**Food Industry Plants (Unit Operations)**

**2023/2024 a.y.**

**Prof. Andrea Bassani**

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

The purpose of this course is to introduce students to the tools needed to study and understand the phenomena that occur in the food industry unit operations. The first part of the course will deal with the physical-mathematical models for describing the phenomena of transport (mass, energy and momentum) and the balances (of mass and energy) that form the basis of food processing processes. The second part of the course will explore in more depth the practical knowledge needed for designing and managing food industry processes, through a systematic study of the main unit operations. Students' ability to apply knowledge and understanding is essentially developed through numerical calculation tutorials.

At the end of the course, students will know the principles behind the conservation and transport of momentum, energy and matter; they will also fully understand the logical and mathematical connections between the sizes they are presented with. In particular, students will be able to identify the limitations facing actual processes, and describe qualitatively and mathematically both the basic aspects of transporting momentum, energy and matter, and the operating principle behind the equipment typically used in food processes.

### ***COURSE CONTENT***

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|  | ECTS |
| ***Part 1: Transport Phenomena*** |  |
| International measurement system units and dimensions. Introduction to transport phenomena: transport of matter, heat and momentum; applications in the food industry. Mass and energy balances. | 1.0 |
| Momentum transport: rheology of Newtonian and non-Newtonian food fluids. Fluid dynamics: laminar and turbulent flow, Bernoulli equation, continuous and localised pressure losses, pumps, sizing of fluid-dynamic circuits. | 1.0 |
| Heat transfer: conduction, convection and radiation. Coefficients of heat transfer through flat and cylindrical walls. | 1.0 |
| Heat exchangers: types and mechanical aspects, design equations, technical specifications. | 1.0 |
| Tutorials  | 1.0 |
| ***Part 2: Unit Operations of the Food Industry*** |  |
| Concentration (simple and multiple effect evaporation, thermal and mechanical compression). | 1.0 |
| Hygrometry and drying. | 1.0 |
| Solvent extraction. | 0.5 |
| Solid/liquid separation techniques. | 1.0 |
| Innovative technologies in the food industry. | 0.5 |
| Tutorials | 1.0 |

***READING LIST***

R.P. Singh-D.R. Heldman, *Introduction to Food Engineering,* 4th edition, Academic Press Elsevier, 2009.

R.P. Singh-D.R. Heldman, *Principi di Tecnologia Alimentare,* First Edition, Casa Editrice Ambrosiana, 2015.

A. Ibarz-G.V. Barbosa, *Unit Operations in Food Engineering*, CRC Press, 2003.

K.J. Valentas-E. Rotstein-R.P. Singh, *Handbook of Food Engineering Practice*, CRC Press, New York, 1997.

W.L. Mccabe-J.C. Smith-P. Harriot, *Unit Operations of Chemical Engineering*, McGraw-Hill, New York, 1993.

D.R. Heldman-R.W. Hartel, *Principles of Food Processing*, Int. Thomson Publishing, New York, 1997.

R.L. Earle, *Unit Operations in Food Processing*, free downloadable from http://www.nzifst.org.nz/unitoperations/.

C. Peri-B. Zanoni, *Manuale di Tecnologie Alimentari*, CUSL, Milan, 1999.

D. Friso-M. Niero*, Operazioni unitarie dell’ingegneria alimentare,* Ed. Cleup, Padua, 2010.

P. Masi, *Ingegneria Alimentare, modelli predittivi della tecnologia alimentare,* First Edition, Doppiavoce, Naples, 2018.

P. Masi, *Esercitazioni di Ingegneria Alimentare, guida alla risoluzione dei problemi,* First Edition, Doppiavoce, Naples, 2018.

***TEACHING METHOD***

* Theoretical frontal and dialogue-based lectures in which the concepts, calculation rules and methods of solving exercises and problems are presented. The theoretical discussion is always accompanied by application examples.
* Frontal tutorials, during which exercises and problems are solved using the methods seen in class.
* Tutorials proposed for individual study (homework) which will then be discussed in class. In these activities, active participation by students in the undertaking of the work is required.
* Possible in-depth seminars (based on availability) held by sector experts from both industry and the university.
* The teaching materials used during lectures 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 reading list.

***ASSESSMENT METHOD AND CRITERIA***

A 2-hour written exam and an oral test on the days following the written test on the entire programme indicated in the degree course guide, following the reading list indicated therein. The written exam is based on solving two exercises. Each exercise will carry a mark of between 10 and 13 (indicated in the test text) for a maximum of 24. 1 exercise will cover part 1 of the course, while the other will cover part 2 of the course. An additional question will also be proposed for the achievement of “cum laude” mark. While completing the exercises, students may not use any notes, manuals, computers or other electronic devices; only use of a non-programmable calculator is allowed. However, students will be permitted to use a common formulary, containing the main formulas for solving the exercises, that the lecturer will hand out together with the exercises text. The oral test will take place on the days following the written test and will have a maximum mark of 6 to be sum with the mark of the written test.

***NOTES AND PREREQUISITES***

Being an introductory course aimed at offering a summary of the phenomena occurring in food plants and their subsequent design, there are no course prerequisites. However, we recommend a review of the main measurement units of the international system and their conversions. Furthermore, 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.

Information on office hours available on the teacher's personal page at <http://docenti.unicatt.it/>.