BBE 4723/BBE 5723 Food Process Engineering

COURSE SYLLABUS

Lect/Disc:	3:00 – 5:30 PM, W, BioAgEng 106, ST. PAUL CAMPUS
Instructor:	Prof. Roger Ruan 206 BioAgEng Bldg., St. Paul Campus 625-1710, ruanx001@umn.edu
Office Hours:	2:00 – 4:00 pm, M (tentative)
Teaching Assistant:	Dr. Bo Zhang, 6 BioAgEng Bldg.
Guest Instructors:	Drs. Paul Chen, Min Min

Course description:
Principles of food processing engineering, unit operations, equipment, including material balance, energy balance, fluid dynamics, heat and mass transfer, refrigeration, freezing, psychometrics, dehydration, evaporation, non-thermal processing, and separation will be covered in the lectures. Students will learn how to quantitatively analyze basic processes and unit operations, and be able to apply their understanding of engineering principles to the development and control of food processes for production of safe and high quality food products.

Course Outline:

1. I - Introduction to food engineering
   1.1. Objectives of the course
   1.2. Overview of food processing
   1.3. Role of food engineering in food processing
2. Units and Systems
   2.1. units and unit conversion
   2.2. state of systems and system analysis
   2.3. force, temperature, pressure, enthalpy
   2.4. Ideal gas law
   2.5. Phase/state diagrams
3. Mass and energy balances
   3.1. mass balance, purpose and methods
   3.2. introduction to thermodynamics
   3.3. energy balance, purpose and methods
   3.4. Steam tables
4. Fluid flow
   4.1. introduction t fluid mechanics, fluid properties, continuity
   4.2. flow: Reynolds numbers, friction
   4.3. Bernoulli equation
   4.4. Mechanical energy balance, pressure energy, kinetic energy, potential energy, frictional energy loss, power requirements of a pump
   4.5. pumping and piping, characteristics, selection of pumps
   4.6. viscosity and measurement

5. Heat transfer
    5.1. introduction to unit operations in thermal processing
    5.2. thermal properties of foods
    5.3. Modes of heat transfer in foods
    5.4. steady and unsteady heat transfer
    5.5. observation and modeling of heat transfer
    5.6. Microwave heating
6. Introduction to Food preservation Methods
    6.1. Principles of food preservation
    6.2. Thermal processing
    6.3. Non-thermal processing
    6.4. Alternative Management of water in foods
7. Blanching, Pasteurization, and Sterilization
    7.1. Blanching
    7.2. Pasteurization and sterilization equipment
    7.3. Thermal destruction of microbes and inactivation of enzymes
    7.4. General process calculation methods (formula methods)
    7.5. Mathematical models
8. Dehydration
    8.1. States of water in foods
    8.2. Water in air – psychometrics
    8.3. Movement of water - mass transfer
    8.4. Simultaneous heat and mass transfer
    8.5. Characteristics of drying – drying curves
    8.6. Types of drying systems
    8.7. Process calculation and design
9. Evaporation
    9.1. Key process variables
    9.2. Boiling point elevation
    9.3. Types of evaporators
    9.4. Heat and mass balance and design
10. Refrigeration
    10.1. mechanisms of refrigeration
    10.2. Refrigerants
    10.3. Refrigeration systems
    10.4. Pressure-enthalpy charts
    10.5. Refrigeration calculation
11. Freeze
    11.1. Freezing systems
    11.2. Important physical properties in food freezing
    11.3. Freezing time calculation
    11.4. Effect of freezing rate on frozen foods
    11.5. Storage of frozen foods – temperature frustration
12. Membrane separation
    12.1. Properties of membranes
    12.2. Membrane separation systems

   12.3. Process calculation and design
13. Alternative non-thermal processes
   13.1. High hydrostatic pressure (HHP)
   13.2. Light pulse
   13.3. Oscillating magnetic field
   13.4. Pulse electrical field (PEF)
   13.5. Ozonation
   13.6. Non-thermal plasma (NTP)
   13.7. Concentrated high intensity electrical field (CHIEF)

List of Resources:

References:

- Fellows, P. 1991. *Food Processing Technology: Principles and Practice*. Ellis Horwood Ltd.
- Hall, C. W.; Farrall, A. W. and Rippen, A.L. 1986. *Encyclopedia of Food Engineering*. AVI Publishing Co. Westport. Connecticut.
- Rao, M.A., Rizvi, S.S.H. Ashim K. Datta, A.K. 2005. *Engineering Properties of Foods.* CRC; 3 edition
- Singh, R. P. and Heldman, D. R. 2001. *Introduction to Food Engineering*. 3rd Edition. Academic Press. New York.
- Toledo, R.T. 1980. *Fundamentals of Food Process Engineering.* AVI Publishing Co. Westport, Connecticut.

Others: Handouts.

Homework and Grading Policy:

Components	**Weighting Percentages (%)**
Homework and classroom activities	30
Term project report	15
Midterm Exam I	10
Midterm Exam II	10
Midterm Exam III	10
Final Exam	25
Total	100

Grades are based on curve. Students registered for graduate credit (BBE 5723) will be given additional problems on the exams, and in additional they will be required to perform a substantial quantitative analysis in the term paper report.

Homework problems are due one week after assignment. Late homework will be accepted with a penalty of 10 percent per day after the due date (excluding weekends).

Final term project report should be an individual effort showing the ability to complete a basic project from start to finish.

Individual Term Report

Each student is required to prepare a term project report on a selected topic related to food engineering. The term report should be double spaced, word-processed and fifteen pages maximum excluding figures, tables, and reference listing. Each student should consult with the instructor and decide on a topic no later than the end of the fifth week of class. The progress report is due on the first class of November. The complete term report is due on the last day of class. Late submission will no be accepted.

For report preparation, each student is expected to read a substantial amount of technical literature, digest the materials, and then write the paper. Each student will also give a final paper presentation to the class during the last week of class. The paper will be graded for content, appearance, and classroom presentation.

Literature Review

Each student should obtain a few journal articles (at least one dated beyond 1990) related to the chosen project. The articles should develop the justification or history of the problem or contribute to part of the analysis or solution of the problem. The Journal of Food Science, Journal of Food Engineering, Cereal Chemistry, LWT, Transactions of ASABE, and Applied Engineering in Agriculture, etc. are excellent sources.

The best place to search for literature is from scientific abstracts such as Applied Science Abstracts, BIOSIS Reviews, COMPENDEX (engineering index), and AGRICOLA, which are all part of the university library system (indexes and databases).

One progress report (proposal) will be due. The progress report (proposal) should state:

1. The topic picked
2. Brief literature review (two paragraphs) containing reference to all literature obtained.
3. Gantt chart schedule for time assessment
4. General layout of the project including a brief description and preliminary flowchart
5. Statement of progress up to the week of the progress report