Syllabus

Course Description

Course Title	Reaction kinetics in food processing
Course Code	44740
Course Title Additional	
Scientific-Disciplinary Sector	AGRI-07/A
Language	English
Degree Course	Master in Food Sciences for Innovation and Authenticity
Other Degree Courses (Loaned)	
Lecturers	Prof. Matteo Mario Scampicchio, matteo.scampicchio@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/30226
Teaching Assistant	
Semester	Second semester
Course Year/s	1st
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	Reaction kinetics provides quantitative tools to describe, interpret, and predict chemical, biochemical, and microbiological changes in foods during processing and storage. The course covers the development of mechanistic thinking, from rate laws to process design decisions, with a focus on stability and shelf-life issues. Concepts are applied through computational exercises and case studies using food-relevant quality indices.
Course Topics	Topic 1: Thermodynamics and kinetics of food systems Topic 2: Thermal processing and microbial inactivation Topic 3: Enzymatic browning:, kinetics, and inhibition

	Topic 4: Lipid oxidation and antioxidant functionality Topic 5: Maillard chemistry in food processing Topic 6: Shelf-life modelling: stability and study design
Keywords	Reaction kinetics, Food degradation, Temperature dependence, Antioxidants, Shelf-life modelling
Recommended Prerequisites	Topics covered include general chemistry, introductory food chemistry, basic calculus and elementary statistics. Familiarity with spreadsheet would be an advantage
Propaedeutic Courses	None
Teaching Format	Teaching is delivered entirely in person, with asynchronous lecture recordings available for revision. Laboratory sessions are planned at NOI Park, together with at least one excursion to observe industrial-scale processing and quality control practices. Innovative teaching format includes collaborative problem solving in small groups, case studies, guided tutorials, and structured use of artificial intelligence tools.
Mandatory Attendance	No
Specific Educational Objectives and Learning Outcomes	Knowledge and understanding: Deep understanding of the technological, microbiological, biochemical, chemical, and physical principles underlying food transformation processes and responsible for food product degradation, ensuring their stability and prolonging their shelf life. These knowledge areas will be developed through an educational program that integrates theoretical teaching activities with classroom tutorials, including examples, practical applications, individual and group work, and assessments aimed at encouraging active participation and independent solution development. These knowledge areas will be developed through an educational program that integrates theoretical teaching activities with practical activities, such as laboratory exercises, computer simulations, simulations of food processes using pilot plants, and company visits. Ability to apply knowledge and understanding: Ability to manage the technological, microbiological, biochemical, chemical, and physical processes that drive food transformation and the main issues related to the stability and shelf life of food

	products. Making judgements: Independent judgement is developed through a training programme designed to stimulate critical analysis in students. This includes the use of case studies, simulations using spreadsheets and videos, the reading and critical discussion of scientific articles, as well as specialist seminars held by experts in the food sector. The assessment of the independent judgement acquired by students is entrusted to the individual teachers responsible for the training activities, who will assess it through oral and/or written reports on specific topics and/or through exams. Communication skills: Use of the English language, both written and spoken, at a B2 level, with a command of technical and scientific vocabulary related to food science. Structure and draft scientific and technical documentation describing project activities. Interact and collaborate in the design and development of products and processes with peers and industry experts. The degree course provides graduates with the cognitive skills, logical tools and familiarity with new information technologies necessary to ensure continuous updating of knowledge, both in their specific professional field and in the field of scientific research.
Specific Educational Objectives and Learning Outcomes (additional info.)	Upon successful completion, students may be able to develop an integrated understanding of how thermodynamic driving forces, together with kinetic constraints, govern food quality evolution during processing and storage. Core concepts may include rate laws, reaction order, rate constants, as well as Arrhenius and Eyring temperature dependence, thereby supporting interpretation of time–temperature histories in relation to quality retention and safety targets. This conceptual framework may be applied to major degradation pathways in food systems, including: 1. enzymatic browning, 2. Maillard chemistry, 3. lipid peroxidation and antioxidant reactivity 4. microbial inactivation.

	Building on these foundations, students may be able to formulate, solve, and parameterise kinetic models for practical problems, including: 1. lethality metrics 2. quality loss, stability assessment 3. shelf-life prediction. Kinetic parameters may be estimated from experimental datasets using spreadsheet, alongside the design and interpretation of shelf-life studies, including accelerated testing approaches. Communication outcomes may include the ability to convey kinetic and food-chemistry reasoning in English at approximately B2 level, using discipline-appropriate terminology
Assessment	Assessment is based on continuous mid-term components (70%) and a final written examination (30%) focused on shelf-life problems. Mid-term assessment may include in-class multiple-choice and true/false tests, open questions, interviews about small group discussions and problem-based learning works. Students who complete the mid-term components, the final written examination is based on a single shelf-life problem. This problem requires model formulation, parameter interpretation, and shelf life estimation. For students who do not attend lectures, and/or who do not successfully complete the mid-term components, the final examination covers the full programme and includes quiz-style questions together with open questions, alongside the stability and shelf-life problem.
Evaluation Criteria	1. Conceptual correctness: thermodynamics and kinetics. 2. Calculations: mathematically correct. 3. Units: consistent units and dimensional checks. 4. Model choice: first, second, or zero order. 5. Shelf-life judgement: endpoint and stability conclusion. 6. Communication: correct use of specific terminology
Required Readings	**Course materials:**

	• Lecture slides, spreadsheets (modelling templates), together with the lecturer's notes. • Exercise notes distributed during tutorials and laboratory sessions. **Online Textbook:** Earle, R. L.; Earle, M. D. *Fundamentals of Food Reaction Technology*. Royal Society of Chemistry, ISBN 978-1-904007-53-1.
Supplementary Readings	**Reference book** van Boekel, M. A. J. S. *Kinetic Modeling of Reactions in Foods*. CRC Press, Boca Raton, Two thousand eight. DOI: 10.1201/9781420017410.
Further Information	All course materials are available via the course TEAMS channel.
Sustainable Development Goals (SDGs)	Zero hunger, Good health and well-being, Climate action, Responsible consumption and production, Industry, innovation and infrastructure