By Mohammad Abu Hashya.

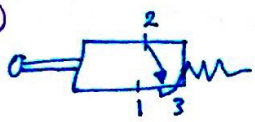
Measurement & Control Laboratory "Summary"

※ Electropneumatic Control systems:

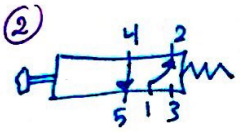
E N.O "Normally open"

E N.C "Normally Close"

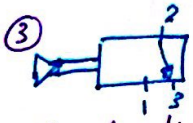
- Power supply in the pneumatic system is air signal.
- Valves:

① 

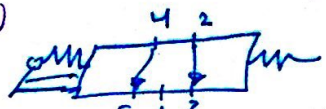
3/2 Directional Push-button with spring centering valve.

② 

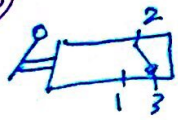
5/2 Directional Push-button with spring centering valve.

③ 

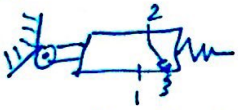
3/2 directional pedal valve.

④ 

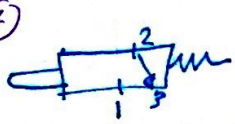
5/3 directional Lever with spring centering valve.

⑤ 

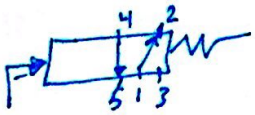
3/2 directional Lever valve.

⑥ 

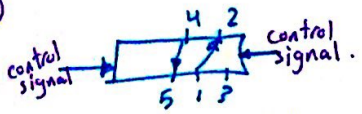
3/2 directional roller valve.

⑦ 

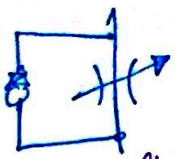
3/2 directional plunger valve.

⑧ 

5/2 Mono-stale indirect controller valve.

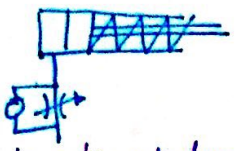
⑨ 

Bistable indirect controller valve.

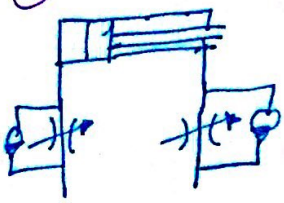
⑩ 

Manual Airflow Regulator valve.

- Cylinders:

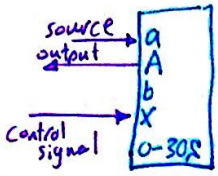
① 

Single acting cylinder.

② 

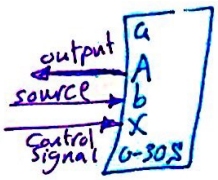
Double acting cylinder.

- Timer:



"b Not connected"

① N.C timer.



"a Not connected"

② N.O timer.

X ≡ Control signal
A ≡ Output.

- Logic Gates & Memory Cell:

*performance of →
- AND gate: Logical Product.
- OR gate: Logical Addition.
- Not gate: Logical inverse.
- YES (Buffer) gate: Logical identity.

- SR flipflop: S=0 & R=1 (Reset). ; S=1 & R=1 (invalid).
S=1 & R=0 (set). ; S=0 & R=0 (save).

- Solenoid Sensors: Translates the mechanical motion to electrical signal.

* * *

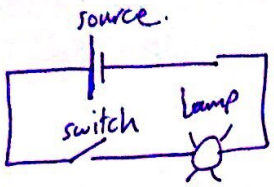
※ PLC & Ladder Logic:

PLC ≡ Programmable Logic Controllers.

- Name of the used device: "PLC SIEMENS S7-200".

- in Ladder: → vertical called Rails.
→ Horizontal called Rungs.

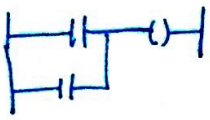
N.O: ⊣ ⊢ N.C: ⊣/⊢ output: —( )—



Equivalent in ladder ⇒ for NO:

for NC:

* OR Gate:



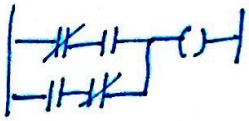
* And Gate:

* Not gate:

* NAND Gate:

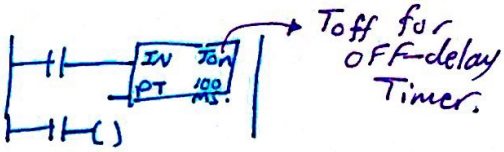
* NOR Gate:

* XOR Gate:



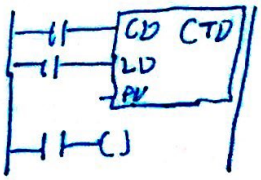
* Equivalent cct for the Motor:

* ladder diagram for ON-delay Timer:



⇒ * Number for TOF & TON must be different (i.e we can't take TOF&TON using TS2 for Both).

CTU ≡ Count Up. CTD ≡ Count Down.



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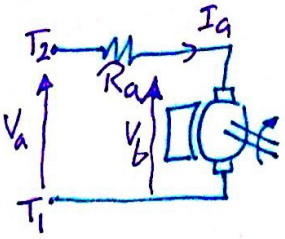
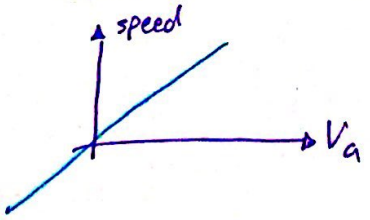
* DC Servo Motor:

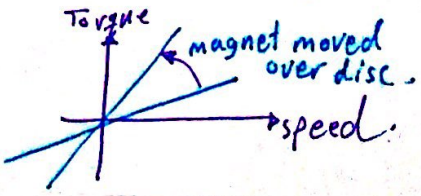
- The difference in the comparison called error signal, the part that carries out the comparison called error channel.
- e.g of actuator: geared motor, we use amplifier to drive it.



$V_a \propto$ speed



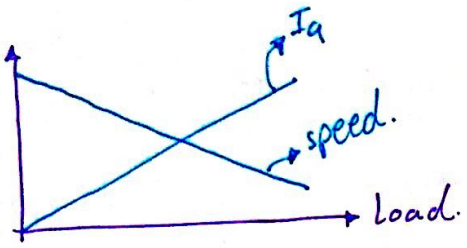
* V_a is provided by Power Amplifier.

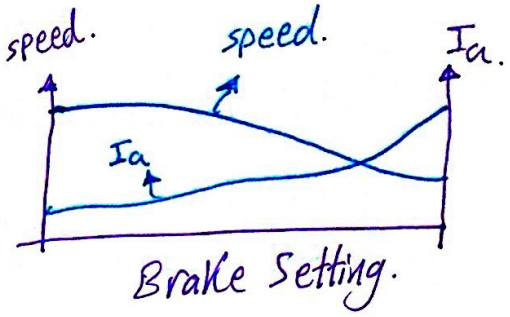


* The previous two figures → speed $\propto$ Va represents DC Motor charc.
  → Torque $\propto$ speed represents charc. of Magnetic Brake.

* In the experiment, Motor speed = 32 * output shaft speed. (RPM).

* Motor charc. Related to load:

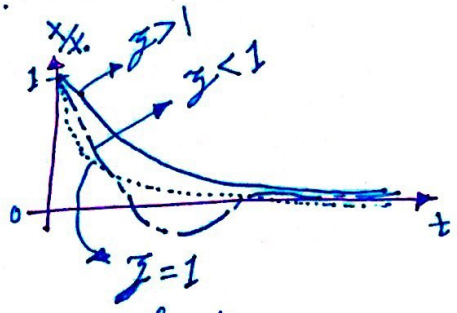




* Overshoot: overshoot = Peak - steady state

* Doubing the gain speeds-up the response.

* System Behavior:
  → Critical Damping ($\zeta = 1$)
  → over Damping ($\zeta > 1$)
  → Under Damping ($\zeta < 1$)

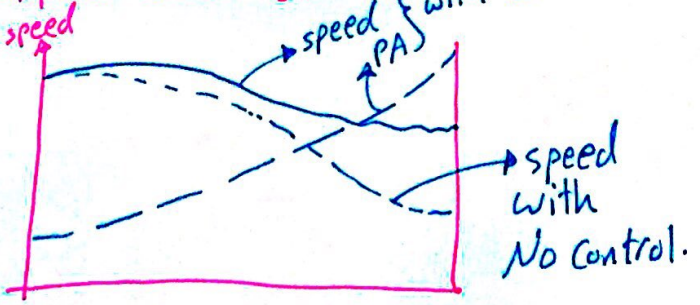


• Velocity Feedback:

* all practical motor have constant friction called: coulomb friction.
  , also an increased amount of friction force called: striction.
  , the minimum input below which the system won't respond called: Dead-Band. "it is reduced when the gain is high".

* Dead boat response occur just when the motor does NOT reverse.
* Reversing polarity of Velocity make the system Unstable.

• Speed Control System:



- Digital shaft position sensing:

  * Two Types of encoders: → Absolute Encoder. → use Gray Code.
    → Incremental Encoder.
    ↳ called incremental Because the generation of a pulse indicates an incremental change in position.

* Analogue Unit:

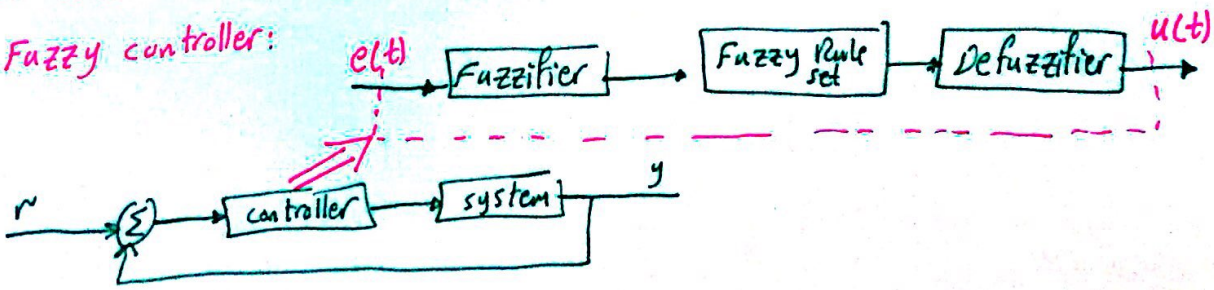
  - Fault switches: these enable faults to be introduced. if No fault, all switches should be down.
  - Error Amplifier: Combine potentiometer signals to provide the error.
  - P_1 & P_2: Provide system gain Control & tachogenerator signal adjustment.
  - power Amplifier (PA): Drives the motor.
  - Motor: Mech. unit & dirves the brake disc & tachogen. directly
  - Brake Disc & Magnet: provide an adjustable load for the motor.
  - Tachogen.: provide voltage proportional to motor speed.
  - P_3: Can be linked to any input to provide an adjustable input to the error amplifier.
  - Controller: Contain Op-amps with associated networks to enable various compensating & control ccts.

* * *

※ Fuzzy Logic Control:

- Fuzzy logic controllers are widely used to operate the automatic functions of washing machines, vedio recorders, CD's, air conditioning systems, cameras.
- Main Purpose of fuzzy: Power Saving.

* Fuzzy controller:



- Fuzzy Logic Operators:
  - AND gives Minimum.
  - OR gives Maximum.
  - NOT gives Complement.

- Classification of the fuzzy Control Law:
  1) Large -ve control (-10V).
  2) Medium -ve Control (-5V).
  3) Small control (Zero).
  4) Medium +ve Control (5V).
  5) Large +ve control (10V).

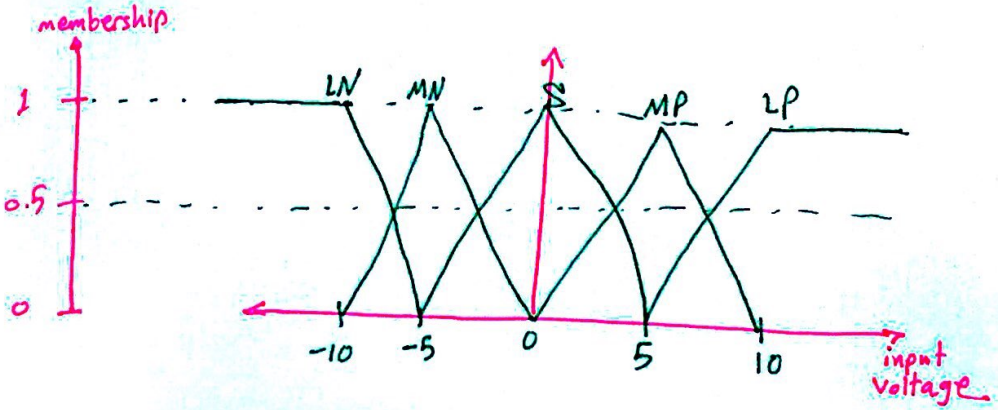
- Some Abbreviations: LN ≡ Large Negative. , LP ≡ Large Positive. , S ≡ Small. , MN ≡ Medium Negative. , MP ≡ Medium Positive.

- Voltage Range is $0 \leq V \leq 10$ Why?!

  $V \geq 0$ since the pump can't suck water out of the tanks, so it shouldn't be less than 0.

  $V \leq 10$ since the pump max. speed is achieved with 10 Volt, so it shouldn't be greater.

* Fuzzy Membership:



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Best of Luck.