# FDSCTE/FABE 7430 Advanced Food Process Design

## Autumn 2020

## Credit Hours: 3

## Meeting Dates and Location:

**Lectures: Tuesday/Thursday; 220-315 pm** **114 Parker Food Science and Technology Building**
**Recitation: Monday; 215-415 pm** **114 Parker Food Science and Technology Building**

## Course Format: P

## Instructor:

Dennis R. Heldman
Heldman.20@osu.edu
Office hours, Fridays, 10 a 12 noon in 229 Parker

Aishwarya Badiger; TA (badiger.1@osu.edu)

Office hours: Tuesday, 10am – 12 noon (via Zoom)

Wooju Kim; TA (kim.7272@osu.edu)

Office hours: Monday, 10 -12 am

**Prerequisites:** FST 5400/FABE 4410 or equivalent

**Course Description:** a graduate level course with focus on integration of kinetic models used to describe changes in food quality attributes with models for heat and mass transfer in foods to create simulations of quality attributes of foods as a function of conditions throughout the food supply chain.

## Goals:

1. To develop and illustrate the use of kinetic models to describe changes in food quality attributes as a function of typical process parameters.
2. To develop and apply appropriate heat and mass transfer models for conditions occurring during the handling, storage, processing, packaging, distribution and preparation of foods.
3. To integrate the kinetics of quality change with heat and mass transfer models for prediction of food quality attributes.
4. To optimize process design for maximum retention of quality attributes, while ensuring food product safety and process efficiency.

## COURSE MATERIALS AND TECHNOLOGIES

### Textbooks/Readings:

Heldman, Dennis R. 2011. ***Food Preservation Process Design.*** Elsevier-Academic Press. San Diego, CA. 354 pp.

### Optional Readings:

Coupland, John E. 2014. *An Introduction to the Physical Chemistry of Foods.* Springer Science Publishers. New York. 182 pp

Heldman, Dennis R., Daryl B. Lund and Cristina Sabliov. 2019. *Handbook of Food Engineering.* Third Edition. CRC Taylor & Francis. Boca Raton, FL. 1194 pp.

Irudayaraj, Joseph (Ed). 2001. *Food Processing Operations Modeling.* Marcel Dekker, Inc. New York. 347 pp.

Peleg, Micha. 2006. *Advanced Quantitative Microbiology for Foods and Biosystems*. CRC Taylor & Francis. Boca Raton, Fl. 456 pp.

Rao, M.A. and S.S.H. Rizvi (Ed). 1995 *Engineering Properties of Foods.* Second Edition. Marcel Dekker, Inc. New York. 531 pp.

Shyam, Sablani S., M. Shafiur Rahman, Ashim K. Datta, M. and Arun S. Mujumdar (Eds). 2007. *Handbook of Food and Bioprocess Modeling Techniques*. CRC Taylor & Francis, Boca Raton, FL. 605 pp.

Sun. D-W (Ed). 2005. *Emerging Technologies for Food Processing*. Elsevier- Academic Press. San Diego, CA. 767 pp.

van Boekel, M.A.J.S. 2008. *Kinetic Modeling of Reactions in Foods.* CRC-Taylor & Francis. Boca Raton, FL. 767 pp.

## Other Fees or Requirements: None

## Course technology

For help with your password, university e-mail, Carmen, or any other technology issues, questions, or requests, contact the OSU IT Service Desk. Standard support hours are available at OCIO Help Hours, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** (http://ocio.osu.edu/selfservice)
- **Phone:** 614-688-HELP (4357)
- **Email:** 8help@osu.edu
- **TDD:** 614-688-8743

## Technology skills necessary for this specific course

- Zoom text, audio, and video chat
- Recording a slide presentation with audio narration
- Recording, editing, and uploading video

## Required equipment

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed and tested
- Microphone: built-in laptop or tablet mic or external microphone

## Required software

- Microsoft Office 365: All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Full instructions for downloading and installation is found https://ocio.osu.edu/kb04733.
- Approved browsers:

## Carmen Access

You will need to use BuckeyePass multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you take the following steps:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass - Adding a Device help article for step-by-step instructions.
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click "Enter a Passcode" and then click the "Text me new codes" button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- Download the Duo Mobile application to all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and the IT support staff will work out a solution with you.

## GRADING AND FACULTY RESPONSE

## How your grade is calculated

| ASSIGNMENT CATEGORY | POINTS |
|---|---|
| **Case study reports (8)** | 40 |
| **Mid-semester examination** | 15 |
| **Term project report**<br>**Final Exam** (comprehensive) | 20<br>25 |
| **Total** | 100 |

## Description of course requirements

1. Reading assignments from text, references and specific research papers; materials from these assignments are covered on mid-semester and final examination.
2. Case study assignments; 8 during the semester; individual reports on each case study; evaluation of assignments are based on both presentations and written reports.

3. Term project; based on a topic selected in the student's area of interest; evaluation of outcomes is based on a presentation and written paper based on term project.
4. One mid-semester examination and a comprehensive final examination.

## Academic integrity policy

### Ohio State's academic integrity policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's *Code of Student Conduct* (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

**If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct.** If COAM determines that you have violated the university's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.
Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct web page (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)
- Eight Cardinal Rules of Academic Integrity (go.osu.edu/cardinal-rules)

## Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

## Statement on Title IX

All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.
If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information on OIE, visit equity.osu.edu or email equity@osu.edu.

## Commitment to a diverse and inclusive learning environment

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

## Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. No matter where you are engaged in distance learning, The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find yourself feeling isolated, anxious or overwhelmed, on-demand resources are available at go.osu.edu/ccsondemand. You can

reach an on-call counselor when CCS is closed at 614- 292-5766, and 24-hour emergency help is also available through the 24/7 National Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org. The Ohio State Wellness app is also a great resource available at go.osu.edu/wellnessapp.

# ACCESSIBILITY ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

## Requesting accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. **SLDS contact information:** slds@osu.edu; 614-292-3307; 098 Baker Hall, 113 W. 12th Avenue.

## Accessibility of course technology

This online course requires use of CarmenCanvas (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Canvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)
- Collaborative course tools

# COURSE SCHEDULE:

| Week Number | Date of Week | Topics |
|---|---|---|
| 1 | 08/25-31 | Introduction to process design, as applied to the food supply system. Defining the design criterion at stages in the system; product handling, storage, processing, packaging, distribution and preparation. Read Chap 1 Introduction to kinetic models; zero, first and multiple parameter models. A physical-chemical basis for kinetic models; the first-order model. Read pp 19-30 |

| Week Number | Date of Week | Topics |
|---|---|---|
| | | Recitation; a discussion of case studies and term projects; selection of topics. |
| 2 | 09/01-03 | Estimating kinetic rate constants from experimental data; factors to be considered when collecting experimental data; the Arrhenius model. Read pp 30-36<br>Kinetic rate constants; statistical parameters for rate constants. Statistical reliability of kinetic models. |
| 3 | 09/08-14 | The first-order model for microbial survivors; alternative models for microbial survivors during processes and storage. Models for prediction of microbial growth in foods; risk analysis for perishable foods. Read pp 37- 48<br>Applications of kinetic models to the quantitative description of changes in microbial populations.<br>Read pp 49-85<br>Recitation; Case Study #1 - analysis of experimental data based on shelf-life limiting reactions. Report #1 due |
| 4 | 09/15-21 | Applications of kinetic models to shelf-life limiting reactions during processes and storage. Read pp 49-85<br>Use of kinetic models to describe retention of food quality attributes in foods during processes and storage; nutrients, color, flavor, texture, etc. Read pp 87-95<br>Recitation; Case Study #2 – analysis of data for changes in product quality attributes Report #2 due |
| 5 | 09/22-28 | Prediction of shelf-life limiting quality attributes using kinetic models as a function of process or storage parameters. Read pp 95-110<br>A review of models to describe unsteady-state heat transfer in food products; prediction of thermo-physical properties based on food composition. Read pp 111-125<br>Recitation; Case Study #3 – prediction of shelf-life limiting reactions and quality attribute changes during a process or storage Report #3 due |
| 6 | 09/29-10/05 | Impact of phase change on thermo-physical properties; ability to predict property changes as a function of phase change.<br>Applications of unsteady-state heat transfer models to heating and cooling of foods at various stages in food |

| Week Number | Date of Week | Topics |
|---|---|---|
| | | chain; from post-harvest handling to home preparation. Read pp 125-131<br>Recitation: Case Study #4 – prediction of thermo-physical properties based on food composition.<br>Report #4 due |
| 7 | 10/06-12 | Numerical methods for prediction of changes in product properties during transient-state processes with thermal energy transfer pp 131-138<br>Numerical models for prediction of temperature distribution histories within food products during processes; ohmic and microwave heating pp 138-145<br>Recitation; Case Study #5 – temperature and/or concentration distribution histories in foods.<br>Report #5 due |
| 8 | 10/13-19 | Water in food systems; equilibrium moisture content versus water activity; equilibrium moisture isotherms.<br>A review of models to describe unsteady-state mass transfer in foods; evaluation of properties.<br>Recitation; Case Study #6 – numerical prediction of distribution histories for microbial populations or other shelf-limiting reactions during preservation or storage.<br>Report #6 due |
| 9 | 10/20-26 | Integration of kinetic models with unsteady-state heat and mass transfer models; prediction of microbial populations, shelf-life limiting reactions and food quality attributes as a function of time and location within the food product pp 147-162<br>Mid-Semester Examination<br>Recitation; Case Study #7 – numerical prediction of quality changes (retention) during a process or storage Report #7 due |
| 10 | 10/27-11/02 | Use of numerical methods to predict microbial population or shelf-life limiting attribute distribution histories within the product during process or storage pp 162-216<br>Integrations of kinetic models with unsteady-state mass transfer models; prediction of water activity as a function of time and location within a dry food. |

| Week Number | Date of Week | Topics |
|---|---|---|
| | | Recitation; Case Study #8 – optimization of a process or storage condition to achieve maximum quality retention<br>Report #8 due |
| 11 | 11/03-09 | Prediction of quality attribute changes in a dry food during storage. An introduction to heat and mass transfer during food dehydration.<br>Optimization of food processes; use of two or more kinetic models for simultaneous prediction of two or more shelf-life limiting or product quality attributes during a process or storage pp 245-258<br>Recitation; Presentation of student term projects |
| 12 | 11/10-16 | Applications of models for description of inactivation of pathogens in a food during a thermal process.<br>Prediction of the impact of a thermal process on heat-sensitive food components. The mass average temperature and/or concentration concept.<br>Recitation; Presentation of student term projects. |
| 13 | 11/17-23 | Thermal processes with maximum product quality retention, ensuring product safety; risk assessment pp 258-65<br>Models for prediction of temperature distribution histories within a refrigerated or frozen food; applications of microbial growth models.<br>Recitation; Presentation of student term projects |
| 14 | 11/24 | Prediction frozen food quality attributes during storage; impact of thermal abuse during storage and distribution on frozen food quality |
| Final Exam Week: | 12/07-12/11 | Thursday, Dec 10; 2 – 345 pm |