ESIROI
ÉCOLE D'INGÉNIEURS
UNIVERSITÉ DE LA RÉUNION

DEPARTMENT : *AA*
SEMESTER : *S7*

IDENTIFICATION

Course code : ESI-SPI-CI-AG4-S7-UE1-EC6
ECTS : 4

DURATION

Lectures :	15
Tutorial classes :	45
Labs :	0
Total :	60

Project :
Personnal work :

ASSESSMENT

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Kaies SOUIDI Aman ZIAIIFAR (ATER)
kaies.souidi@univ-reunion.fr

Modifié le : 14 juillet 2026

UE : UE7-PROD

COURSE : Food Process Engineering 2

SCOPE OF THE COURSE

OBJECTIVES

The aim of this module is to provide in-depth expertise on complex unit operations for food transformation and stabilization. It covers conventional and emerging technologies (conventional, innovative, nanotechnologies), specific tropical sectors (such as sugar, starches, milk, etc.), and the use of digital tools (modeling, simulation, image analysis) to optimize processes according to multi-objective criteria (quality, economy, safety).

COMPETENCE AND SKILLS

Upon completion of this course, the student will be able to : - Design conventional thermal processing equipment, separation units (settling, centrifugation, membrane processes), evaporation-concentration systems, and drying processes (spray drying, freeze-drying). - Compare and select innovative stabilization processes (thermal and non-thermal) based on the food matrix. - Calculate and optimize mass and energy balances for a complete process. - Analyze food products using industrial vision (ImageJ) for quality control. - Develop and simulate mathematical models (deterministic, empirical, etc.) of mass/heat transfers using numerical tools (Matlab, Python, Comsol) applied to stabilization, preservation, and agro-food transformation processes.

PROGRAM

1. Unit operations and processes
2. Separation processes (extraction, membranes, settling, centrifugation)
3. Stabilization processes via evaporation-concentration
4. Dehydration processes (spray drying, freeze-drying, convective air drying)
5. Food product texturing (granulation, extrusion)
6. Innovative food processing technologies (alternative thermal processes (microwaves, infrared radiation, ohmic heating, ...))
7. Non-thermal food processing technologies (irradiation, homogenization, ultrasound, pulsed electric fields, high pressure, pulsed light)
8. Sugar technology : steps in sugar production processes (extraction of sugarcane and sugar beet juice, juice purification, evaporation, crystallization, sugar separation, drying and packaging) and calculations related to the different manufacturing stages, equipment used
9. Applications of nanotechnology in the food industry (nanotechnology basics, nanoparticle fabrication, micro and nanoemulsions, nano-encapsulation)
10. Multi-criteria optimization of processes (trade-offs between nutritional, sanitary, sensory, technical, and economic quality)
11. Digital images, processing and analysis for industrial applications (image acquisition, lighting, sensors and ImageJ software)
12. Modeling in food industries (mathematical models based on balances and mass/energy transfers, empirical models, process optimization)
13. Numerical simulation and software (Comsol Multiphysics, Matlab and Python) : Introduction to solving transfer equations in Matlab/Python and introduction to finite elements with Comsol Multiphysics.

BIBLIOGRAPHY

— Jeantet, R., et al. (2021). *Food Process Engineering Applied to the Agri-Food Industry* (Vol. 1 & 2). Lavoisier.
— Mafart, P. (2010). *Food Industrial Engineering : Unit Operations*.
— Berk, Z. (2018). *Food Process Engineering and Technology*. Academic Press.
— Singh, P. & Dennis Heldman. (2004). *Introduction to Food Engineering*, Fourth Edition.
— Sun, D. W. (2014). *Emerging Technologies for Food Processing*. Academic Press.

REQUIREMENTS

— Biology/Microbiology/Biochemistry : Microorganism structure and basics of bacterial growth.
— Physics/Chemistry : Concepts of temperature, heat, pressure, and simple mass balances.
— Applied Mathematics or Math Complements : Use of logarithmic and exponential functions, graph reading.
— Physics Complements.