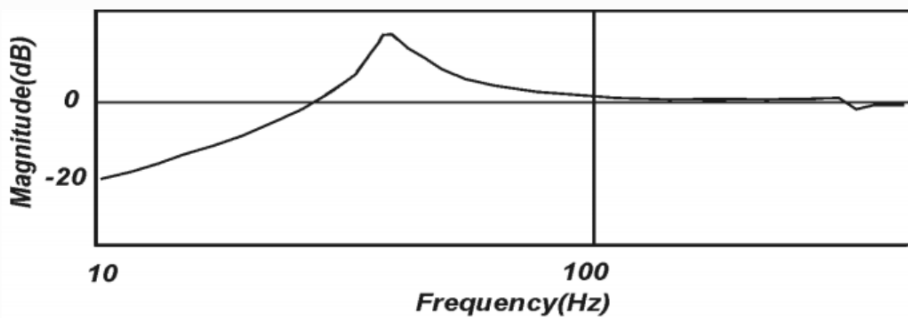
1 DoF system

Equation: $m\ddot{x} + C\dot{x} + Kx = F$

Laplace: $m s^2 X + C s X + K X = G I$
 $X (m s^2 + C s + K) = G I$

$$\frac{X}{I} = \frac{G}{m s^2 + C s + K} \rightarrow \frac{F}{I} = \frac{-G s^2}{s^2 + 2\zeta \omega_n s + \omega_n^2}$$

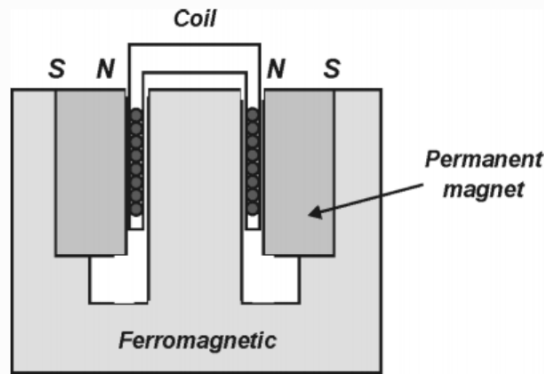
ζ ← $\frac{C}{2m\omega_n}$
 ω_n ← $\frac{\sqrt{K}}{m}$



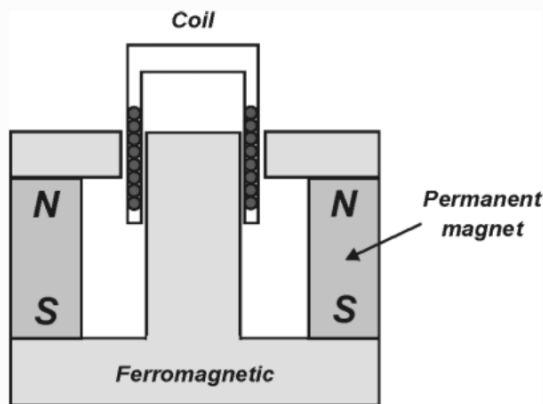
Configuration of voice coil actuators

1. Radial force V.C.A

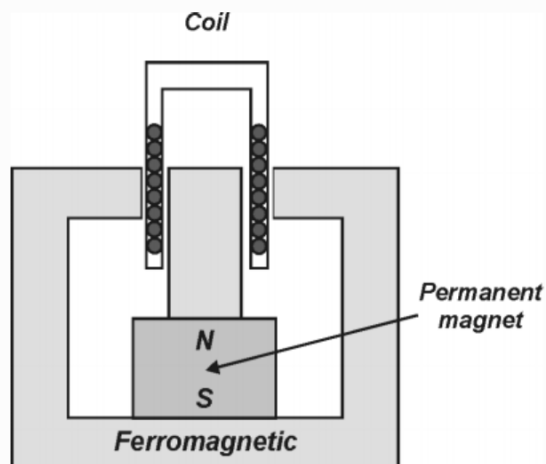
- High force
- Expensive



2. Axial force V.C.A

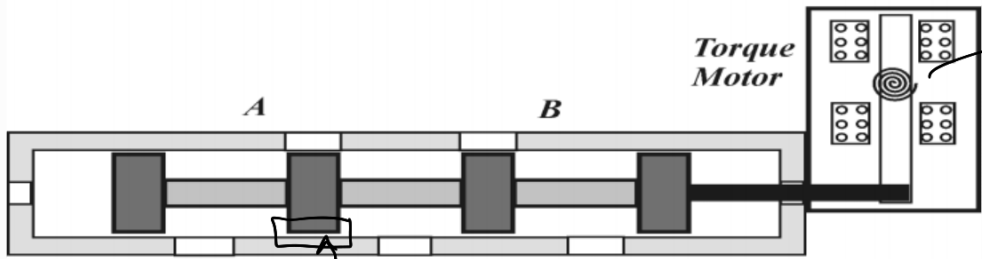


3. Axial disk V.C.A



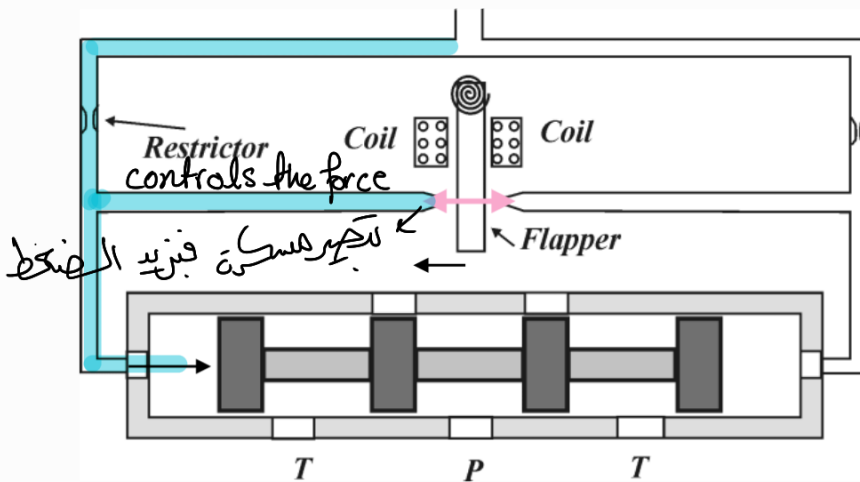
Servo Valves → armatures moves in full stroke (open or closed)

- Single stage spool valve

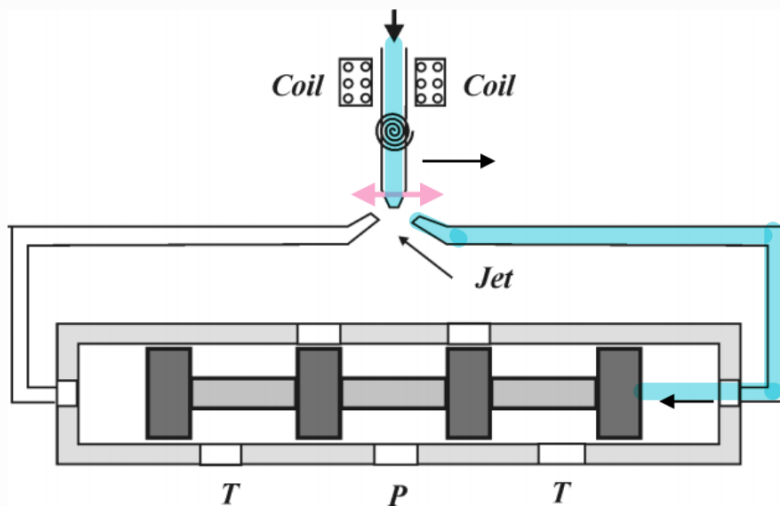


There is a friction here and so **dither signal** is used
 ↳ Signal with small amplitude and a high frequency of 100 Hz

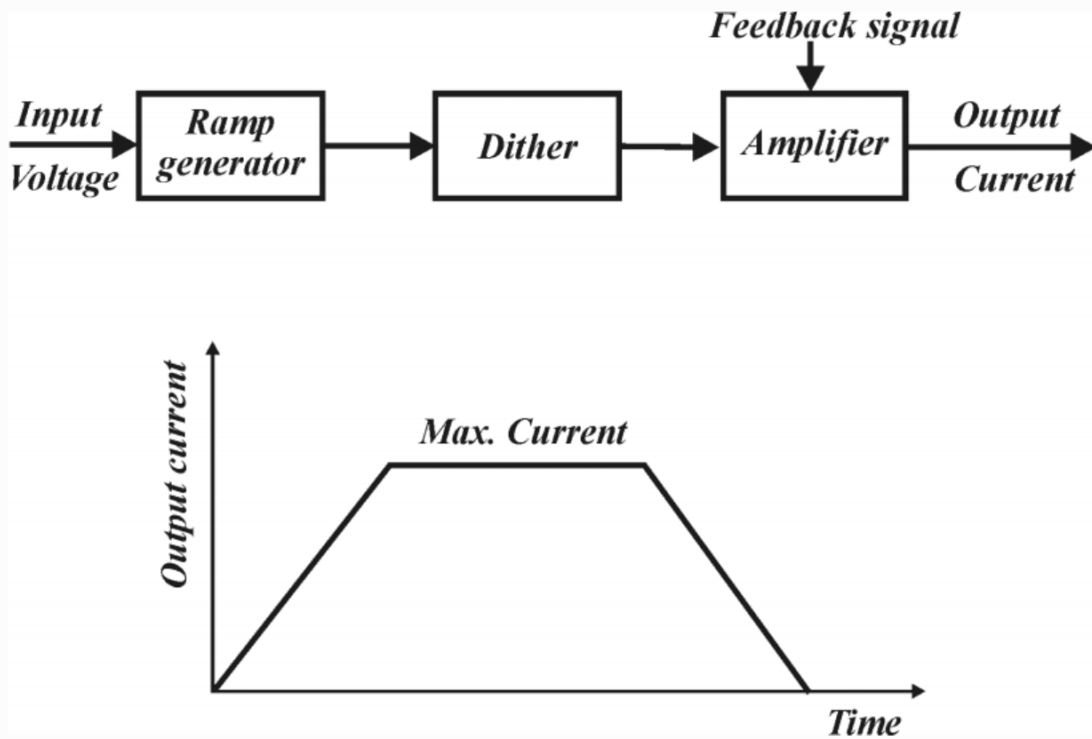
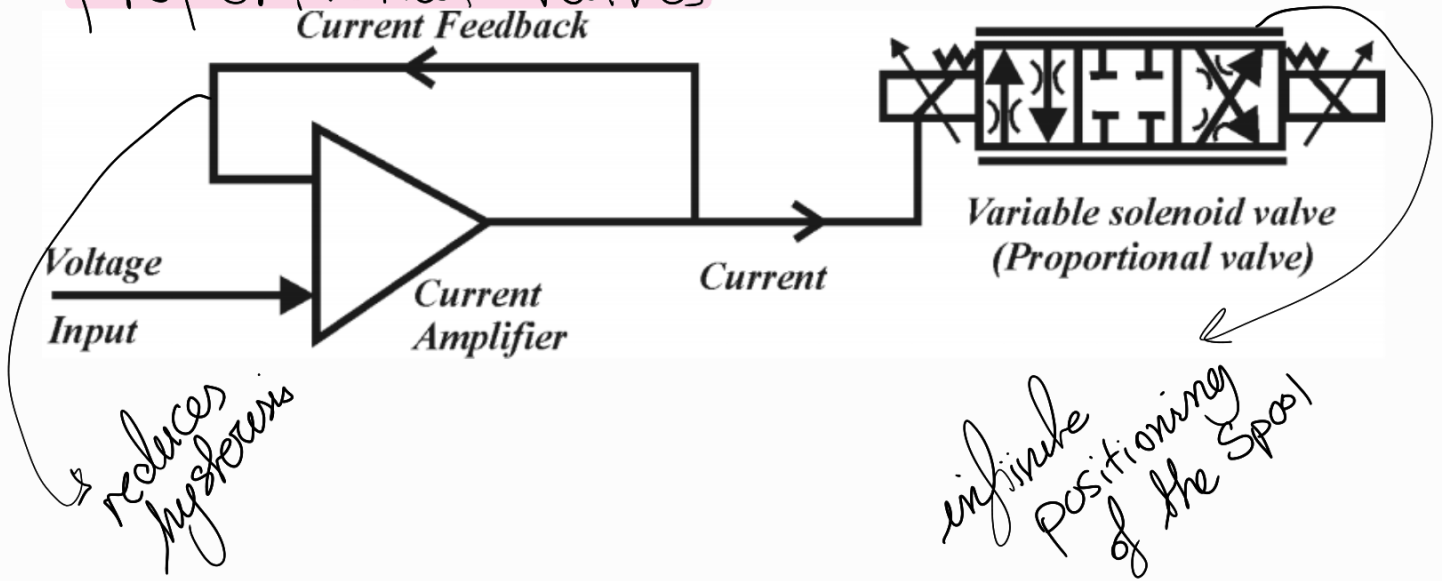
- Flapper type valve



- Jet type servo valve



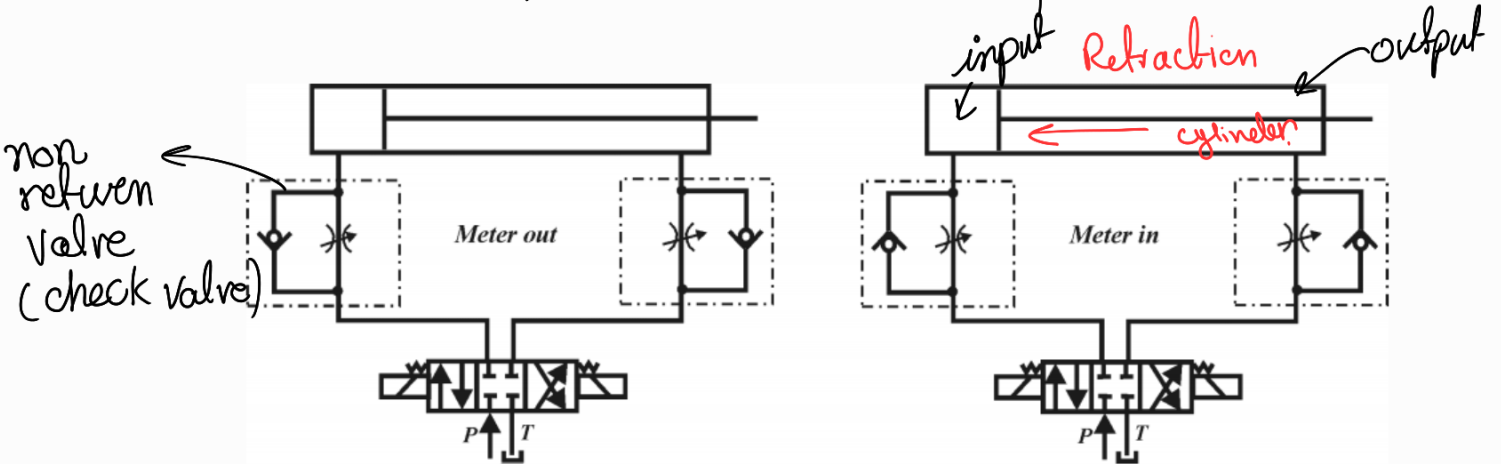
Proportional valves



Characteristic	Proportional valve	Servo valve
Valve lap	Overlap with dead zone	Zero or underlap without dead zone
Response time	40 - 60 ms	5 - 10 ms
Operating frequency	10 Hz	100 Hz
Hysteresis	1% - 5%	0.1%

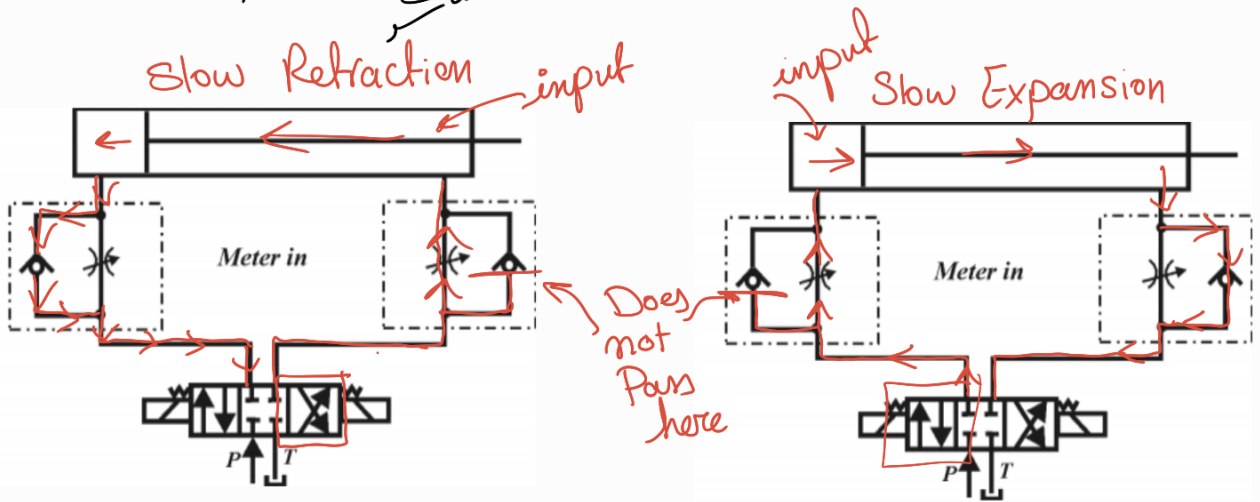
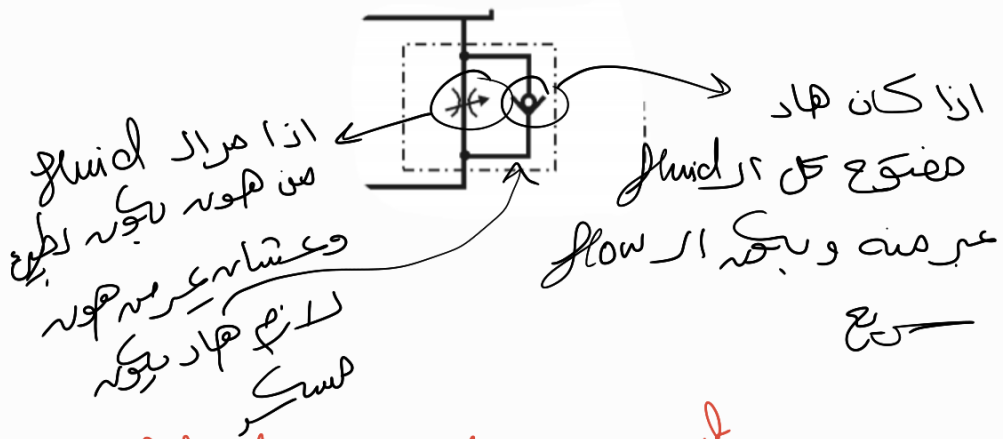
Control of actuators

Meter in and Meter out technique



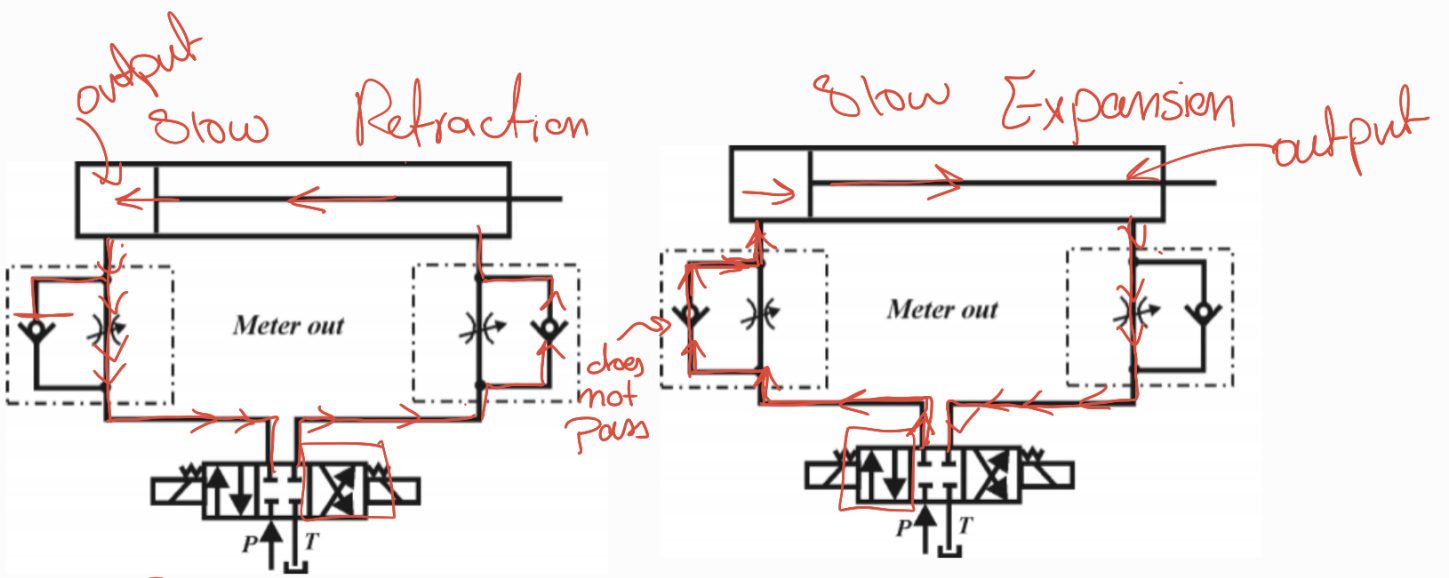
controls fluid coming out

controls fluid coming in



قدرا نفع
سبره از input

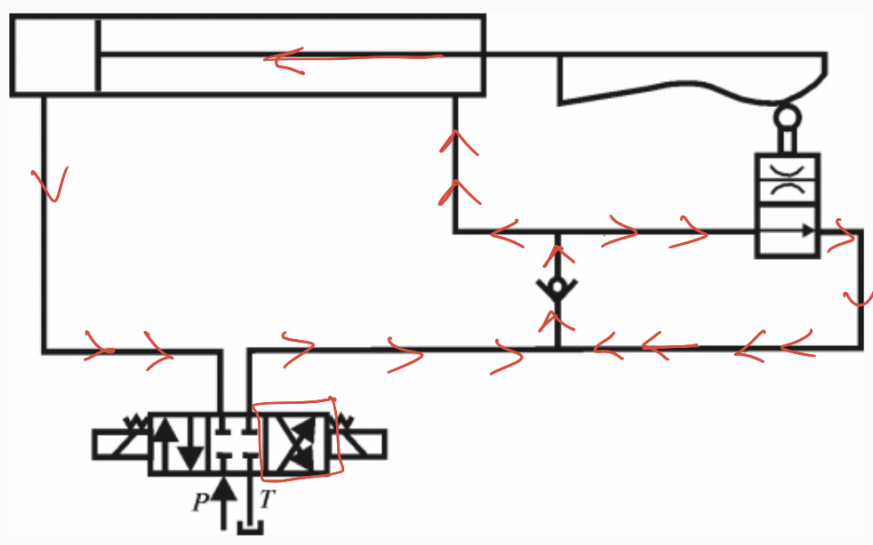
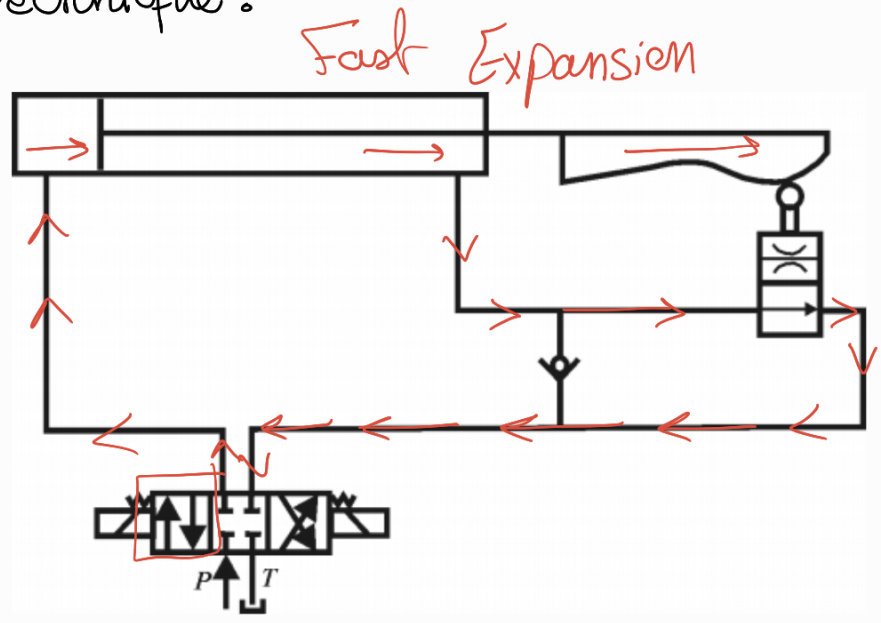
دهون قدرا نفع
سبره از input



قبرنا نضع
 سرعة ال- output

دهون قبرنا نضع
 سرعة ال- output

Another technique:



Pump control

Pressure relief valve (PRV)

No flow
No control

