FST/FABE 7430
Advanced Food Process Design

Fall Semester, 2016
Lectures; Tu Th 220-320
Recitation; M 355-515

Instructor:
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Course Objectives:

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 References:

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

References:

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

Heldman, Dennis R. and Daryl B. Lund. 2007. *Handbook of Food Engineering.* Second Edition. CRC Taylor & Francis. Boca Raton, FL. 1023 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.

Topic Outline:

The objectives of the course will be achieved through a combination of lectures, homework assignments, recitation sessions, case studies and term projects.

Date	Topic	Assignment
Aug 23	Introduction to process design, as applied to the food chain. Defining the design criterion at stages in the chain; product handling, storage, processing, packaging, distribution and preparation	Chap 1
Aug 25	Introduction to kinetic models; zero, first and multiple parameter models. The physical-chemical basis for kinetic models; the first-order model	pp 19-30
Aug 29	A discussion of case studies and term projects; selection of topics	

Aug 30	Estimating kinetic rate constants from experimental data; factors to be considered when collecting experimental data; the Arrhenius model	pp 30-36
Sept 1	Kinetic rate constants; statistical parameters for rate constants. Statistical reliability of kinetic models	
Sept 6	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	pp 37- 48
Sept 8	Applications of kinetic models to the quantitative description of changes in microbial populations	pp 49-85
Sept 12	Attend CoFE16. Complete Case Study #1 -- analysis of experimental data for shelf-life limiting reactions	Report #1
Sept 13	Applications of kinetic models to shelf-life limiting reactions during processes and storage	pp 49-85
Sept 15	Use of kinetic models to describe retention of food quality attributes in foods during processes and storage; nutrients, color, flavor, texture, etc.	pp 87-95
Sept 19	Completion of Case Study #2 – analysis of data for changes in product quality attributes	Report #2
Sept 20	Prediction of shelf-life limiting quality attributes using kinetic models as a function of process or storage parameters	pp 95-110
Sept 22	A review of models to describe unsteady-state heat transfer in food products; prediction of thermo-physical properties based on food composition	pp 111-125

Sept 26	Complete Case Study #3 – prediction of shelf-life limiting reactions and quality attribute changes during a process or storage	Report #3
Sept 27	Impact of phase change on thermo-physical properties; ability to predict property changes as a function of phase change	
Sept 29	Applications of unsteady-state heat transfer models to heating and cooling of foods at various stages in food chain; from post-harvest handling to home preparation	pp 125-131
Oct 3	Complete Case Study #4 – prediction of thermo-physical properties based on food composition	Report #4
Oct 4	Numerical methods for prediction of changes in product properties during transient-state processes with thermal energy transfer	pp 131-138
Oct 6	Numerical models for prediction of temperature distribution histories within food products during processes; ohmic and microwave heating	pp 138-145
Oct 10	Complete Case Study #5 – temperature and/or concentration distribution histories in foods	Report #5
Oct 11	Water in food systems; equilibrium moisture content versus water activity; equilibrium moisture isotherms	
Oct 17	Complete Case Study #6 – numerical prediction of distribution histories for microbial populations or other shelf-limiting reactions during preservation or storage	Report #6

Oct 18	A review of models to describe unsteady-state mass transfer in foods; evaluation of properties	
Oct 20	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
Oct 24	Mid-semester Examination	
Oct 25	Use of numerical methods to predict microbial population or shelf-life limiting attribute distribution histories within the product during a process or storage	pp 162-216
Oct 27	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	
Oct 31	Completion of Case Study #7 – numerical prediction of quality changes (retention) during a process or storage	Report #7
Nov 1	Prediction of quality attribute changes in a dry food during storage. An introduction to heat and mass transfer during food dehydration	
Nov 3	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
Nov 7	Completion of Case Study #8 – optimization of a process or storage condition to achieve maximum quality retention	Report #8

Nov 8	Applications of models for description of inactivation of pathogens in a food during a thermal process	
Nov 10	Prediction of the impact of a thermal process on heat-sensitive food components. The mass average temperature and/or concentration concept	
Nov 14	Presentation of student term projects	
Nov 15	Thermal processes with maximum product quality retention, ensuring product safety; risk assessment	pp 258-65
Nov 17	Models for prediction of temperature distribution histories within a refrigerated or frozen foods; applications of microbial growth models	
Nov 21	Presentation of student term projects	
Nov 22	Prediction frozen food quality attributes during storage; impact of thermal abuse during storage and distribution on frozen food quality	
Nov 28	Presentation of student term projects	
Nov 29	Models for prediction in water activity in a dry food during storage; temperature and relative humidity	
Dec 1	Impact of package permeability on distribution of water activity and product quality attributes within the product during storage. Dry food shelf-life prediction	
Dec 5	Presentation of student term projects	
Dec 6	Review for Final Examination	
Dec 13 (4-545 pm)	Final Examination	

Course and Classroom Activities:

1. T w o 6 0 - m i n lectures per week
2. One 80 min recitation period per week
3. Independent study, analysis and reports

Assignments:

Assignments during the semester:

1. Reading assignments from text, references and specific research papers.
2. Case study assignments; 8 during the semester; individual reports on each case study.
3. Term project; based on a topic selected in the student's area of interest; report and presentation at end of semester.

Examinations:

One mid-semester examination and a final examination.

Grading:

Case study reports (8)	40
Semester examination	15
Final examination	25
Term project report	20

93-100%	A
90-93	A-
87-89	B+
83-86	B
80-82	B-
77-79	C+
73-76	C
70-72	C-

Academic Honesty:

Academic honesty requires that each student complete all assignments and related work on an independent basis. Students must protect their integrity by being honest in all intellectual endeavors. Proper credit for all information used in an assignment is critical, and the written report or summary must include the citation for any book, magazine, newspaper or web site used in the completion of the assignment.

Collaboration is expected and encouraged. All reports from independent projects must represent independent work by the student.

Academic misconduct will not be tolerated. Suspected academic misconduct will be referred automatically to the Committee on Academic Misconduct as required by Faculty Rules.

Academic misconduct is defined in the Code of the Student Conduct(33352304,http:/jstudentaffairs.osu.edujinfo_for_studentsjcsc.asp) and the Rules of the University Faculty (3335-31-02, http:/ jwww.acs.ohio-state.edu/offices/assjproceduresj1.0.html)

Disability Services:

Any student who may need an accommodation based on the impact of a disability should contact the course instructor to discuss specific needs. The Office for Disability Services assists faculty in verifying the need for accommodations and developing accommodation strategies. If you have not done so, you are encouraged to contact the Office for Disability Services at 614-292-3307 in room 150 Pomerene Hall to register your disability.