[Drying v/s evaporation
Langarangian v/s Eulerian]  __/__/____

# IPC

→ Disturbance (load variable) (LU)

→ Primary measurement (controlled variable) (CV)

→ Manipulative variable (MV)

→ Transducer :- Only physical quantities like voltage, current can be transmitted not T, P, C
convert T, P, C to Voltage, current —

→ Transmission line :-
used to carry measurement signal from sensor to controller.

→ relative volatility = $\dfrac{y_i/x_i}{y_j/x_j} = \dfrac{P_A}{P_B}$ (more volatile)

$\alpha > 1 \rightarrow$ separable.
$\alpha \leq 1 \rightarrow$ non-separable.

function of T, P

T, P ↑, $\alpha$ ↓

compares vapour pressure of liq mix of compound.
It indicates ease or difficulty of using distillation.

($\alpha = 1 \rightarrow$ azeotropes)

→ P ↑ → low BP component's BP ↑ significantly.
but high BP component's BP increase is not that significant
∴ $\alpha$ ↓

Transfer function = $\dfrac{\text{Output}}{\text{Input}}$

investigates the process behavior with time

$$\bar{F}(s) \longrightarrow \boxed{G(s)} \longrightarrow \bar{y}(s)$$

$$G(s) = \frac{\bar{y}(s)}{\bar{F}(s)} = \frac{Q(s)}{P(s)}$$

$Q(s) = 0 \rightarrow$ zeros → process dynamics (change in input variable)

$P(s) = 0 \rightarrow$ poles → tell about the stability

Pole $> 0$ → unstable (exponential)

Pole $< 0$ → stable.

→ 2nd order system → damping.

## 2nd order

$$G(s) = \frac{k_p}{\tau^2 s^2 + 2\psi\tau s + 1}$$

$\tau$ → speed of response

$\psi$ → damping factor

$\psi = 0$ → undamped → const amplitude

$\psi < 0$ → unstable system & increasing amplitude

$\psi > 0$ → Stable → oscillation with decreasing amplitude.

$\psi > 1$ → overdamped

$\psi = 1$ → critically damped

$0 < \psi < 1$ → underdamped

→ Peak time: time required for output to reach 1st max value

→ Overshoot :-

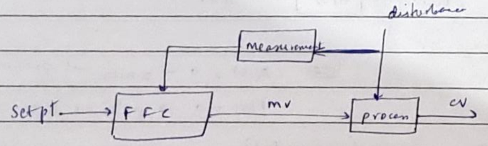
→ rise time :- time taken for the response to first reach its final SS value

→ Feed forward controller: measures one or more inputs, calculates the required value of other inputs and then adjusts it

→ has to predict the output as it does not measure it

~~→ takes corrective action before the disturbances enter into the process.~~

→ provides direct solution to control problem by measuring disturbance and compensating the controlled variable before it deviates from set pt (open loop control)




→ Measures the disturbance directly and controller predicts the impact on the process.

Madhuri

dead time → time delay i.e time the system takes to respond.
↳ TF will be added.

## FFC

- → Acts before hand
- → good for slow systems
- → does not introduce instability
- → requires disturbance measurement

- → cannot cope with unmeasured disturbance
- → sensitive to process parameters variation

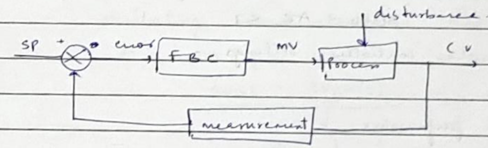
## FBC

- → No measurement of disturbance
- → Insensitive to parameters change
- → acts after the effect of disturbance has been felt
- → creates instability in closed loop

→ FBC :-

Measures output

~~altero~~ Altering MV in response to the deviation between CV and set point to eliminate deviation




→ Controller:- recieve error signal and provides pneumatic signal

### Proportional controller:-

signal is proportional to error signal

$$c(t) = K_c \epsilon(t) + c_s$$

### PI controller (actions corresponding to past)

$$c(t) = K_c \epsilon(t) + c_s + \left(\int_0^t \epsilon(\tau)d\tau\right)\frac{K_c}{\tau_I}$$

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**PID controller (future)**

$$c(t) = k_c\,\epsilon(t) + c_s + \frac{k_c}{\tau_I}\int_0^t \epsilon(\tau)\,d\tau + \tau_D k_c \frac{d\epsilon}{dt}$$

→ servo problem :- $\bar{d}(s) = 0$ , $\bar{y}_{sp} \neq 0$

→ regulatory :- $\bar{y}_{sp}(s) = 0$ , $\bar{d}(s) \neq 0$

→ Integral action corresponds to 2nd order system
↳ offset = 0
(desired value − value attained after long time)

$G(s) = \frac{Q(s)}{P(s)}$ roots of $P(s) < 0$ | real part < 0
characteristic eqn ↳ stable

→ routh test → for stability

→ Frequency response :- behavior is analysed using bode plot
stable → AR < 1

→ Ziegler nicolas controller settings ←

→ ① Controller performance
② Controller selection } notes
③ Tuning

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Temperature measurement :- thermocouple, RTD (resistance), bimetallic thermometer, radiation pyrometer

Pressure measurement :- manometer, Piezometer, Bellows, diaphragms, Bourdon tubes.

flow :- venturimeter, orificemeter, rotameter, coriollismeter.

Composition :- chromatography, spectroscopy, Turbidimetry, $p^H$, conductivity

liq level :- $\Delta P$ measurement

**Functional elements**

① Primary sensing elements
② Variable conversion element
③ Variable manipulation element
④ Variable transmission element
⑤ variable presentation element.

Coriolismeter :- directly measures mass flow
↳ Principle :- The inertia created by fluid flowing through an oscillating tube causes the tube to twist in proportion to mass flow rate.

$$\text{twist} = \underbrace{\rho v_r}_{\text{mass flow}}\,\omega(t)$$

Flapper nozzle :- notes

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Liq level :- ΔP measurement

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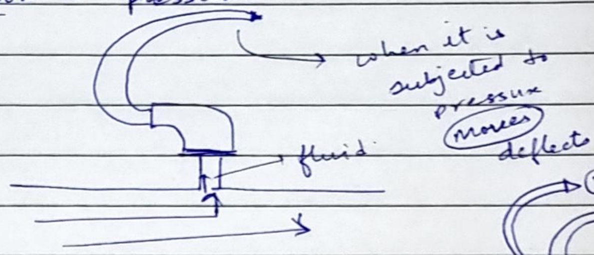
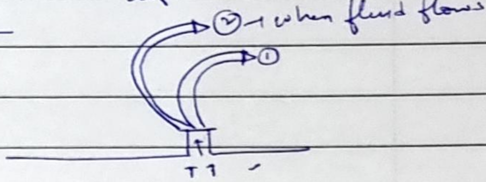
## Bordoun tube (elastic transducer).

displacement is converted to pressure

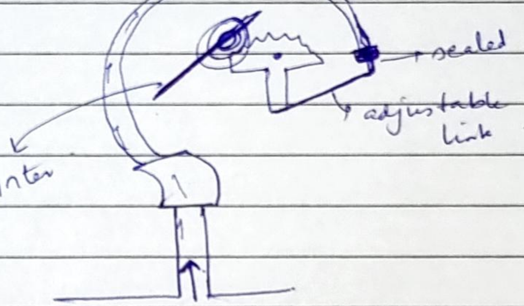
→ Used to measure guage pressure

→ deflection $\propto$ pressure.




deflection is proportional to pressure.




static pressure

When the fluid flows, oval shape tube converts to circular

→ give accurate results.

→ hysteresis ??

→ P & ID diagram