**. - Food Industry Plant and Equipment (Unitary Operations)**

## Prof. Roberta Dordoni

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

 *Part 1:* This course provides the student with the instruments necessary for studying the phenomena occurring in the unit operations in the food processing industry. These instruments are based on physical-mathematical models established to describe transport (mass, heat, momentum) and balance phenomena (material and energy) that form the basis of industrial food processing.

 *Part 2:* Students will gain the practical skills required for planning and design of food industry processes, through a systematic study of the pertinent unit operations.

At the end of the course, students will know about the functioning of the main machines and basic equipment of the food industries, as well as understanding how they work. Students will also be able to identify and apply the main methods of sizing and analysing the equipment and operations being studied.

***COURSE CONTENT***

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| **Material and energy balances**. Units and dimensions in the international system of measurement. Introduction to food engineering and transport phenomena: transport of mass, transport of heat, and transport of momentum; applications in the food industry. Material and energy balances.  | 1.0 |
| **Transport phenomena**. Transport of momentum: rheology of Newtonian and non-Newtonian fluid foods. Fluid dynamics: fluid statics and dynamics, laminar flow and turbulent flow, Bernoulli equation, continuous and localised friction losses, dimensioning of fluid-dynamic circuits, pumps, operating equipment calculation.  | 1.0 |
| Heat transfer: conduction, convection, irradiation. Evaluation of transfer coefficients through rectangular and cylindrical walls.  | 1.0 |
| Heat exchangers: classification and mechanical aspects, project equations, technical specifications. | 1.0 |
| Tutorials | 1.0 |
| **Unit operations in the food industry**. Concentration (simple and multiple effect evaporation, thermal compression). | 1.0 |
| Dehydration. | 1.0 |
| Extraction with solvents. | 0.5 |
| Solid-liquid separation techniques. | 1.0 |
| Innovation in food engineering. | 0.5 |
| Tutorials | 1.0 |

***READING LIST***

During the course, the presentations and supplementary materials (videos, catalogues, etc.) illustrated and discussed in class will be made available. For more in-depth study, the following texts are recommended:

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,* Prima Edizione, 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, Milano, 1999.

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

P. Masi, *Ingegneria Alimentare, modelli predittivi della tecnologia alimentare,* Prima Edizione, Doppiavoce Napoli, 2018.

P. Masi, *Esercitazioni di Ingegneria Alimentare, guida alla risoluzione dei problemi,* Prima Edizione, Doppiavoce Napoli, 2018.

***TEACHING METHOD***

Lectures supported by computer aids and slides, guided numerical exercises, on-site visits and seminars in food processing plants.

***ASSESSMENT METHOD AND CRITERIA***

The examination will take place in different ways for students attending and not attending classes:

* For attending students there will be an intermediate written test concerning the program carried out in the first part of the course (5 credits). The test will last three hours and will consist in performing three exercises including a questionnaire with theoretical choice questions.

After completing the lessons, there will be a second written test concerning the program carried out in the second part of the course (5 credits). The test will take place with the methods prescribed for the first test.

The passing one or both the intermediate tests exempts the student from preparing the corresponding program part for the final examination.

The score of each test will be expressed in thirtieths and will contribute to form the overall score in the final examination.

Students who have not taken or have not passed one or both tests, or who do not intend to accept the scores and the corresponding partial exemptions obtained in the tests, may take the oral examination with methods and contents defined for not attending students.

* Not attending students will have to take the orally examination on the entire program (theory and exercises) reported in the guidelines according to the bibliography.

***NOTES AND PREREQUISITES***

There are no prerequisites for attending the course. However, a review of the main notions of mathematics and physics is recommended.

***OFFICE HOURS FOR STUDENTS***

Prof. Roberta Dordoni is available to meet students in Cremona or in Piacenza, at the DiSTAS – Department for Sustainable food process. It is advisable to send an e-mail (roberta.dordoni@unicatt.it) in order to agree on a day and a time for seeing her.