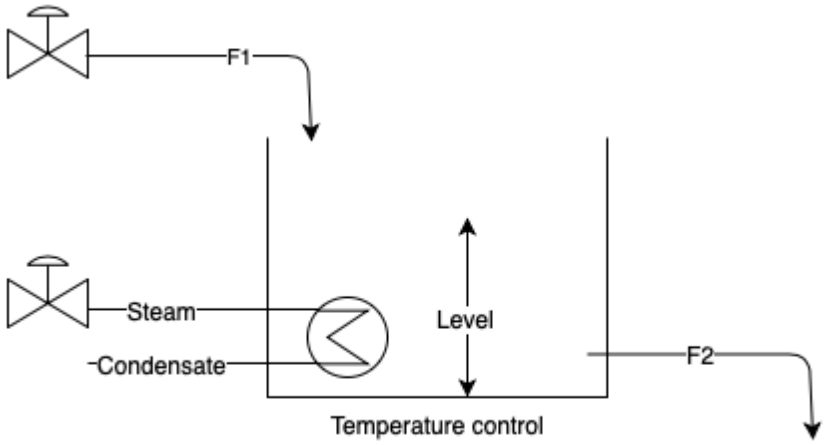
The project is to design controllers for level and temperature in a reactor.
A reactor is used where the temperature and level should be maintained constant. Inflow F1 is a flow that we can manipulate with the use of a control valve. Outflow F2 is a flow that we can measure. Temperature in the reactor and the level are measured. To maintain the temperature in the reactor steam is used. The steam flow could be manipulated by a control valve.
Figure 1 Temperature and level control in a reactor
Write a report of 2,500 words maximum, excluding references using the above description on:
"Level



Consider/discuss the following in the report:
1. Problem statement

Provide a description of the problem at hand. Clarify where such units are used and identify the typical control objectives. What are the requirements? Tight control, relaxed control, fast control…
Discuss safety and economic requirements.
The variables should be identified and categorised into manipulated variables, disturbance variables and process variables.
2. Modelling and block diagrams

For each process variable draw an open loop block diagram showing all blocks (process dynamics, disturbance dynamics), final control elements, and sensors. At this stage no controller is shown. Name each block and signal in the block diagram.
Explain how a model could be obtained from the differential equations and/or by experiment for each block in the block diagram. You may write the first principle equations that lead to develop the transfer functions. You are expected to discuss how in practice you can experiment to obtain the transfer functions or verify the ones obtained from first principle.
Present the type of transfer functions to expect for each block (order, deadtime or not, sign of the gain).
3. Control strategies (single loop, cascade, feedforward)

For each process variable describe the different possible control strategies, feedback, feedforward, cascade, or any combination of these, and compare them. For each control strategy provide a block diagram clarifying it.
Recommend one control strategy for each process variable.
4. Features of P, PI, PID

Describe P, PI, PID controllers. For each controller, provide its formula and transfer function.
Provide a comparison of the controllers and present the expected results (reaction curves).
Clearly specify when to use each controller type.
Recommend which ones to use for the case at hand.
5. References

It is expected that you cite any source used to develop the report. IEEE referencing style is recommended.

Expand your mid-term report to write a report of around 4,000 words maximum (including your mid-term report), excluding references, on:
"Analysis, design and implementation of a suitable feedback control strategy for level and temperature control in a reactor process."
An experiment was carried out by opening the flow F1 control valve by 10% the level in the reactor increased by 20 cm. The step change in the valve resulted in a response in the level that is 99.3% in 20s. During the first 4 seconds no change of the level was observed however.
A step change in the steam valve of 10% resulted in an increase of 5ºC in the temperature in the reactor. From our experiments we assume the temperature process to be a first order plus dead time process with a dead time of 5s and a time constant of 5s.
Add the following to your mid-term report:

- • Transfer functions
- – Estimate the process transfer functions for level and temperature from the experiments given. We assume the control valves' transfer functions to be unity.
- – What do you expect the disturbances transfer functions to look like for both level and temperature loops? Propose suitable ones.
- • Block diagram to simulate
- – Draw the block diagram of a feedback control solution showing the variables and the transfer functions. The block diagrams should be the ones you will be simulating. You are expected to simulate a feedback control strategy for temperature and level here.
- • Tuning
- – Provide the tuning parameters of a P, PI and PID controller using MATLAB pidtune() function and using one semi-empirical method.
- • Simulation

- – Provide simulation results of setpoint tracking and disturbance rejection by using P/PI/PID controllers tuned using the different tuning methods.
- – You should discuss the stability of the proposed system.
- • Fuzzy logic
- – Discuss how in practice you can use fuzzy logic control in the case at hand.
- • Hardware for implementation

Recommend a controller (PLC or DCS) for implementation, and discuss flexibility, availability and cost.

• Safety

– Discuss a possible safety critical shutdown system. Describe the safety functions required and draw a diagram showing a suggested Safety Instrument System.