Part IIA Project GF1: Control System

Project leader: Prof. R. Sepulchre
based on notes of Prof. J.M. Maciejowski

May 2022

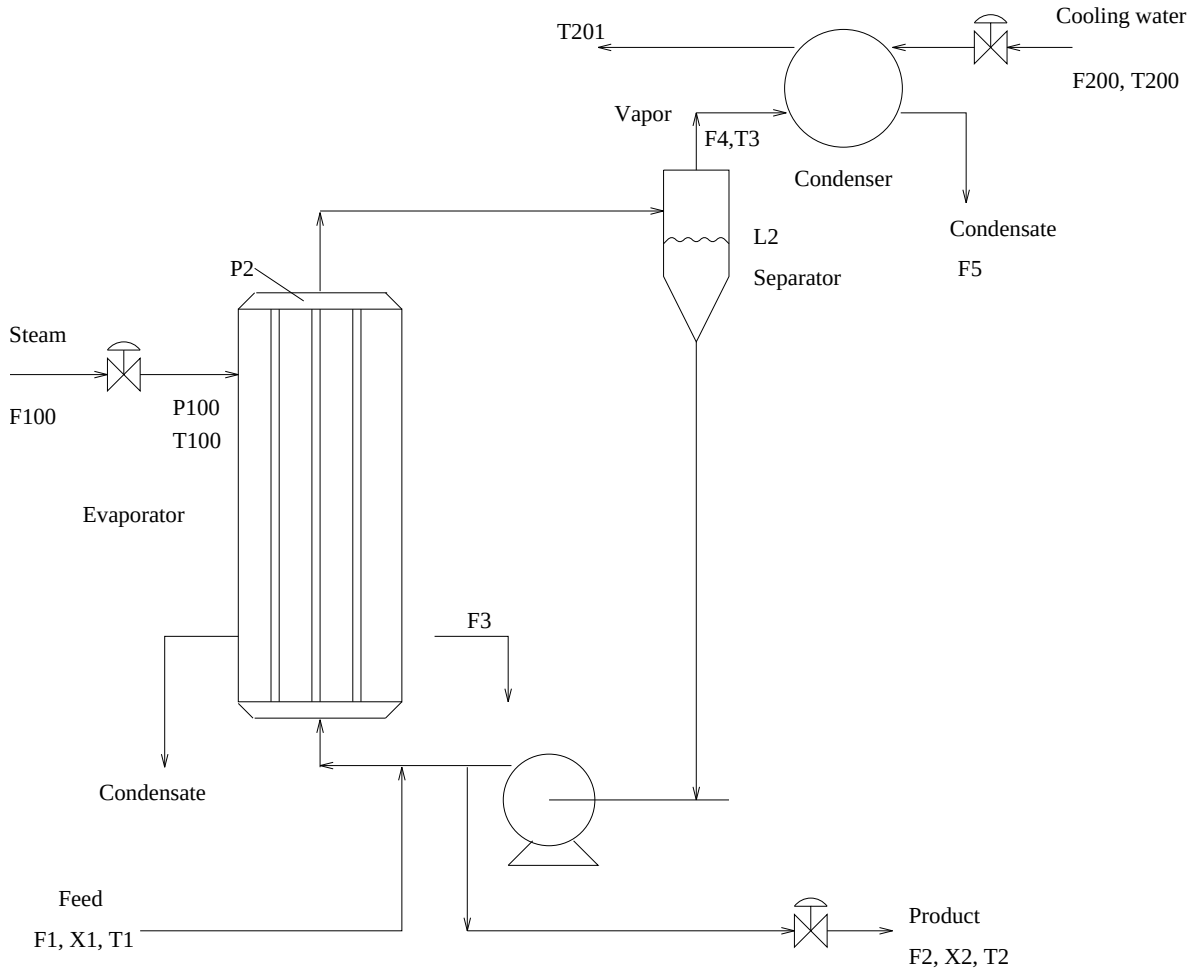
Introduction
Project Description

- The project involves the **modelling** and **control** of an ‘evaporator’, a process used in many industries (e.g., dairy products, chemicals).
- As a first step, a simulation model is built and tested.
- Then a control system is designed for the process, and its performance checked by simulating its operation with the evaporator.
- Modern simulation and analysis software is used throughout.

Introduction

The Evaporator — as you will see it

F1	Feed flowrate
X1	Feed composition
T1	Feed temperature
F2	Product flowrate
X2	Product composition
T2	Product temperature
F3	Circulating flowrate
T3	Vapour temperature
L2	Separator level
P2	Operating pressure
F100	Steam flowrate
T100	Steam temperature
P100	Steam pressure
Q100	Heater duty
F200	Coooling water flowrate
T200	Cooling water inlet temp
T201	Cooling water outlet temp
Q200	Condenser duty



Introduction

The Evaporator — a real example

Introduction
Aims

- To take students through the simulate/analyse/design/test cycle for an industrial control system (unfortunately omitting implementation).
- To expose students to state-of-the-art software for control engineering.
- To give students experience of simulating dynamic systems.
- To give students experience of working in teams to achieve a challenging task.

Introduction
Procedure

- Students work in pairs for the first 3 weeks. All pairs produce similar simulation models and initial control schemes.
  - The twelve pairs are assigned as follows:

pair 1 : akb62 + chmr3	pair 7: mf699 + xx814
pair 2: rb919 + fc494	pair 8: amah2 + lik26
pair 3 : amp212 + as2992	pair 9: lm859 + rrm40
pair 4 : ejpe3 + hps30	pair 10: jm2323 + hw527
pair 5 : rc801 + ct584	pair 11: kao34 + mo475
pair 6 : ff339 + ajmw4	pair 12: mii25 + ws398

- In the final week (Tuesday 7 June, am), each pair will make a proposal of a ”best” controller and demonstrate the performance of the controlled system online. Two pairs will present a solution based on gain scheduling, and two pairs will present a solution based on state-feedback design.

Introduction
Procedure

- Unless agreed otherwise, attendance is **compulsory** at the timetabled sessions:
  - Tuesdays 9am to 11am
  - Tuesdays 2pm to 4pm
  - Fridays 11am to 1pm
- You must ensure at least one chat contact with a demonstrator or with the project leader during those sessions. Video calls will take place during those sessions, either with the demonstrator or with the project leader. Each team will be called separately at specific times arranged via chat contact on Teams.

Introduction
Activities

Week 1: Familiarisation with SIMULINK simulation and MATLAB software. Familiarisation with description and mathematical model of evaporator. Construction of SIMULINK model of the evaporator.
First interim report.

Week 2: Completion of testing SIMULINK model of the evaporator. Refining the model. Closing one control loop.
Second interim report.

Week 3: Initial control design for the whole model. Investigation of performance when model behaviour changes. Investigation of integrator wind-up.

Week 4: Evaluation of controller when operating point changes. Investigation of gain-scheduled controller. Design of state-feedback controller.
Final report.

Introduction
Deliverables

Assessment	Length	Submission date	Marks
Interim report 1	2 pages	Friday 20 May 2022	20
Interim report 2	2 pages	Friday 27 May 2022	20
Final report	10 pages	Friday 10 June 2022	40

Reports **must** be submitted electronically **in PDF format** using Moodle by **4pm** on the indicated dates. There is no possibility of extending the deadline for the final report.

`http://www.vle.cam.ac.uk`

- The textual content of your reports should be your own work.
- You can share printouts and plots within your pair/group.
- Report are individual: you must document your own contributions but you can refer to other reports when discussing alternative solutions. A common abstract for the pair is permissible (encouraged).

Submission instructions

- Report submissions are carried out through the “Assignments” section of the GF1 course page in Moodle.
- Submission pages will become active in sequence
  - GF1 Control System: First interim report
  - GF1 Control System: Second interim report
  - GF1 Control System: Final report
- The submission web page will have instructions on the file name format you should use and the maximum number of pages your report should be
- Remember to click ”Submit Assignment” at the bottom of the submission page in order for your work to be fully submitted rather than in Draft form.
- The assignment pages will automatically **deactivate** 15 minutes after the deadlines (missing the 4pm deadline = lost marks though!) and be re-activated when your reports are marked with feedback provided through Moodle.

Introduction
Demonstrators

- At least one demonstrator will be available during each scheduled session:
  - Raphael Schmetterling (rjzs2)
  - William Rodhe (wr281)
- Use Teams for any contact with demonstrators and project leader.