# Design of PLC control system


**B.Sc. (Honours) in Instrument Engineering**

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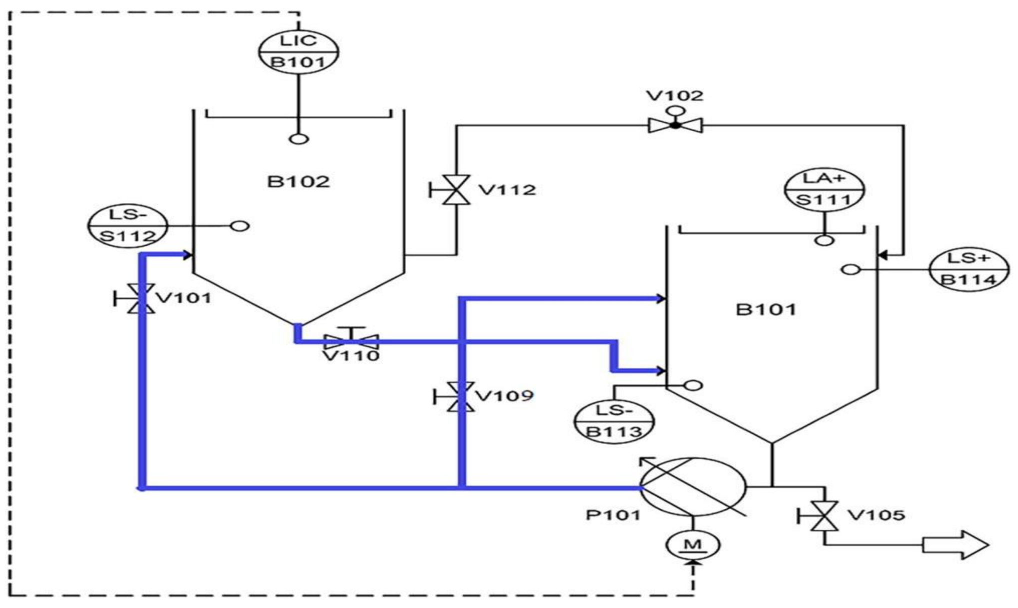
## Background of Project

### Abstract

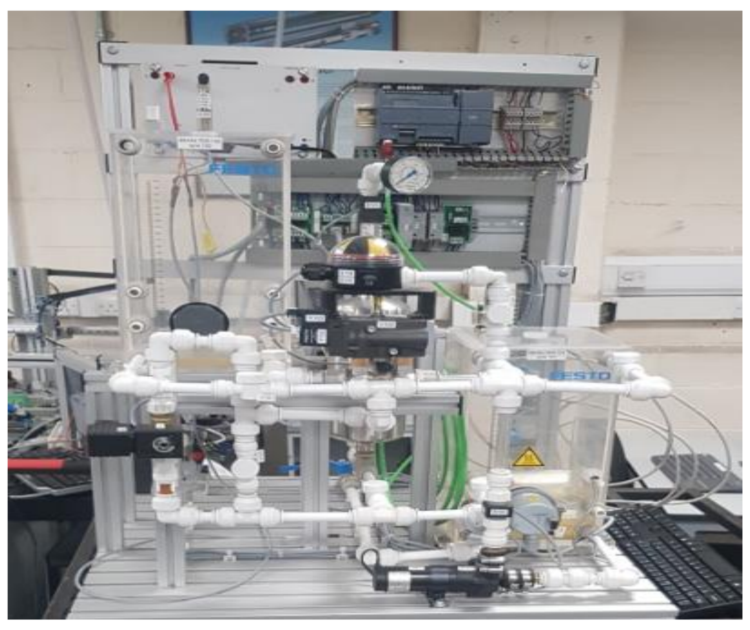

This project, involves the design of two water tank processes that work in tandem with a Siemens 1200 PLC system to offer a control framework for the process that maintains water level and temperature in the specified water tanks at a set point.


Below picture shows a P&ID diagram of the Rig which can be seen in figure 3. The blue tint represents the flow of water in the tank as it passes through the pipes. A ultrasonic level sensor can be seen detecting the process variable, which in this case is the liquid level in tank B102, the higher tank. The system's pump, designated P101, serves as an actuator, while the lower tank, designated B101, serves as a reservoir.[1]




### Project requirements

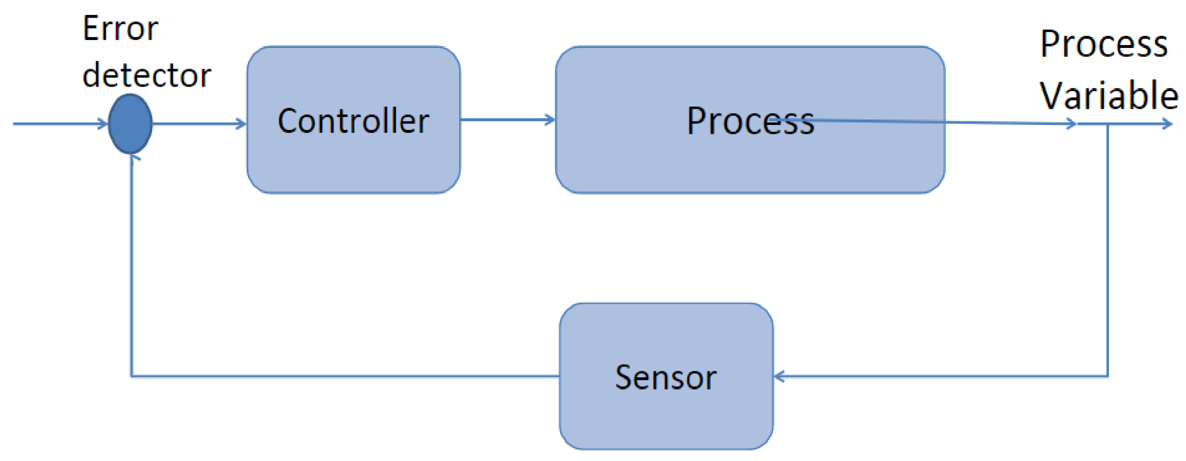
- Review the architecture of the rig architecture including components, sensor function and operation and safety protocols.
- Review the Siemens PLC 1200 and study the best practice regarding interfacing sensors and components with the platform.
- Investigate, prescribe, deploy and test a control strategy for the system.
- Design and build a user-friendly interface to control the sensors of the system.
- Critically analyse the performance of the system.



## Methodology

### PID Control

PID (Proportional-Integrative-Derivative) controllers are employed in almost every industrial control environment across the world. They have a simple design with only three parameters, which is part of the reason for their success; they are simple and straightforward to operate. This is the most popular choice among control engineers because the simple design is much easier to apply to control systems than more complicated control techniques




### Tuning a PID controller

Any project that uses a controller must be tailored to a specific environment. This entails deciding which control modes to utilize and which control settings to use. This means determining whether proportional control, proportional plus derivative, proportional plus integral or proportional plus integral plus derivative is to be used and selecting the values of KP, KI and KD These influence how the system reacts to a disturbance or change in the set value, how quickly it responds to changes, how long it takes to settle down after a disturbance or change in the set value, and whether a steady state error will occur. [2]

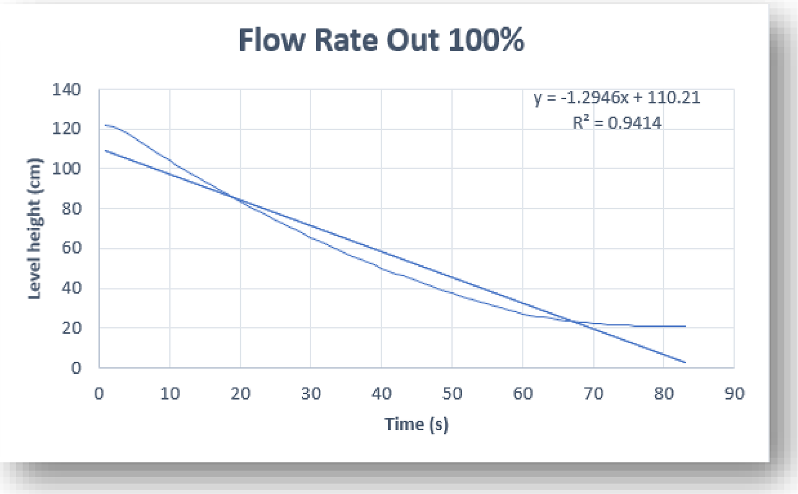
$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt + K_d \frac{de(t)}{dt}$$

- u(t) = PID control variable.
- $K_P$ = Gain (Proportional). This is a linear response to the error.
- e(t) = error value
- $K_I$ = Reset (Integral). Elimination of the offset error introduced by linear response.
- de = change in error value
- dt = change in time

## Results

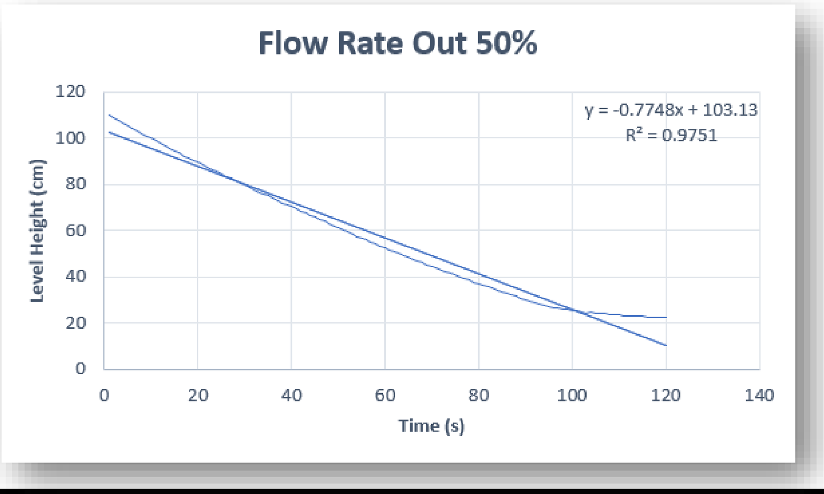
### Disturbance 100%

- Below shows the flow rate when the disturbance valve has been opened 100%.
- This is the outlet flow of water with no pump running and the disturbance valve been fully open.



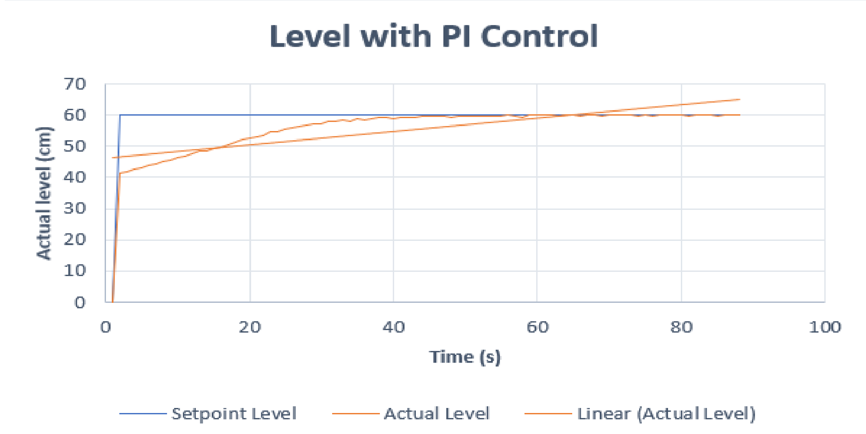

### Disturbance 50%

- Below shows the flow rate when the disturbance valve is opened by 50%.
- This is the outflow of water with a 50% disturbance in the system.
- The PI controller counteracted this outflow with the Pump and maintained level with minimal error.




### Control of level attained with Transfer function.

- The tuned level was attained using PI control.
- Constants used for tuning were a gain of 17, and integral of 2 seconds.




### Conclusions

- Level was controlled using a PI controller.
- System is a first order response.
- A PI controller proved to have less overshoot and had less settling time than the PID controller.
- Temperature was controlled using ladder logic where it would heat to the set point temperature and switch off.

## References


[1] https://www.sciencedirect.com/science/article/pii/S221509861831615X

[2]"9.3: PID Tuning via Classical Methods", Engineering LibreTexts, 2022. [Online]. Available https://eng.libretexts.org/Bookshelves/Industrial_and_Systems_Engineering/Book%3A_Chemical_Process_Dynamics_and_Controls_(Woolf)/09%3A_Proportional-Integral-Derivative_(PID)_Control/9.03%3A_PID_Tuning_via_Classical_Methods#:~:text=The%20Cohen%2DCoon%20method%20is,evaluate%20the%20initial%20control%20parameters. [Accessed: 20- Apr- 2022]