

**FDSCTE 5400 – Unit Operations in Food Processing**  
**FABENG 4410 - Unit Operations in Food Engineering**  
**Spring 2020 (3 Credits)**

**Lecture:** Tuesday: Thursday: **8:00 AM-8:55 AM**

**Recitation and Unit Operations lab:** Monday: **9:10 AM-11:55 AM & 3:00 PM-5:45 PM**

**INSTRUCTOR**

V.M. Bala Balasubramaniam, Professor of Food Engineering,  
333 Parker Food Sci & Tech.  
614-292-1732(voice)  
E-mail: [Balasubramaniam.1@osu.edu](mailto:Balasubramaniam.1@osu.edu)

Instructor website: <http://go.osu.edu/foodsafetyeng>

A note on instructor name- phonetically it can be spelled as “*ba-la-su-bra-money-um*”. But you are welcome to call him simply as “Bala”.

Instructor welcome and encourages the students ask questions during the lecture or after the class. You can meet with instructor immediately after the class (9-10 AM Tu & Th), during the recitation lab hours or by appointment.

**COURSE DESCRIPTION**

Study of various engineering principles relevant for preserving foods by thermal and alternative food processing methods. Laboratory section would include mathematical problem recitation section as well as use of pilot plant equipment. Interdependence of food engineering, chemistry, and microbiology principles in food preservation

**Prerequisites:** FDSCTE 2400, FABEng 3481, and Micrbio 4000, or graduate standing.  
Cross- listed as FDSCTE 5400/FABEng 4410.

**OUTCOMES OF INSTRUCTION / GOALS**

By the end of the course, the students should:

1. *Understand engineering principles associated with preserving foods through various conventional and emerging food-processing methods.*
2. *Identify key components of different food process equipment, and discuss their purpose in food preservation*
3. *Identify key food processing and product parameters that can influence microbiological safety, and quality of the processed product.*
4. *Importance of kinetic models in food process design and development.  
Calculate selected key food process parameters such as D, z and process lethality.*

## TEACHING ASSOCIATES

- Jerish Joyner Janahar, Graduate Research Associate, Email: [janahar.1@osu.edu](mailto:janahar.1@osu.edu)
- Howard Park, Graduate Research Associate, Email: [park.2928@buckeyemail.osu.edu](mailto:park.2928@buckeyemail.osu.edu)

## RATIONALE

This class will help you to build background in process engineering principles and basic mathematical skills that are necessary for preservation of foods. The food engineering knowledge is useful for you to perform wide variety of food manufacturing tasks. Examples include food process development, equipment operation, evaluation of microbial safety of processed foods, formulation of new food products, understanding food-packaging interactions, reformulate existing products to meet changing consumer demand, test nutritional content of processed food, develop strategies for improving manufacturing and packaging operation, enforce certain federal and state regulations for making safe product, and study consumer acceptance of formulated products.

During the class, you will understand why knowing process engineering principles (including heat transfer, fluid flow, mass transfer among others) and underlying physics are important for different food process operations. You will learn the importance of understanding the process-engineering principles help you to ensure food safety, preserve food quality and minimize nutrition loss. We will also learn to do simple process calculations that may help answer “what-if” scenarios – how varying different food process parameters influence microbial safety and quality of the processed product.

## COURSE ORGANIZATION

We meet twice a week for lectures and once a week for recitation and/or pilot plant / laboratory session. Instructor encourage active student discussion and questions.

Background reading material & PowerPoint slides are posted via Carmen. *You are encouraged to read the available material from Carmen website prior to the class. Bring a calculator for both lecture & recitation session.*

## SOCIAL MEDIA AND CELL PHONE USE

*Use of cell phone or browsing social media during the class period is a distraction to your fellow students & the instructor. Thus it is highly discouraged. Instructor may ask the violators to remove the cell phone outside the class room or deposit it in the front desk.*

*You welcome to bring a laptop computer for the sole purpose of reviewing PowerPoint lecture slides and / or take class notes is acceptable.*

## TENTATIVE LECTURE SCHEDULE

Week	Lecture
<b>Jan 6</b>	<b>Classes begin</b>
Jan 6-10	Role of food engineering in food preservation <ul style="list-style-type: none"> <li>▪ Importance of unit operations</li> <li>▪ Importance of Kinetic models in ensuring food safety and quality</li> <li>▪ Thermometry</li> </ul>
Jan 13-17	Food preservation by application of heat <ul style="list-style-type: none"> <li>▪ Blanching</li> <li>▪ Pasteurization</li> <li>▪ Sous vide</li> </ul>
Jan 20	<b>Martin Luther King Day -- no class</b>
Jan 20-24	Heat Sterilization <ul style="list-style-type: none"> <li>▪ Retort processing</li> <li>▪ Retort types</li> <li>▪ Key processing steps</li> <li>▪ Least heated zone</li> <li>▪ Heat penetration</li> <li>▪ Process uniformity</li> <li>▪ Thermal process calculations</li> <li>▪ Extended shelf life foods</li> </ul>
Jan 27-31	Heat processing by advanced thermal processes Aseptic Processing <ul style="list-style-type: none"> <li>▪ Residence time distribution</li> <li>▪ Identifying least treated particle</li> </ul> Ohmic heating <ul style="list-style-type: none"> <li>▪ Process description</li> <li>▪ Key food properties</li> </ul>
Feb 3-7	Microwave heating <ul style="list-style-type: none"> <li>▪ Process description</li> <li>▪ Key food properties</li> </ul> Review - midterm 1 <b>Midterm Exam 1 (Thursday, Feb 6)</b>
Feb 10-14	Processing by heat removal Food freezing <ul style="list-style-type: none"> <li>▪ Freezing physics, equipment</li> <li>▪ Freezing food properties</li> <li>▪ Freezing time prediction</li> <li>▪ Impact of freezing on food safety and quality</li> </ul>

Feb 17-21	Selected non thermal processing methods High pressure processing <ul style="list-style-type: none"> <li>▪ Equipment</li> <li>▪ Process description</li> <li>▪ Microbial safety</li> <li>▪ Food quality</li> </ul> Pulsed electric field processing <ul style="list-style-type: none"> <li>▪ Equipment</li> <li>▪ Process description</li> <li>▪ Microbial safety</li> <li>▪ Food quality</li> </ul>
Feb 24-28	Nonthermal Processing - Food irradiation Food preservation by removal of moisture (dehydration) <ul style="list-style-type: none"> <li>▪ Dehydration equipment</li> <li>▪ Spray drying</li> <li>▪ Freeze drying</li> </ul>
March 2-6	Food dehydration lectures continued
March 9-13	<b>Spring break (no classes)</b>
March 16-20	Midterm 2 review <b>Midterm Exam 2 (Thursday March 19)</b>
March 23-27	Evaporation, Separation, Concentration
March 30-April 3	Extrusion processing
April 6-10	Cleaning and Sanitation Food Processing Sustainability
April 13-17	Federal regulations governing food processing
April 20	Final exam review
April 22-28	<b>Final Exam (as per university registrar) Wednesday April 22<sup>nd</sup> 8 AM-9.45 AM</b>

### **TENTATIVE RECITATION / PILOT PLANT SCHEDULE**

There will be two recitation periods (Monday morning and afternoon). During recitation we will work on (a) pilot plant experiments (b) mathematical problem solving exercise for learning how to estimate pertinent food process parameters (c) combination of both. Students work in assigned teams during both pilot plant periods as well as mathematical problem solving exercise. Students taking both Food Science and Food Ag Bio Eng credit can learn from each other during these activities.

**Pilot plant experiments:** Teams review and sign a team member agreement form as well as a pilot plant user agreement. During the pilot plant experiments, TAs will lead experimentation, and collect the data with the help of student teams. Then TAs share the data among all the members for subsequent analysis and report writing. Instructions (and template) for the preparation of lab reports will be provided during pilot plant orientation. Student teams submit single lab report one week after the lab session. Lab reports are electronically submitted via Carmen (by 5 pm). Late assignments/term papers are penalized at a rate of 10%

loss in points per day late including weekends.

**Problem solving Recitation:** This section help you practice and develop mathematical problem solving skills. You are welcome to work in teams. Since midterm and final exams test your knowledge on such problem solving skills, you are encouraged to use the problem solving recitation to practice all the problems and ask the TAS and instructors in case you have questions.

Bring calculator for both lecture & recitation sessions

## REPORT TEMPLATE

See separate file for instructions and template for lab report

Week	Topic
Jan 6	Orientation Review of basic principles
Jan 13	Thermometry
Jan 20	<b>Martin Luther King Day -- no class</b>
Jan 27	Canning
Feb 3	Problem solving (Thermal Processing)
Feb 10	Problem Solving (Aseptic processing)
Feb 17	Problem solving (Microwave and Ohmic)
Feb 24	Freezing
March 2	Minimal “nonthermal” food processing
March 9-13	<b>Spring break (no classes)</b>
March 16	Dehydration
March 23	Problem solving (Separation and Concentration)
March 30	Evaporator, Spray drying & filtration demos
April 6	Problems solving exercise continue
April 13	Graduate Student presentation
April 20	Review (last day of regularly scheduled semester class)

## READING MATERIAL

Pdf copies of PowerPoint & reference material for various lectures and recitations are available via CARMEN. You may also find the following optional reading material useful (you may also able to access these books via OSU digital ebook collection)

- R.P. Singh and D.R. Heldman. 2009. Introduction to Food Engineering. Elsevier.
- Earle, R.L. and M.D. Earle. Unit Operations in Food Processing.  
<http://www.nzifst.org.nz/unitoperations/>
- Zhang, H.Q., Barbosa-Canavas, Gustavo V., VM Balasubramaniam, C. Patrick

Dunne, Daniel Farkas, and James T.C. Yuan. 2011. *Nonthermal Processing Technologies for Food*. IFT Press.

- P. Fellows. 2009. *Food Processing Technology, Principles and Practice*, Third edition. Woodhead Publishing Lmt, England.
- D.R. Heldman, R. W. Hartel. 1998. *Principles of Food Processing* Aspen.

## **GRADING**

Students will be graded based up on which section you enroll (FDSCTE 5400 (undergraduate & graduate), FABENG 4410(undergraduate). Graduate students will also be separately graded We use the following criteria:

### **FDSCTE 5400 – Unit Operations in Food Processing (Undergraduate credit)**

- Recitation Laboratory report 20%
- Midterm exams (2; 20% each) 40%
- Final Exam (cumulative) 40%

### **FABENG 4410 - Unit Operations in Food Engineering (Undergraduate credit)**

- Recitation Laboratory report 20%
- Midterm exams (2; 20% each) 40%
- Final Exam (cumulative) 40%

### **FDSCTE 5400 – Unit Operations in Food Processing (Graduate credit)**

- Individual Critical literature review  
(consult instructor for topics) 10%
- Recitation Laboratory report 20%
- Midterm exams (2; 20% each) 40%
- Final Exam (cumulative) 30%

During the first day of the class, we will discuss the grading policy and revise the grading breakdown and midterm exam dates if necessary.

*For your own benefit, plan on attending all the lectures and recitation periods. Absence with valid reasons (such as medical) is reasonable, provided you consult the instructor or have relevant documentation. **Random checks will be made.** For each day you are not present (without prior approval), 1% will be deducted from your final grade at the discretion of instructor.*

For all the classes listed above, each class is graded on a straight scale:

100-93	=	A
92.9-90	=	A-
89.9-87	=	B+
86.9-83	=	B
82.9-80	=	B-
79.9-77	=	C+
76.9-73	=	C
72.9-70	=	C-
69.9-67	=	D+
66.9-63	=	D

< 63 = E

It is possible (and desirable) for the entire class to receive *A*.

### **QUIZ (Bonus points)**

There will be optional quizzes assigned via Carmen (that can help you to learn & practice material covered in the class). You may also find the material useful for midterm and final exams.

Quiz will be available through CARMEN every **Thursday 9:00 AM and closes the following week by Wednesday 5:00 PM**. It is your responsibility to take quiz within assigned time frame (no extensions will be provided). You will obtain 2 bonus points for attempting at least 80% of the assigned quizzes. If you score minimum 70% in each of these quizzes, additional 1 bonus points will be added.

### **CARMEN**

Carmen is the primary web-based course management system supported by the Office of Information Technology (OIT) at the Ohio State University. To log into Carmen and see your online courses, first use your web browser to open a link to [carmen.osu.edu](http://carmen.osu.edu). A login box is on the left side of the screen that appears. Type your username and password and click on the Log In button. In most cases, your Carmen username is the same as your OSU Internet username (the name you use for checking your e-mail, etc.). For example: doe.999. When entering your username, be certain your caps lock is off and that you type it all in lowercase. If you are having problems, please contact Carmen at (614)688-HELP (4357)

### **TERM PROJECT (Graduate credit only)**

By first week of February, each graduate student will in consultation with the instructor identify a contemporary critical literature review topic. Turn in a 15-20 page term paper by April 13 and prepare a presentation for the presentation during the assigned class time

### **PARTICIPATION**

For your own learning, active participation in both class and laboratory activities is encouraged. Participation means you will

- attend lectures and ***being on time***
- work with the team members & submit lab reports ***on time***
- be an equal partner in the activities of your lab group
- participate in class discussion and ask questions either during the lecture time or during the recitation time.

### **Academic misconduct**

We all have a responsibility to maintain a high standard of academic honesty, and I am confident that you will meet the required standard of academic integrity. Any suspected violation of the Code of Student Conduct will be forwarded to the Committee on Academic Misconduct.

We will follow the university policy in this course to maintain academic integrity, rather than to try to trap and to punish. In fairness to all students in the class, violations of academic integrity will not be tolerated.

Violations of academic integrity includes:

- Plagiarism,
- Submission of work that is not your own for homeworks, reports or exams where an individual work is required.
- Submission or use of falsified data.  
*Plagiarism* includes (but is not limited to) failure to indicate the source with quotation marks or footnotes, if any of the following are reproduced in the work submitted by a student:
  - A graph or table of data
  - Exact wording taken from the work of another person, published or unpublished including web
  - When you work together to solve homework problems, you may not simply copy solutions from a classmate or from solution sets from previous years to which you might have access. Presenting someone else's work as your own is plagiarism.

Team work is expected and required in this course. Students are allowed to work on their recitation reports and/or problem solving exercise together, but each student must use their own expression. Discussion and interpretation of results is encouraged.

Academic misconduct is defined in the Code of the Student Conduct and the Rules of the University Faculty ([http://studentaffairs.osu.edu/info\\_for\\_students/csc.asp](http://studentaffairs.osu.edu/info_for_students/csc.asp) & <http://www.acs.ohio-state.edu/offices/oa/procedures/1.0.html>).

<http://oa.ohio-state.edu/coam/code-of-student-conduct.pdf>

Suspected academic misconduct will be referred automatically to the Committee on Academic Misconduct as required by Faculty Rules. Per University Rule 3335-31-02, "Each instructor shall report to the committee on academic misconduct all instances of what he or she believes may be academic misconduct." Cheating on examinations, submitting work of other students as your own, or plagiarism in any form is considered academic misconduct.

### **Disability services**

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave, Columbus, OH 43210; telephone 292---3307, TDD 292---0901; <http://slds.osu.edu/>

### **Resources to Stay Healthy**

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. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting [ccs.osu.edu](http://ccs.osu.edu) or calling [614-292-5766](tel:614-292-5766). CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower.

You can reach an on call counselor when CCS is closed at [614-292-5766](tel:614-292-5766) and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at [suicidepreventionlifeline.org](http://suicidepreventionlifeline.org).



**Engineering students are encouraged to reach out to James M. Geckler, Ph.D., LPCC-S.**

Dr. Geckler is an Embedded Clinical Counselor in the College of Engineering, also serving in the Office of Student Life Counseling and Consultation Service. He can be reached at [geckler.6@osu.edu](mailto:geckler.6@osu.edu); [www.ccs.osu.edu](http://www.ccs.osu.edu) where he maintains office hours in both Houck House, Room 019A, Building 194, 61 W Lane Ave Columbus, OH 43210 and Lincoln Tower, 10th Floor, 1800 Cannon Drive, Columbus, OH 43210

**CFAES students are encouraged to reach out to David L. Wirt, M.Ed., LPCC-S.**

David Wirt is an embedded counselor in CFAES and Licensed Professional Clinical Counselor with OSU's Counseling and Consultation Services who will be spending the majority of his time housed in 100Y Ag. Admin. working directly with CFAES students on the Columbus campus.

If a student would like to meet with David, they can go to <https://ccs.osu.edu> and click on "schedule a phone screening." This will enable David, or one of his colleagues, to contact the student to discuss needs, and to schedule the student for sessions, when needed. When a student presents urgent concerns, the student will be scheduled to see a clinical staff member: either David, or one of his CCS colleagues, as promptly as possible. Students can also call 614-292-5766 to start this process. **Please have the student mention they are a CFAES student if they call to be routed to David.** If there are questions, David can be contacted via email at [wirt.9@osu.edu](mailto:wirt.9@osu.edu).

## **Diversity and Inclusion**

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.

## **Bias Assessment and Response Team**

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at [titleix@osu.edu](mailto:titleix@osu.edu)