16:400:609
Thermal and Non-Thermal Processing of Foods
(3 credits)

Instructor: Professor Mukund V. Karwe
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Prerequisites: 16:400:507 at Rutgers
or equivalent courses in engineering
Some knowledge of computer programming (BASIC, Excel, Fortran, MatLab, C++, etc.)

Time and Location: Wednesdays: 5:35 – 8:00 pm, Food Science 107 or 109

NOTE: This course will use self-study-learn & peer teaching format to a large extent.

Course Description and Outline

This course would cover selected topics in thermal and non-thermal processing of food. It is intended for graduate students at advanced level. The course would cover traditional processes such as retorting, extrusion, as well as new and emerging technologies of food processing such as high hydrostatic pressure processing and pulse electric field processing. The emphasis in this course will be on the mathematical models that describe these processes and the impact of processing on food quality and safety. Some discussion of processing equipment will also be included. The course would offer an opportunity to students in food science, chemical, and mechanical engineering to learn about traditional thermal processes as well as new non-thermal processes in a rigorous manner.

Rationale

Most of the foods that are consumed by people are processed in one way or the other. Foods are processed to make them safe (microbiologically), to develop flavor, color, texture, to make them easy for digestion, and to make them convenient for eating and handling. Foods can be preserved by addition or removal of heat. Traditionally, foods have been processed thermally in a variety of ways such as steam retorting, pasteurization, baking, and frying. However, traditional thermal processing methods, which are aimed mainly at eliminating the harmful bacteria by heat, have some disadvantages that include loss of color, flavor, freshness, and some nutritional aspects. New ways of processing food in non-thermal ways offer a way to eliminate some of these disadvantages and ensure food safety.

The material in this course would be based on fundamental engineering principles such as heat and mass transfer, fluid mechanics, and reaction kinetics, which are covered in other courses offered through our department as well as in chemical and mechanical engineering. We will focus on application of these fundamental principles to specific thermal and non-thermal processes for food materials, is not covered in any other course in our department or other departments in our university. At the end of this course, it is expected that the students will develop a good perspective for when thermal processing is suitable and when non-thermal processing is suitable for a given food product. They will also learn how to apply these methods in a quantitative manner.

Topics covered will include both thermal and non-thermal processing of food. Emphasis will be on mathematical description of the processes. Although several processes will be broadly covered, a few processes will be selected for in-depth analysis and discussion.

Textbook:

None

Suggested reference books:

1. "Introduction to Food Engineering," 4th Edition, R.P. Singh and D.R. Heldman, Academic Press, NY, 2009.
2. "Food Processing Technology: Principles and Practice," P.J. Fellows, CRC Press, Boca Raton, FL, 2000.
3. "Food Extrusion," Vol. I and II. J.M. Harper, CRC Press Boca Raton FL, 1980.
4. "Food Extrusion Science and Technology," J. L. Kokini, C.T. Ho, M.V. Karwe (Eds.), Marcel Dekker, New York, 1992.
5. "Trends in Food Engineering," J.E. Lozano, C. Anon, E. Parada-Arias, and G.V. Barbosa-Canovas, Food Preservation Technology Series, Technomic Publications, Lancaster, PA, 2000.
6. "Non-Thermal Preservation of Foods," G.V. Barbosa-Canovas, U.R. Pothakumary, E. Palou, B.G. Swanson, Marcel Dekker, New York, 1998.
7. "Preservation of Food with Pulsed Electric Field," G.V. Barbosa-Canovas, M.M. Gongora-Nieto, U.R. Pothakumary, and B.G. Swanson, Academic Press, San Diego, CA, 1999.
8. "Ultra high pressure treatment of foods," Marc Hendrickx and Dietrich Knorr (Editors), 2003.
9. "Emerging Technologies for Food Processing," Da-Wen Sun (Ed.) Elsevier Academic Press, U.K., 2005.
10. "Thermal Processing of Packaged Food," D. Holdsworth and R. Simpson, Springer, New York, 2008.

Course Topics and Sequence

Topic
Introduction **Overview of Thermal and Non-Thermal Processes**
<u>Traditional Thermal Processing</u> Blanching Pasteurization Heat Sterilization/Canning/Retorting UHT Review of retorts and related equipment 21 CFR 113 A quick review of basic equations, general method, formula method RETORT LAB Calculations based on actual data set from retort Calculation of mass average lethality RTD and calculations for flow problems Quality issues
<u>Baking and Roasting</u> Process basics, simple and complicated models Various methods of baking Quality issues

Ohmic Heating, Microwave Heating Process description and mathematical models Quality issues **Frying** Process basics, simple and complicated models Various methods of baking Quality issues
Extrusion Extrusion presentation W&P movie Basic governing equations
Extrusion Solution to equations, simple and complicated models Extruder and die characteristics RTD and calculation of lethality in extrusion process Quality issues EXTRUSION LAB
High Hydrostatic Pressure Processing Process basics, Equipment issues Mechanisms of microbial destruction Process calculation model Solved example

Quality issues HHP LAB
Pulsed Electric Field Processing Equipment description Process modeling Quality issues
Food Irradiation Equipment Issues Quality Issues Current Status Ozone Processing Ultrasound Processing Plasma Processing
Student Paper/Proposal Presentations

Grading

Assignments:	30%
Written examination	30%
Final paper and presentation	40%

Academic Integrity

All students are expected to abide by the academic standards of Rutgers University. All graduate students have a responsibility to understand and to uphold the standards of the academic community. It is the responsibility of every student to understand these standards thoroughly and to act in accordance with them.
Students are referred to the publication "Academic Integrity: Issues for Graduate Students." which is available from the Graduate School Office in New Brunswick. It is also available online.