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# ICE 3154 [3 0 0 3]

# PIC

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## Pre-requisites:

- Knowledge of Control system elements.
- Knowledge of closed loop control system.
- Basics of mathematical modelling and Laplace transform.



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## Course Objectives:

| | *At the end of this course, the student should be able to:* | No. of Contact Hours | Marks |
|---|---|---|---|
| CO1: | Understand the basic of process modelling and control | 8 | 23 |
| CO2: | Analyse the philosophy of different controller modes | 12 | 34 |
| CO3: | Design of analog and pneumatic controllers | 4 | 11 |
| CO4: | Analyse the performance and tuning of controllers | 6 | 16 |
| CO5: | Describe the principles of advanced control strategies | 6 | 16 |
| | **Total** | 36 | 100 |



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## Syllabus

- ICE 3106-PIC syllabus.pdf



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## Grading

- Continuous Assessment Test - 20Marks
- Internal assessment - 30 Marks
- End semester exam - 50 Marks.
- Total: 100 Marks
- Minimum 18 in the end sem to clear the course
- Attendance : 75%



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- Process
- Instrumentation
  - Measurement
    Monitoring
  - Control
  - Experimental engineering analysis



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## Advantages of Process automation include:

- Consistency and accuracy in the positioning of moving parts of an equipment.
- A more consistent product.
- The more economic use of existing plant by saving of fuel/and or electrical energy.
- The release of skilled personnel for other productive work .
- Reduction of physical effort with consequent reduction of fatigue and boredom
- Improved working conditions.

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**Limitations of automation:**

- Initial cost is high
- power fluctuations,
- Lack of skilled personnel etc.

**Basic steps in process control are:**

- Measurement of the process variable;
- Evaluation and comparison with desired level; and
- Control of the required level of the parameter involved

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## Technical Clubs

- IEEE - You get discount on some electronic gadgets , soft wares etc.
- Formula manipal/ Team Manipal Racing.
- Aero MIT
- Parikshit : student satellite team.
- LUG
- **ISOI**
- ..\..\..\..\list of Non- technical Club (2017).xlsx
- ..\..\..\..\List of Tech Club (2017).xlsx



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## Be part of Fests/Dept. Activities



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## Get to know your faculty

- College is just as much about networking as it is about sitting in class. .



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## Create a resume

- If you don’t already have one, do it and have it critiqued by someone who knows what they’re doing.
- Get a study area.



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## Start interning as soon as you can

- It establishes industry contacts, a glimmer of work ethic and an understanding of how to apply the information into a potential future career.



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## Always go to class.

- Many will debate this one, but I think it’s essential.
- You never know when the professor will drop a crucial test hint, or give out extra credit for attendance.



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**Thank You.**

All the best for the semester.



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## Control System Components: Closed loop system

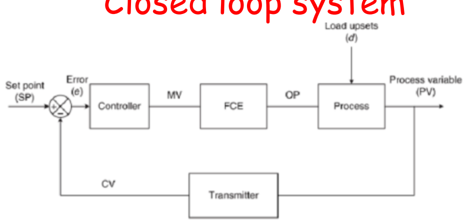


*Figure 3.3. Alternative, classical form of the single input/single output feedback control loop:*



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## Control System Components:

A control system is comprised of the following components:

1. Primary elements
2. Controllers
3. Final control elements (usually control valves)
4. Processes



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## Control System Components:

- **Primary Elements:**

• Primary elements, also known as sensors / transmitters, are the instruments used to measure variables in a process.
• These sensor types can be broadly classified into groups including the following:
1. Pressure and level
2. Temperature
3. Flow rate and total flow
4. Quality or analysis instruments
- 5. Transducers (working with the above or as individual units)



## Control System Components:

**Final Control Elements:**
• Pneumatic, or air-operated, diaphragm control valves are the most common final control element in process control applications.

• Variable speed pumps are also possible but are often costly as motor control is expensive,

• Electric valves :only for large applications above 25 cm pipe/valve diameters.

• Variable electric power control elements such as rheostats are used in small applications such as laboratory water bath temperature control.



## Control System Components:

### Controller Types:

1. ON / OFF
2. P, PI, PD, & PID Control Algorithms
3. Neuro Fuzzy Control Algorithms
4. Advanced PID Algorithms
5. Nonlinear Control Algorithms, etc.



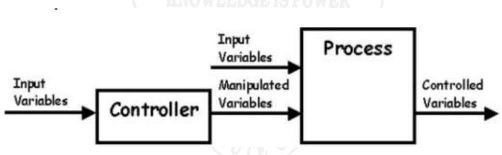
## Control Terminology

### Variables

- **Input variables:**
  - **Manipulated Variables** - input variables are adjusted dynamically
  - **Disturbances** - "load" variables
- **Controlled Variables** - *output variables.*



## Control Terminology(SISO open loop systems)






## Control Terminology(MIMO open loop systems)

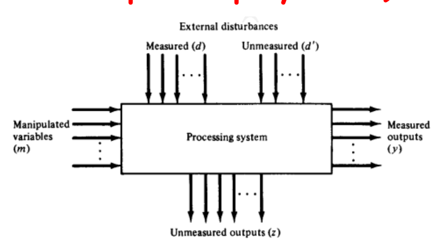
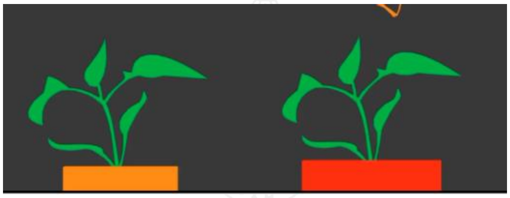



**Figure 2.1** Input and output variables around a chemical process.

# Example:1
## Plant growth experiment





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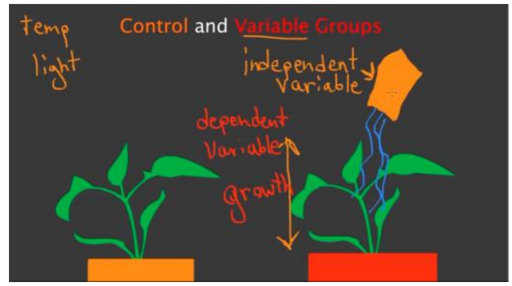




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# Two major control structures.

- 1. **Single input-Single Output (SISO)** - for one control (output) variable there exist one manipulate (input) variable that is used to affect the process.
- 2. **Multiple input-multiple output (MIMO)** - There are several control (output) variable that are affected by several manipulated (input) variables used in a given process.



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- Example 1:

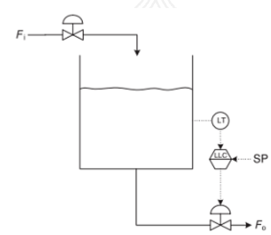


*Figure 2.1* Surge tank level controller.



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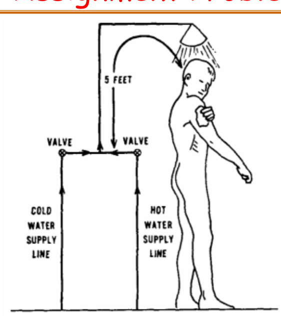
# Assignment Problem :1




Flow diagram for shower example.



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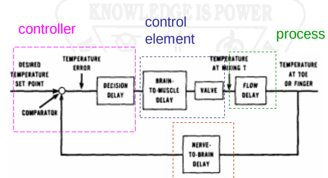


Block diagram of shower control system.

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# Incentives of Chemical Process Control



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## Requirements of an industry:

- Safety
- Production specifications
- Environmental regulations.
- Operational constraints
- Economics



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## Objectives of Control

- Suppressing the influence of external disturbances.
- Ensuring the stability of a chemical process
- Optimizing the performance of a chemical process.



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## Suppressing the influence of external disturbances.

- Example 1: Controlling the operation of a stirred tank heater:
- Operational objective:

(i)Keep temperature of the effluent at a desired value $T_s$
(ii)Keep volume of the liquid at a desired value of $V_s$

Extra: Identify the input, output, Manipulated and controlled variables

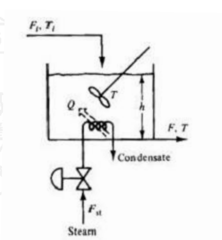


**Figure 1.1** Stirred tank heater.



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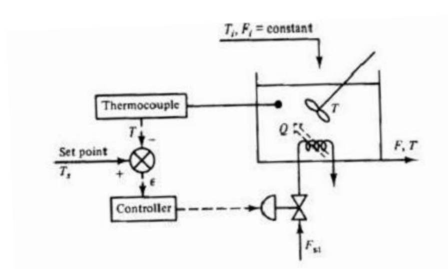
## Temperature control loop:




- Volume control?



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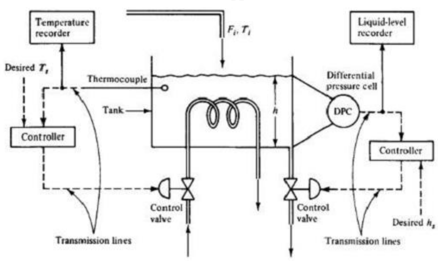
## Combined control



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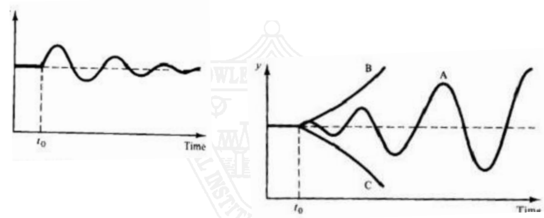
## Ensuring the stability of the process




x/y is a process variable.



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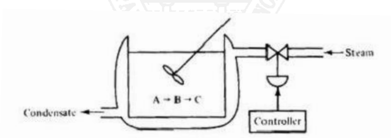
## Optimizing the performance of a chemical process.

- If conditions which affect the operation of the plant is not constant, we should change the operations such that the economic objective is always maximized.



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- Eg: A process $A \longrightarrow B \longrightarrow C$

Endothermic process ;heat required is provided by steam.

- Requirement is:

$$\text{maximize } \Phi = \int_0^{t_R} (\text{[revenue from the sales of product B]} - \text{cost of steam})\, dt + \text{cost of purchasing A}$$

- *Analyze the conditions and give optimum control action*



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## **Design Methodology for Process Control**

- Understand the process:
- Identify the operating parameters:
- Identify the hazardous conditions:
- Identify the measurables:
- Identify the points of measurement
- Select measurement method.
- Select control method
- Set control limits
- Define control logic



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# **Process Control Loops**



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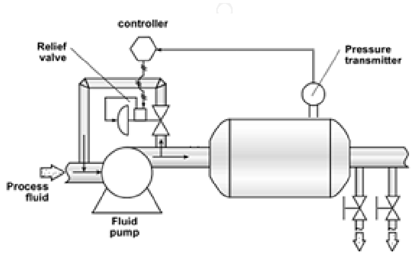
## Pressure Control Loops



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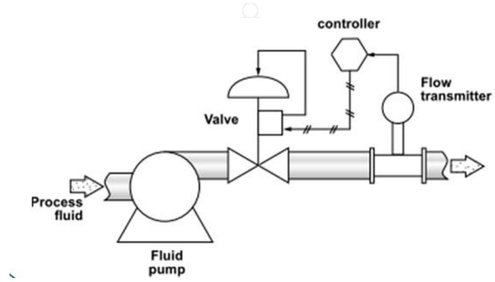
## Flow Control Loops



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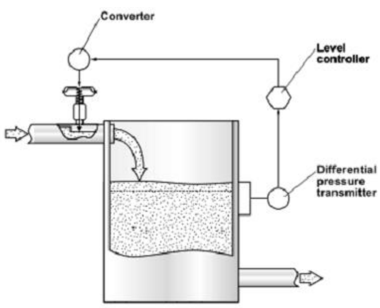
## Level Control Loops



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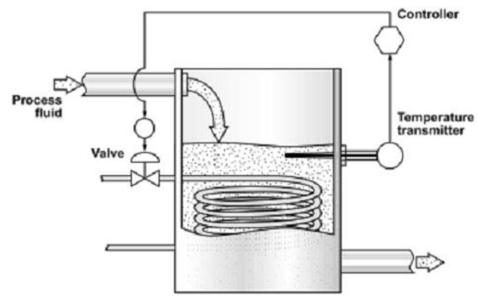
## Temperature Control Loops



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## Summary

- Basics of closed loop control systems.
- Developing block diagrams from chemical process.
- Incentives of chemical process control
- Design aspects of four major process control loops



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## Reference:

Chemical Process Control An Introduction to Theory and Practice
George Stephanopoulos

Introduction to Process Control,
Romagnoli, Jose A. CRC press, 2006.



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