# Process Control and Digitalization in Food Industry

## Prof. Andrea Bassani

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The purpose of this course is to lead the student to a proper knowledge of measuring and process control instruments for the food industry. This knowledge, combined with case studies and seminars, will allow the student to acquire the critical sense to evaluate potential applications in food sector of control methodologies. In addition, the course will provide students with the basis both for reading and interpreting process diagrams and for sizing and calibrating the main process control instruments.

In summary, at the end of the course, the student should be able to:

1. Recognize the main measuring instruments related to process control framework.
2. Know the meaning and the basis of process control methodologies presented during the course.
3. Choose the appropriate control systems for a food process.
4. Evaluate potential applications of these methodologies in the food sector.

***COURSE CONTENT***

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| - | ECTS |
| **Introduction**  | 0.2 |
| **Measuring Devices:** Temperature, pressure, level and flowrate sensors. Some hints related to other specific measuring device (e.g humidity or viscosity). | 1.0 |
| **Control Devices:**Valve descriptions and sizing | 0.8 |
| **Piping and Instrumentation Diagram**General principle about P&ID | 0.2 |
| **Automatic controls (general principles)**: open loop control; closed loop control; feedback controls in single and multiple loop; Proportional-Integral-Derivative (PID) control; some hints on the concept of cascade control and semi-empirical methods for control tuning | 1.8 |
| **Tutorials:** Group work, numerical exercises on measurement devices and valve sizing  | 0.5 |
| **Tutorials:** Group work, Case study simulation of a controlled process. | 1.5 |

***READING LIST***

* Bhuyan, Manabendra. Measurement and control in food processing. CRC Press, 2007.
* Anderson, Norman A. Instrumentation for Process Measurement and Control, Third Editon. Crc Press, 1997.
* Vyas, J. Jaidev, Balamurugan Gopalsamy, and Harshavardhan Joshi. Electro-Hydraulic Actuation Systems: Design, Testing, Identification and Validation. Springer, 2018.
* Marchal, Pablo Cano, Juan Gómez Ortega, and Javier Gámez García. Production Planning, Modeling and Control of Food Industry Processes. Springer International Publishing, 2019.

***TEACHING METHOD***

* Lectures in which concepts and work methodologies are presented. These lectures are coupled with case studies.
* Numerical tutorials during which problems are solved with the methods seen during the lectures
* Different in-depth seminars held by experts from both industry and academia (depending on the availability pf the experts).
* The teaching materials used during the lessons will be available on the common platform for students (i.e. Blackboard). The course slides are to be considered an integral part of the reference bibliography.

***ASSESSMENT METHOD AND CRITERIA***

The student will be required to take a final oral exam consisting in 2-3 theoretical questions and in the discussion of the working group. The latter will be carried out during the year, with an illustration of the topics and aims of the work, and the requirements of the final report (PowerPoint presentation). The work groups may consist indicatively of a maximum of 3-4 students, and the contribution and role of each individual member must be explicitly indicated in the final report. The final report will be assessed with a mark out of 30. The final mark will be taken as a weighted arithmetic mean of the mark obtained in the oral test (with a 2/3 weight) and that obtained in the group work assessment (with a 1/3 weight). In the case of working students or students unable to participate in the group work, this must be communicated to the lecturer at the beginning of the course, who will then be able to provide appropriate alternative ways to cover this part of the programme.

***NOTES AND PREREQUISITES***

The course requires some basic knowledge of reaction kinetics, and the chemical-physical characteristics of food products. Moreover, it is suggested that students review the basics of mathematics and physics with particular reference to equations, powers, exponential and logarithmic functions with related properties.

***OFFICE HOURS FOR STUDENTS***

Prof. Andrea Bassani is available for the students after the lectures helded in Cremona. In addition, he is available to receive students following specific appointment or through remote meetings. In any case, it is suggested to write an e-mail (andrea.bassani@unicatt.it) in order to agree on the day and time of reception.