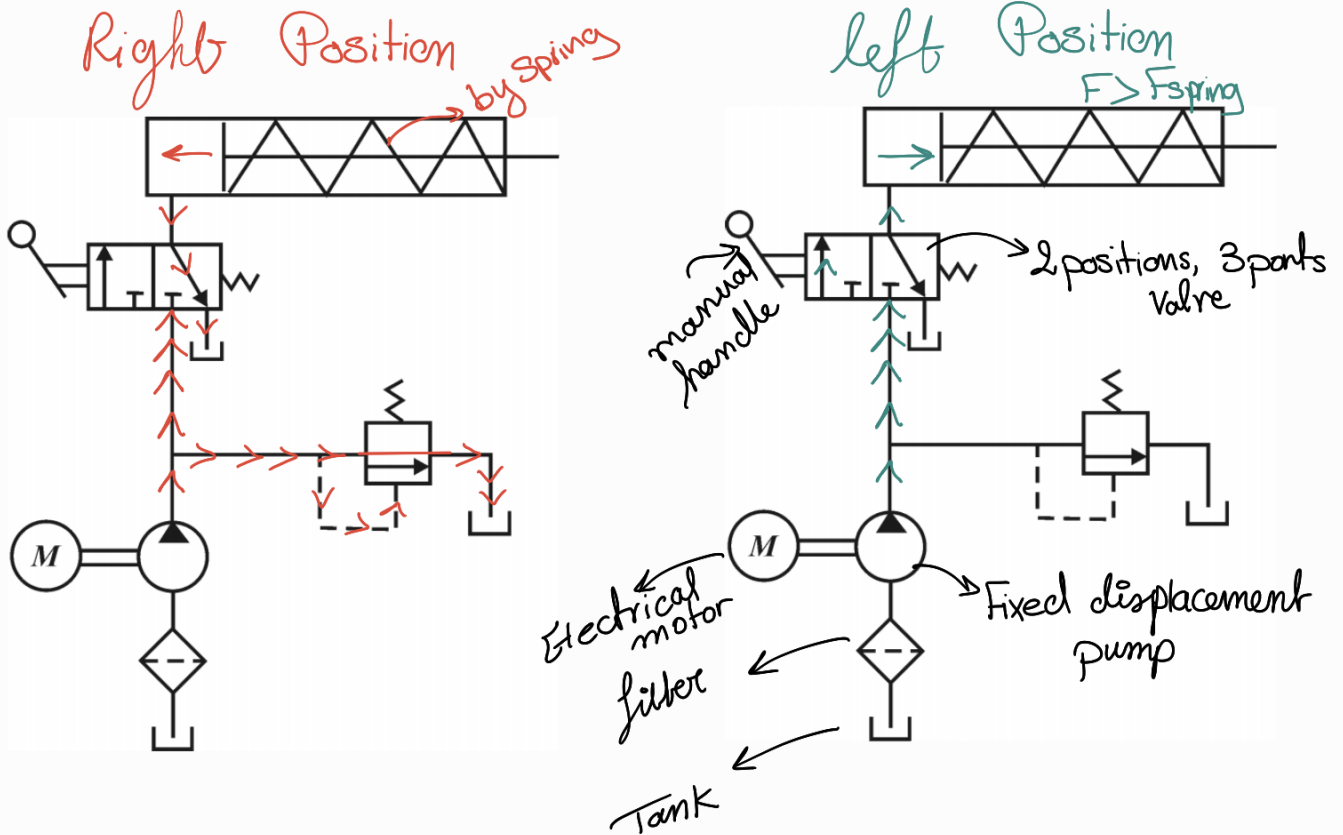
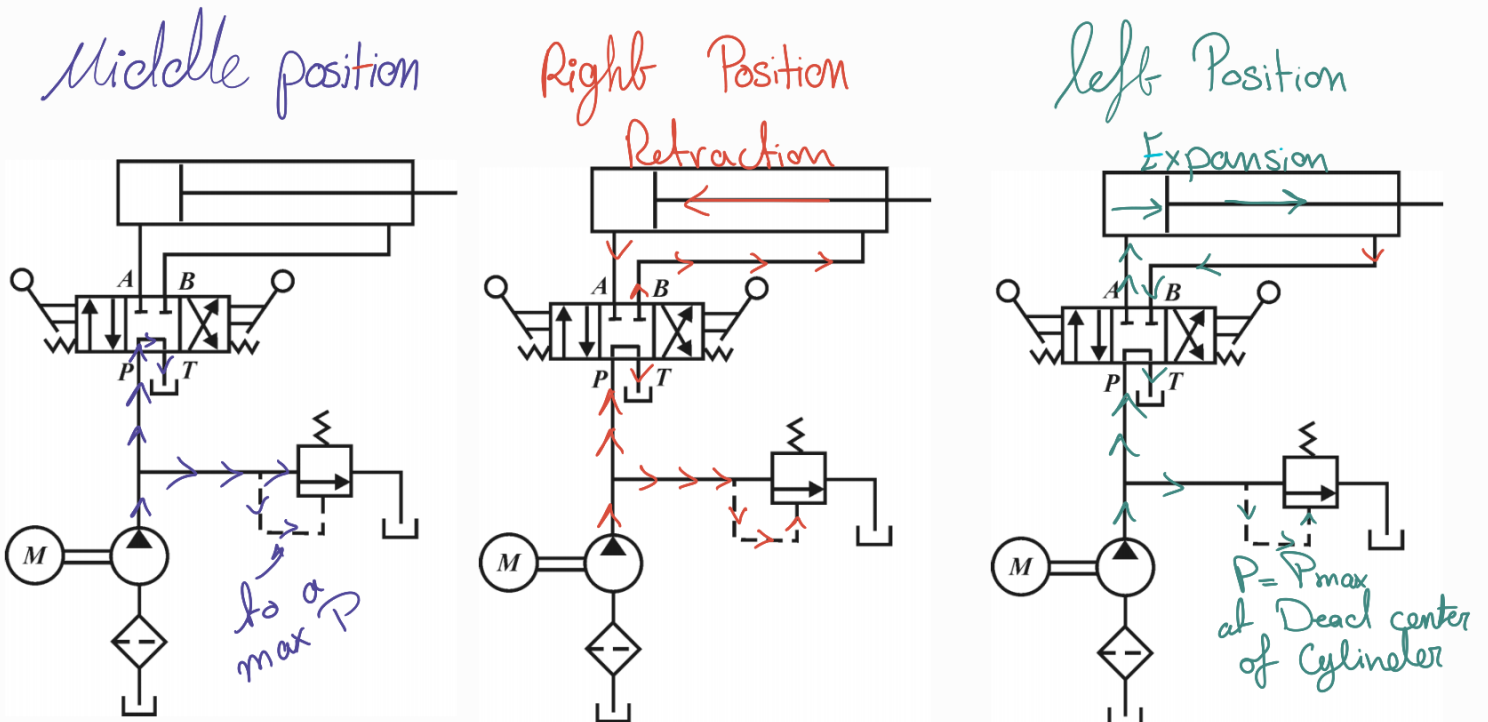


Chapter 5

Single Acting hydraulic cylinder

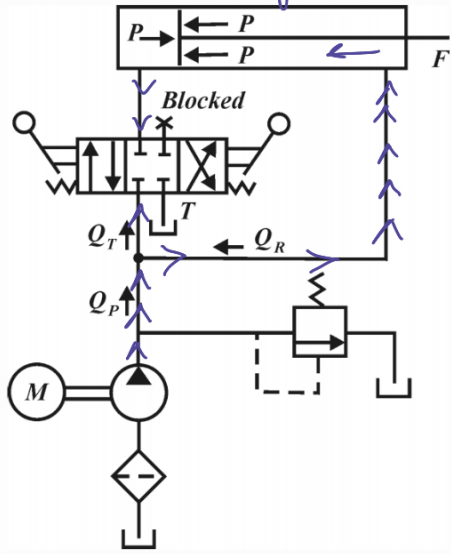


Double Acting hydraulic cylinder



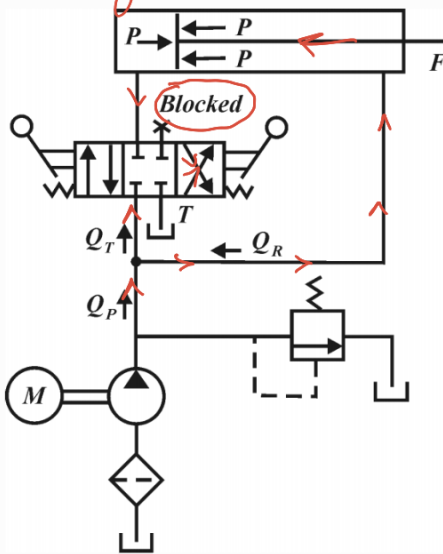
Regenerative hydraulic cylinder

Middle position



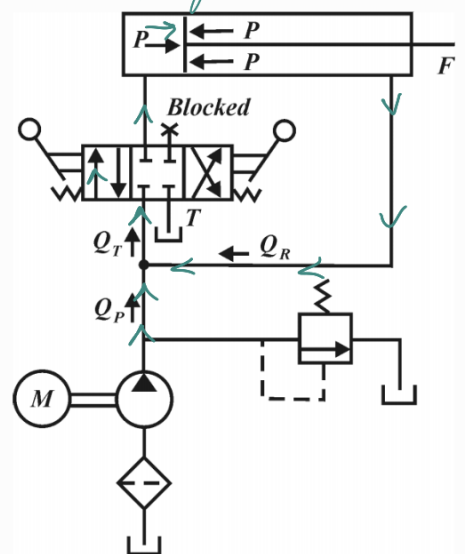
No movement

Right Position



Normal Retraction

left Position

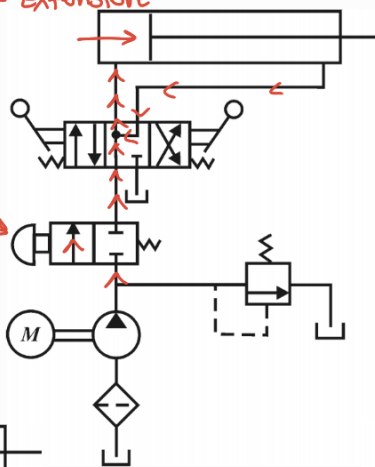


high Speed Expansion

Example on this mechanism
hydraulic drilling machines

Center Position
Fast Extension

when Pushed (for safety)



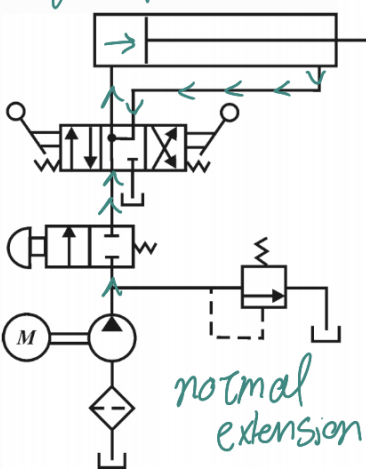
$$Q_p = Q_T - Q_R$$

$$Q_p = A_p v - (A_p - A_r) v$$

$$v = \frac{Q_R}{A_r}, \quad F = P A_r$$

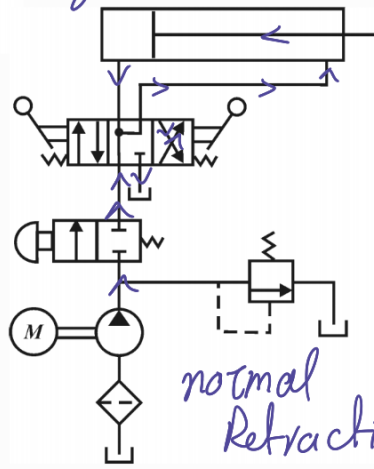
speed increases But power decreases (for a)

left position



normal extension

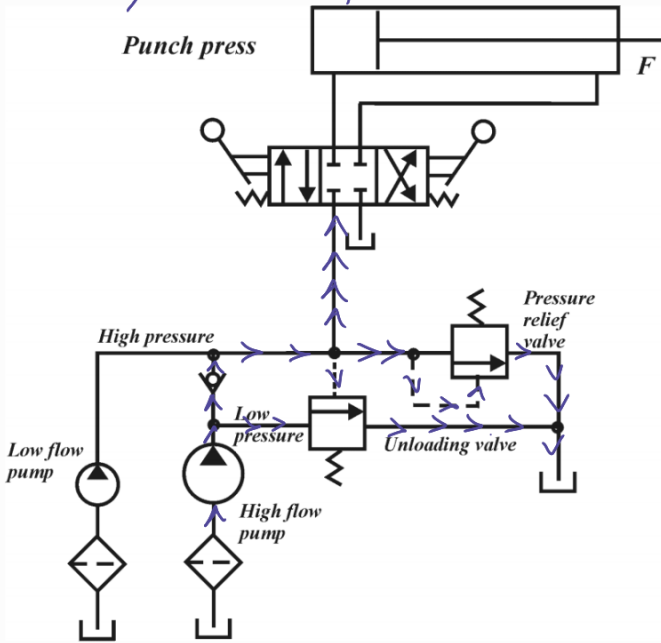
Right position



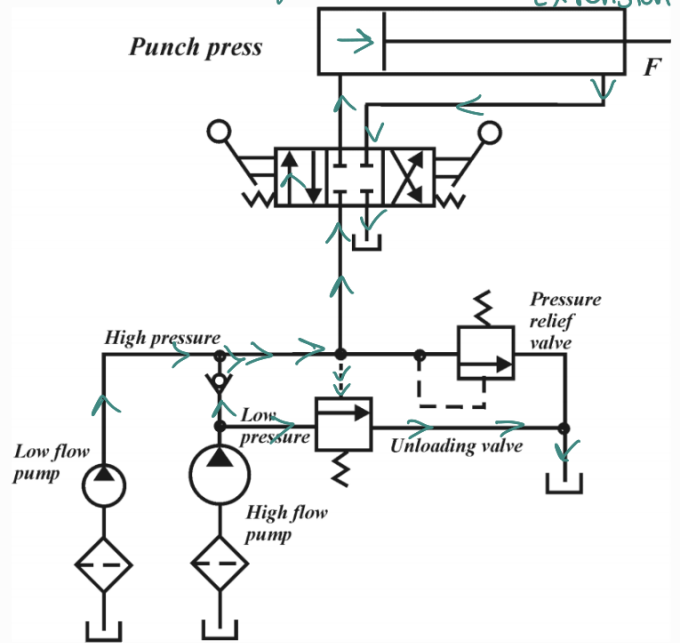
normal Retraction

Double Pump Hydraulic System

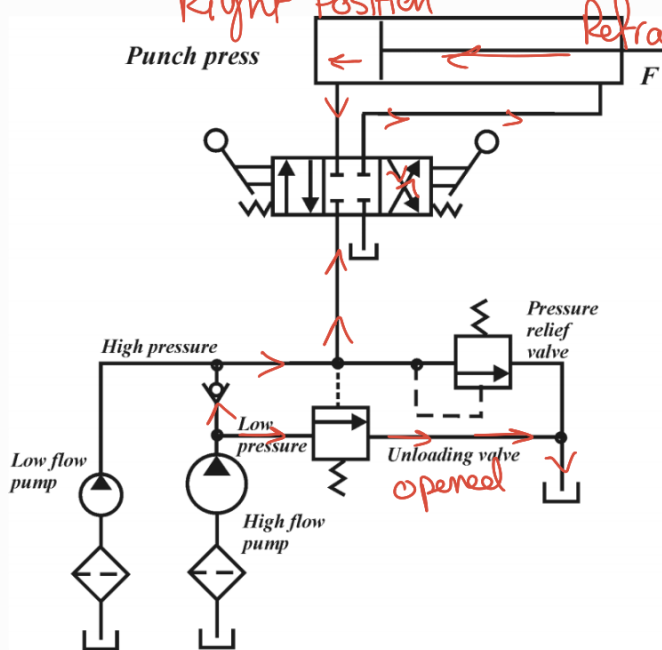
Middle Position



left Position Extension

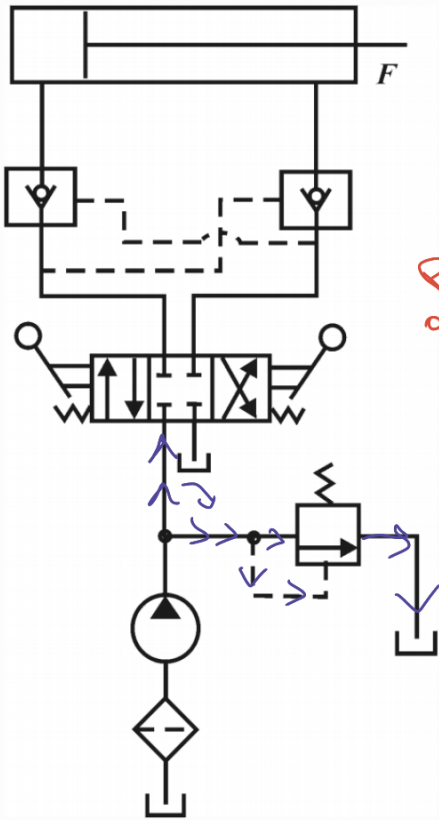


Right Position Refraction



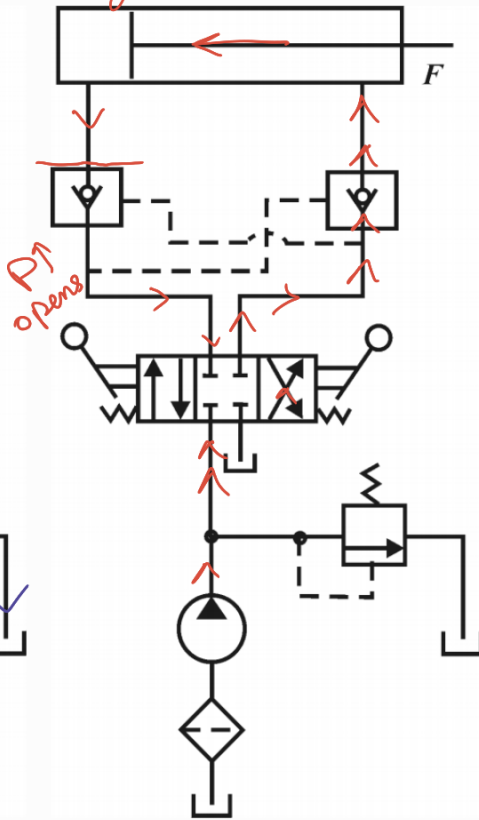
Locked Cylinder Hydraulic System

Middle Position



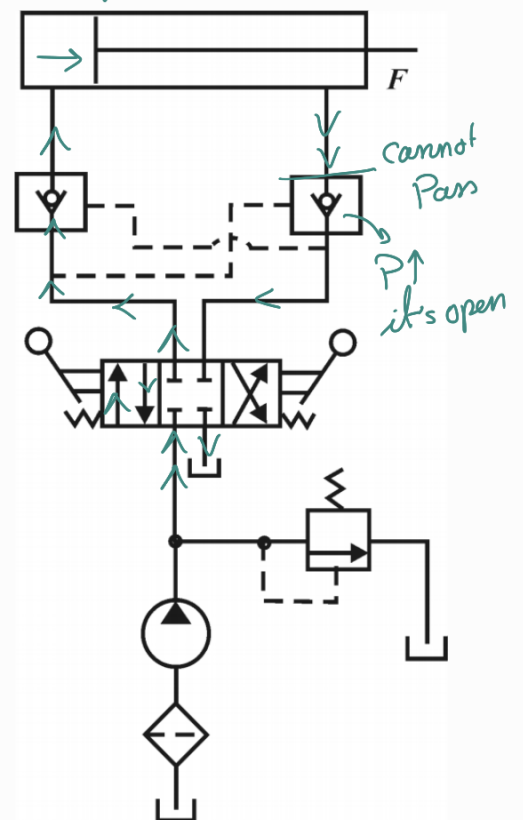
No movement

Right Position



Retraction

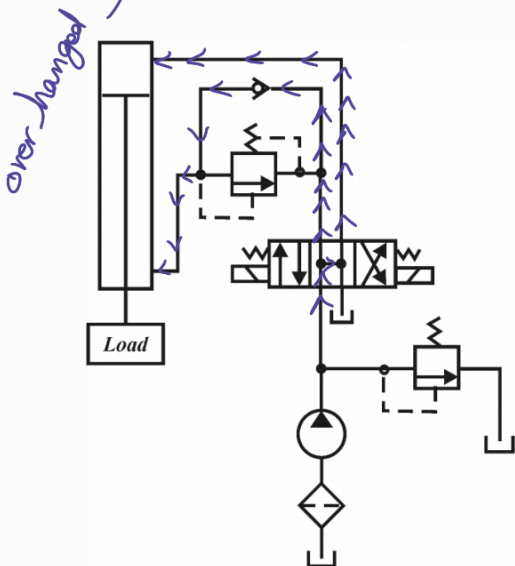
Left Position



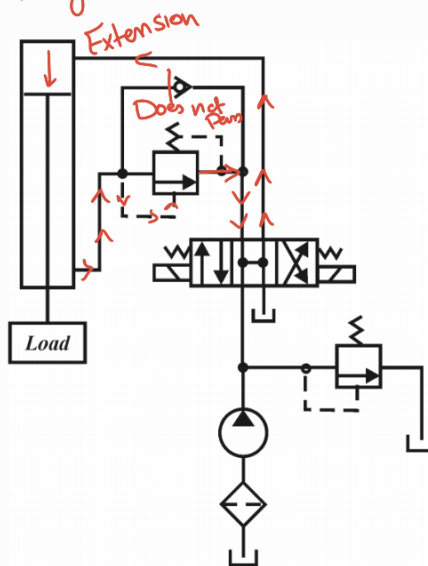
Extension

Counterbalance Hydraulic System

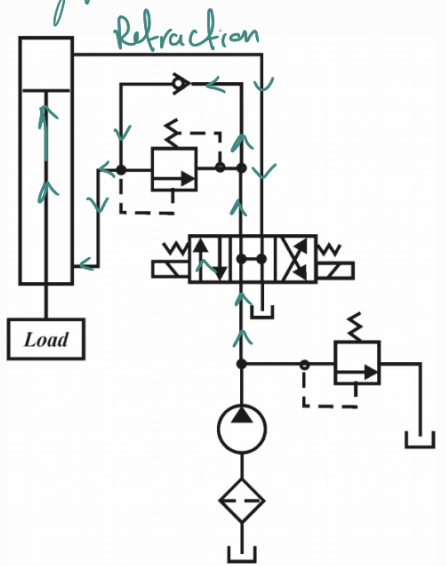
Middle Position



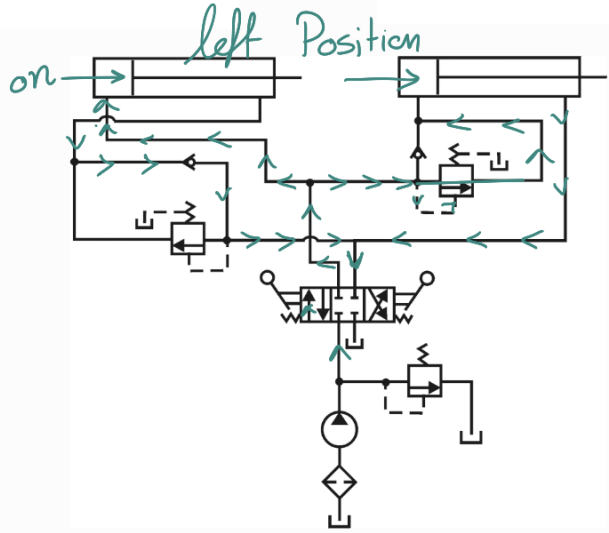
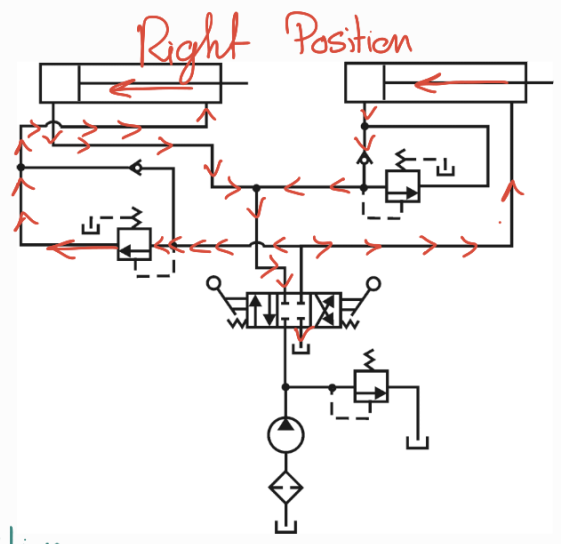
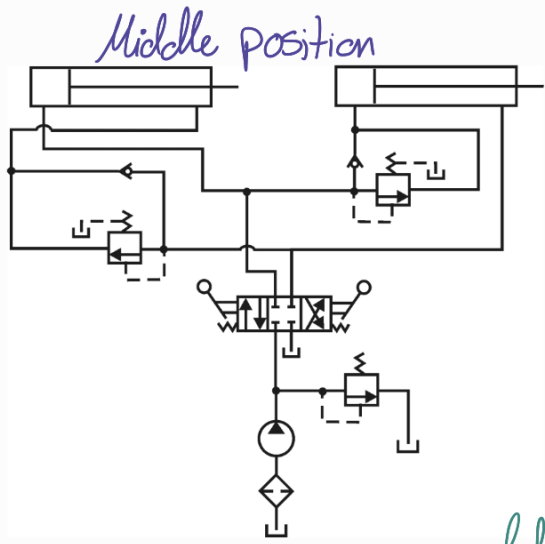
Right Position



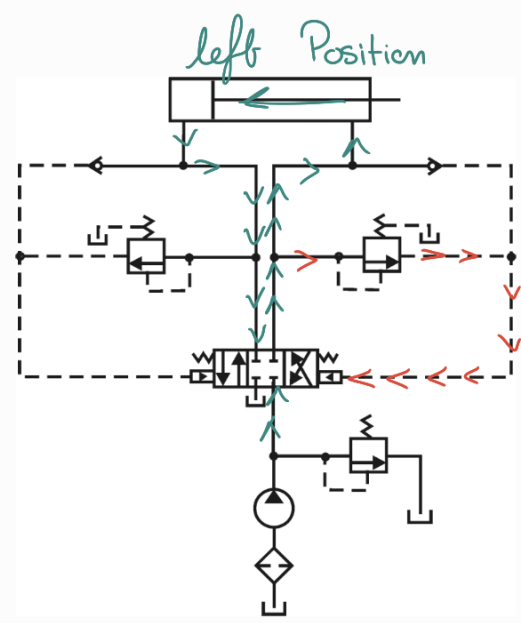
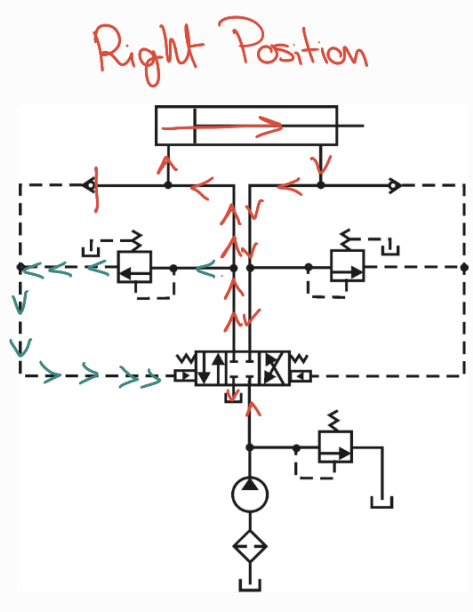
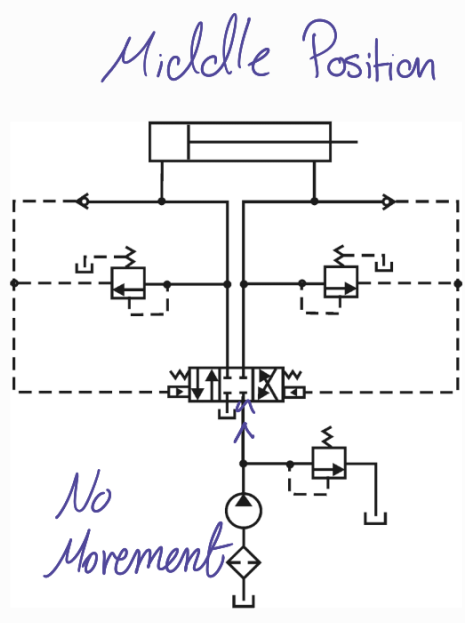
Left Position



Sequence Cylinder Hydraulic System



Automatic reciprocating hydraulic system

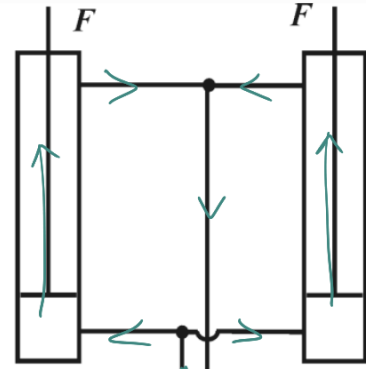
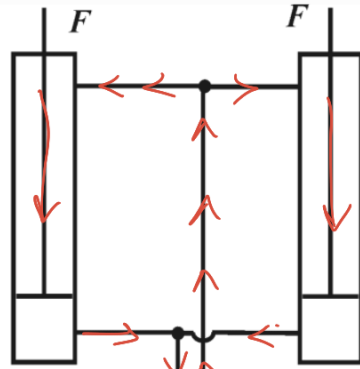
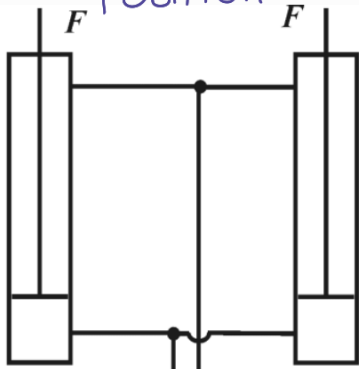


Parallel connected hydraulic cylinders

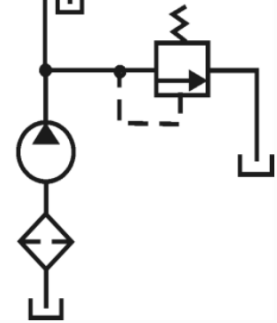
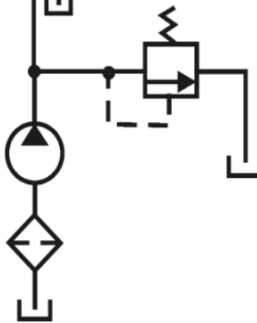
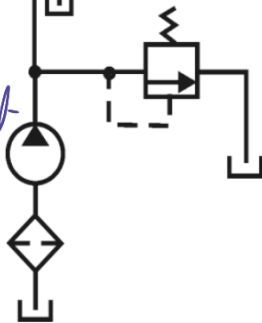
Middle Position

Right Position

left Position



No movement

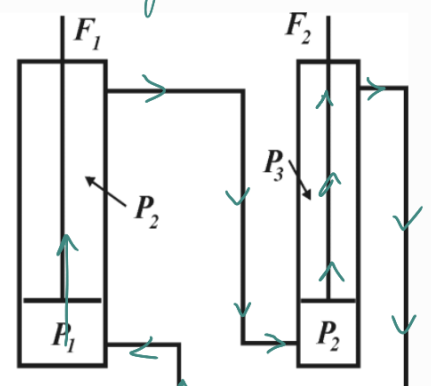
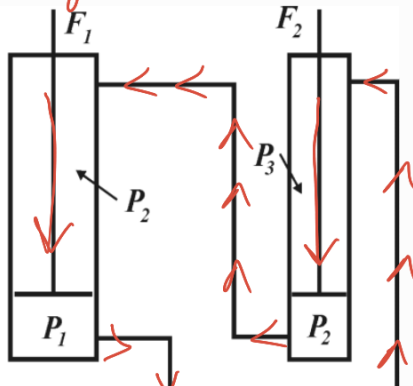
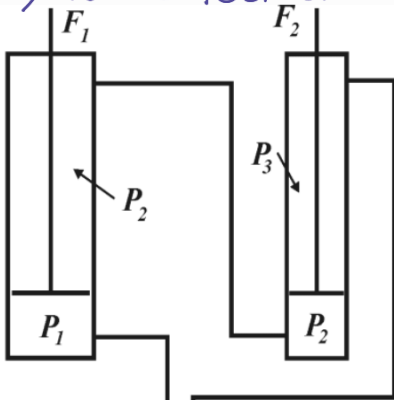


Series Connected hydraulic System

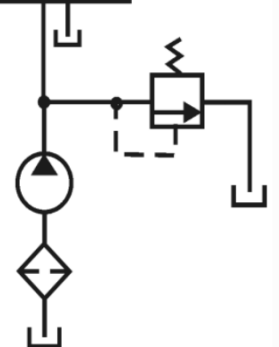
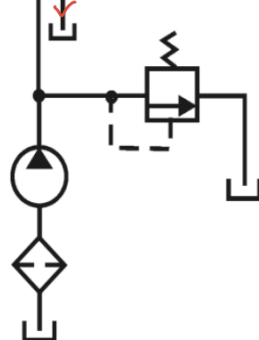
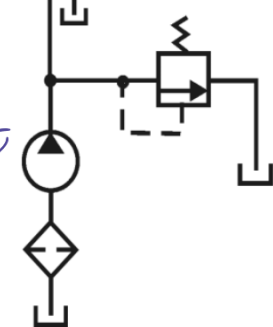
Middle Position

Right Position

left Position



No Movement



Analysis of the System

$$(Q_{out})_1 = (Q_{in})_2 \quad v_1 = v_2 \text{ (synchronization)}$$

$$(Av_1)_1 = (Av_2)_2$$

$$(A_{P_1} - A_{R_1})v_1 = (A_{P_2})v_2 \rightarrow \underline{\text{condition}}$$

$$A_{P_1} - A_{R_1} = A_{P_2}$$

Forces Analysis

Cylinder 1

$$P_1 A_{P_1} - P_2 (A_{P_1} - A_{R_1}) = F_1$$

Cylinder 2

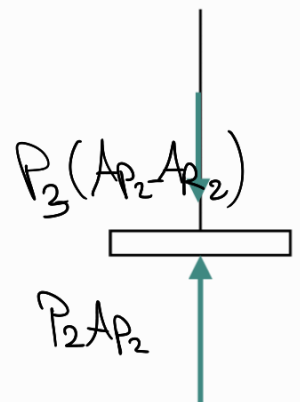
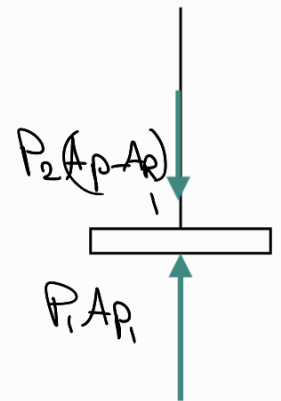
$$P_2 A_{P_2} - \cancel{P_3 (A_{P_2} - A_{R_2})} = F_2$$

And so:

$$P_1 A_{P_1} - \cancel{P_2 (A_{P_1} - A_{R_1})} + \cancel{P_2 A_{P_2}} = F_1 + F_2$$

where $A_{P_2} = A_{P_1} - A_{R_1}$

$$P_1 A_{P_1} = F_1 + F_2$$

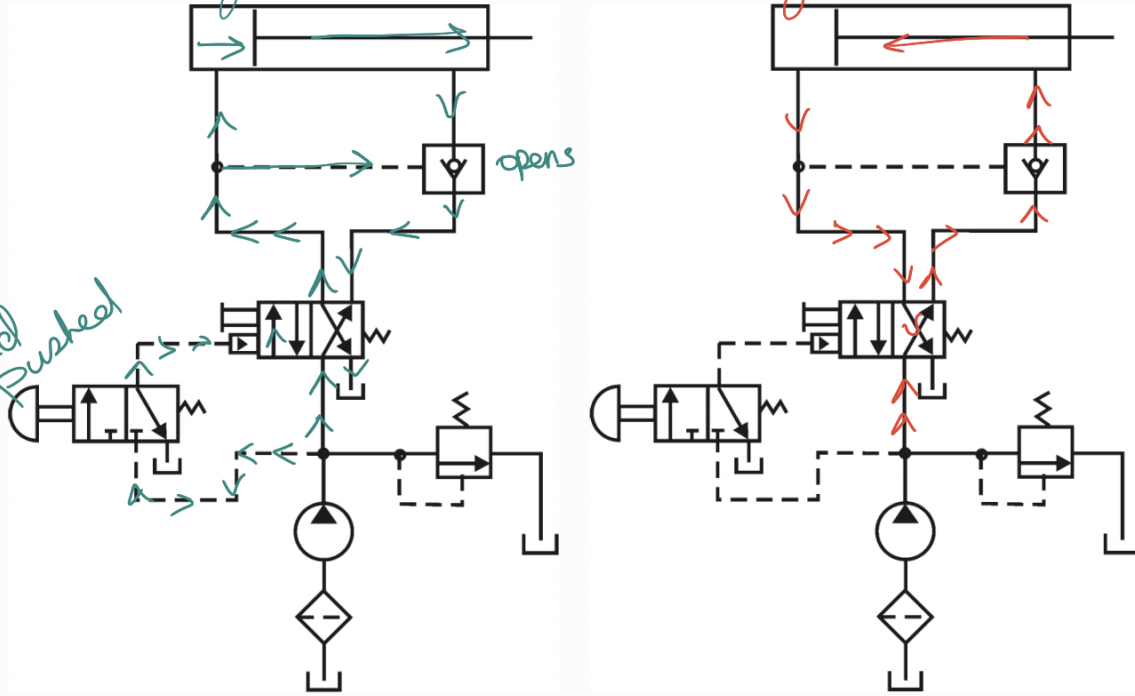


Fail Safe Circuits

left Position

Right Position

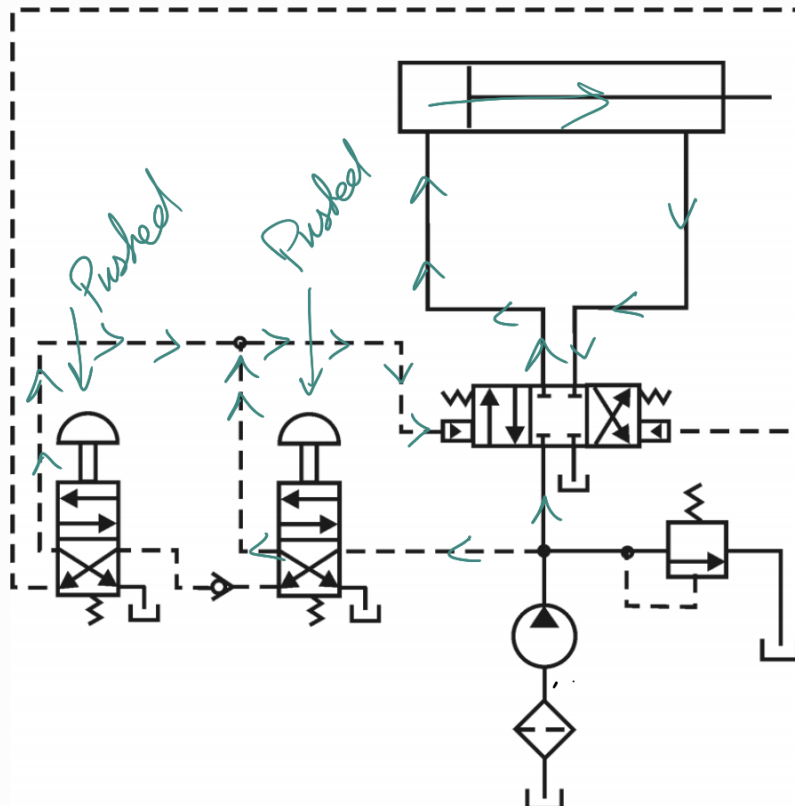
should be Pushed



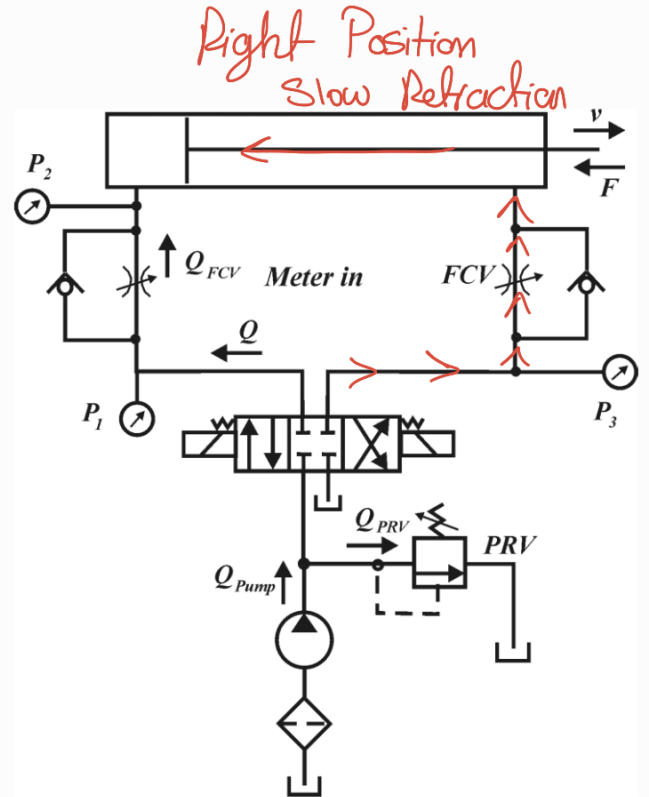
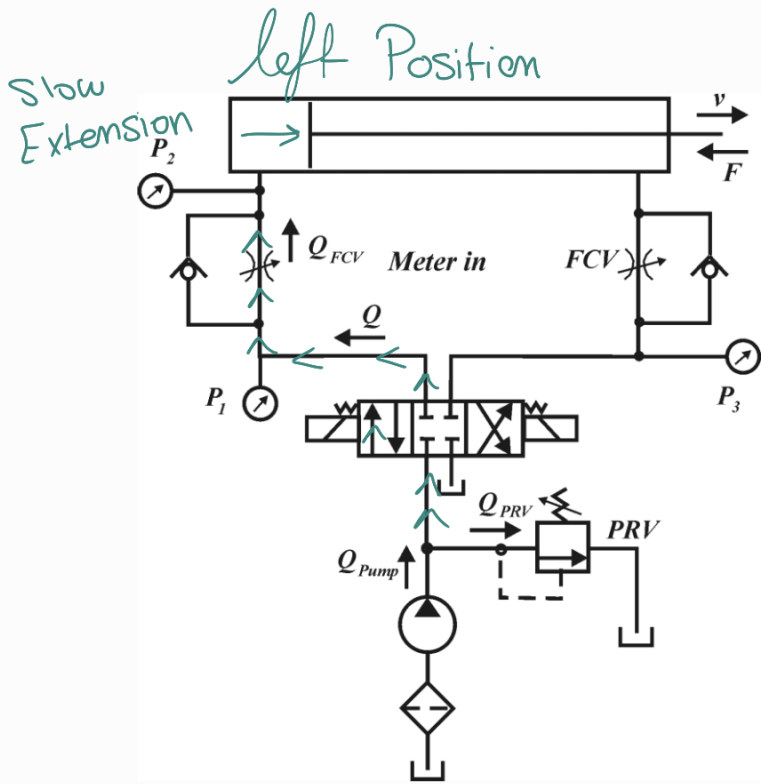
For extra safety

Fully Retracted

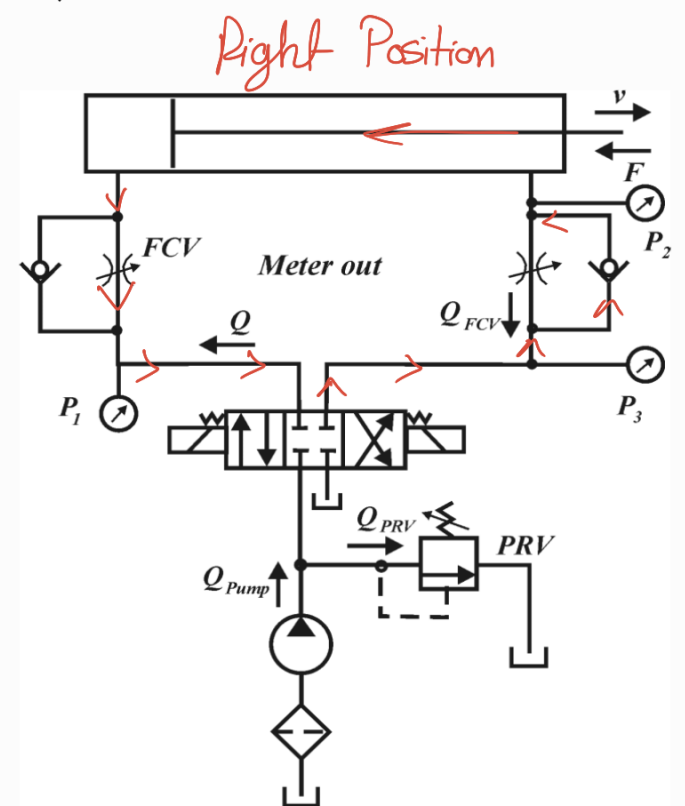
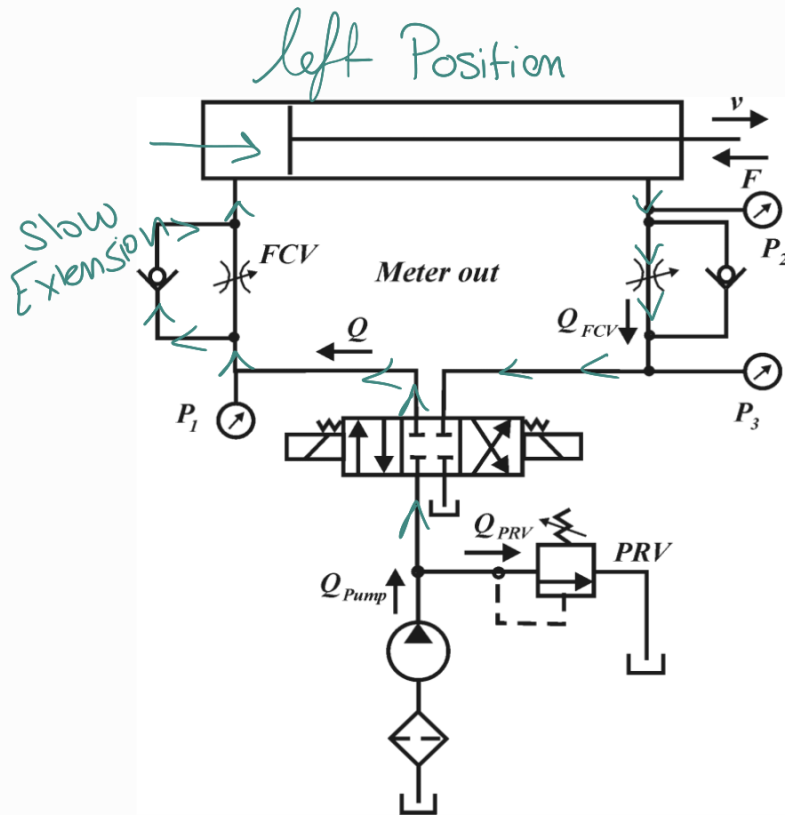
To perform extension



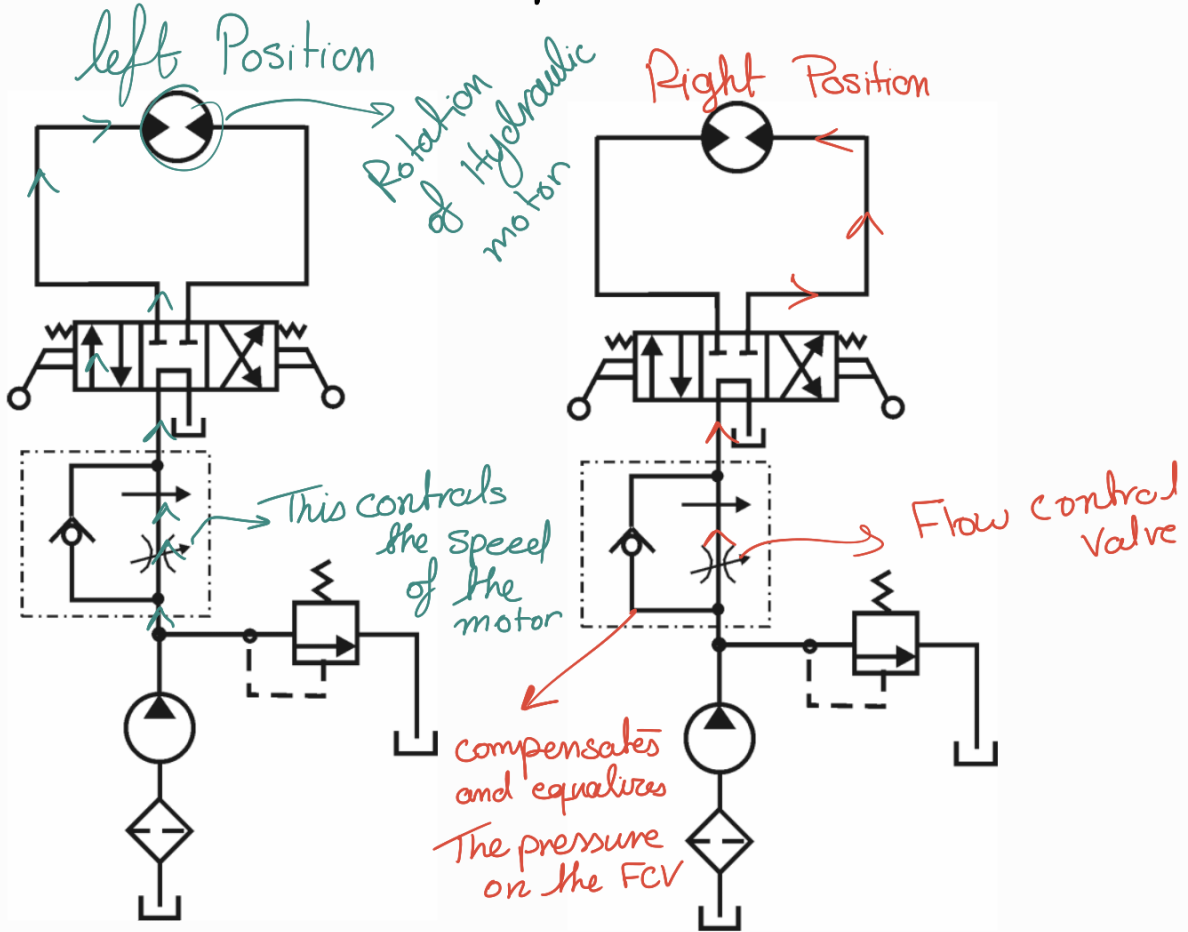
Meter in circuit (input control)



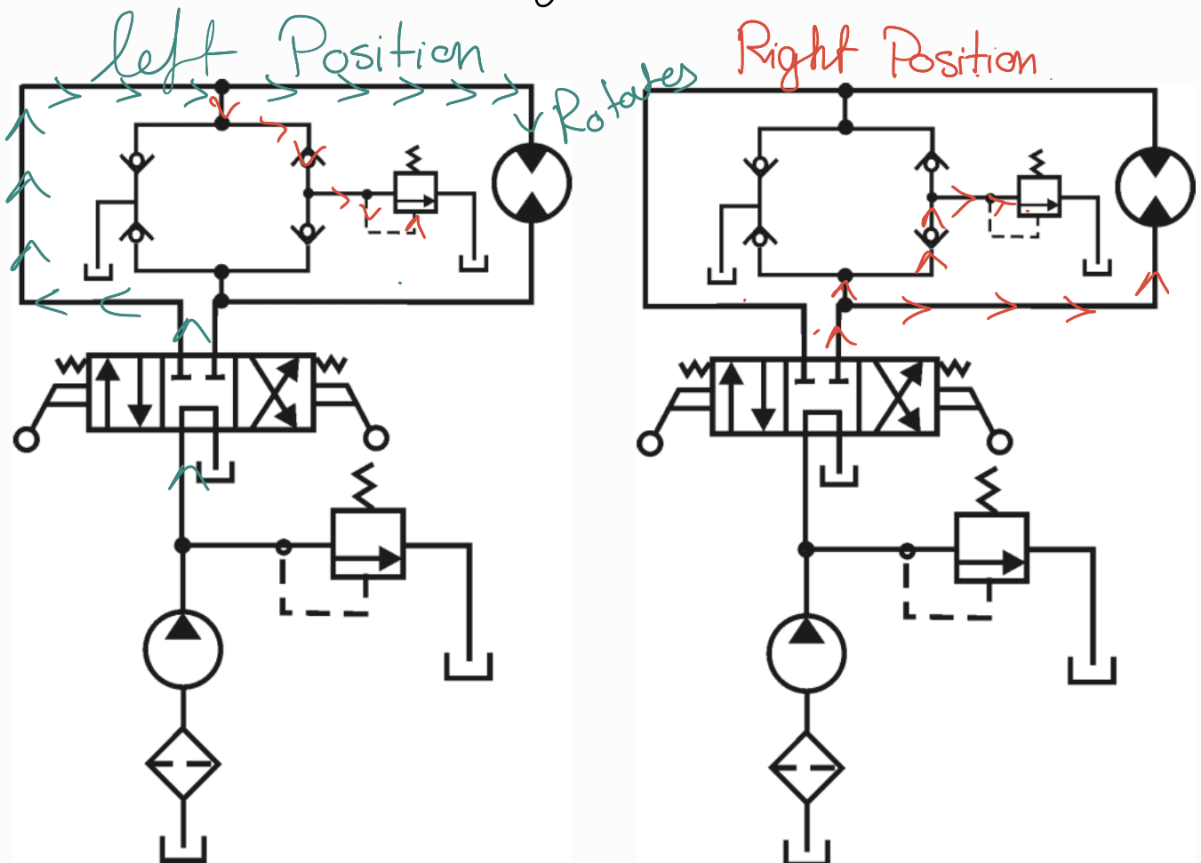
Meter out circuit (output control)



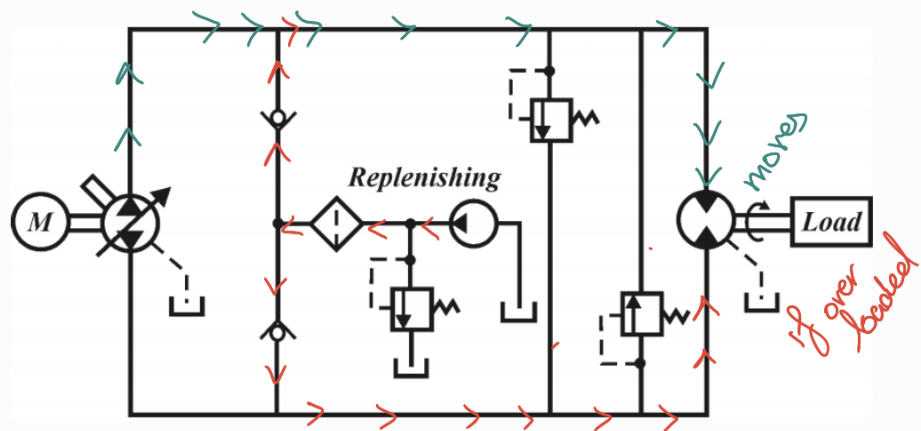
Hydraulic motor speed control



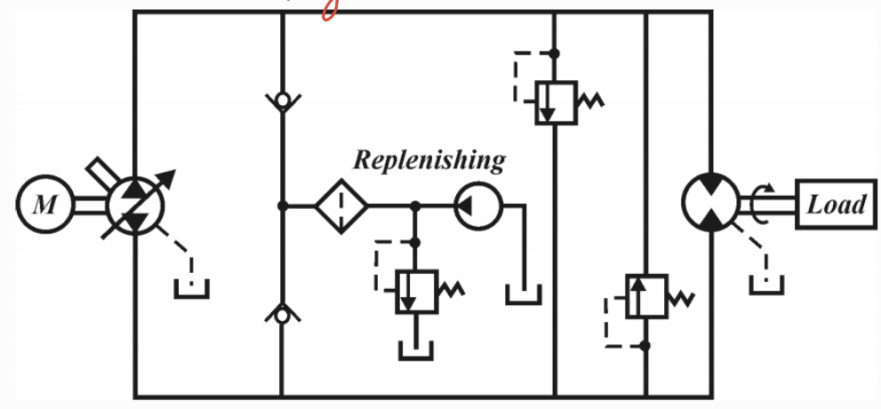
Hydraulic Motor Braking System



Hydraulic Transmission System

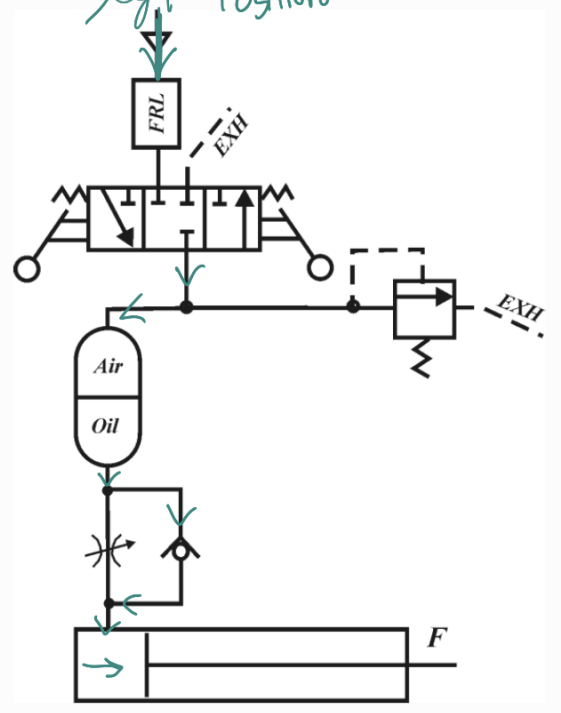


Right Position



Air over oil System

Left Position



Right Position

