

## BE 4352: TRANSPORT PHENOMENA IN BIOLOGICAL ENGINEERING

- 2011-12 Catalog Description:** Mass balances with consideration of chemical and biological reaction kinetics; energy balance and principles of conduction, convection, and radiation including 3-D diffusion, transient heat transfer, and convection analysis; energy transfer in engineering design and analysis; principle of mass transfer.
- Credit:** 3 hr Credit (lecture).
- Prerequisites:** BE 2352, BIOL 2051; credit or registration in CE 2200 and ME 3333
- Required Textbook:** None required. A notes booklet (sold through LSU Union/Paw Prints/BAE front office) or partial notes will be passed out before each class. Material may also be posted on Moodle.
- References:**
- Datta, A.K. 2002. Biological and Bioenvironmental Heat and Mass Transfer. Marcel Dekker, Inc., New York, NY. ISBN: 0-8247-0775-3\*.
- Bailey, J., and Ollis. D. 1986. Biochemical Engineering Fundamentals. 2nd Edition, McGraw-Hill, New York, NY. ISBN 0070032122.
- Tchobanoglous, G. and Burton F.L. 1991. Wastewater Engineering: Treatment Disposal and Reuse, Metcalf and Eddy Inc. 3<sup>rd</sup> edition. McGraw-Hill, New York, NY. ISBN 0070416907.
- Drapcho, Caye or other prior Faculty Members at BAE. 2003. Lecture notes developed at LSU for BE 4352.
- Campbell, G.S. and Norman, J.M. An Introduction to Environmental Biophysics (2<sup>nd</sup> Ed). Springer-Verlag, New York, NY. ISBN: 0-387-94937-2.
- Class Schedule:** **Lecture:** 10:40–12:00 P.M. T, TH; Room 1114, Patrick Taylor Hall
- Instructor:** Chandra S. Theegala, Associate Professor  
Biological and Agricultural Engineering  
Office Location: Room 161, E.B. Doran Bldg.  
Office Phone: 225-578-1060  
Office Hours: 12:30 PM – 2:00 PM Tuesday  
10:30 AM – 12:00 PM Wednesday  
Other times are ok – Please schedule before you come.  
E-mail: [theegala@lsu.edu](mailto:theegala@lsu.edu)

### Purpose of the Course

This is a Junior/Senior/Graduate level course designed to help the students learn the basics of biological kinetics and apply the principles of material and energy balances in reactor design. The students will also learn the concepts of heat/mass/energy transfer (or balances) that are pertinent to the biological engineering curriculum. The class project is anticipated to provide an opportunity for students to have hands-on experience on a transport related problem.

**Course Objectives:**

1. To develop an understanding of mass balances with considerations to chemical reactions and biological growth kinetics
2. To understand and master the principles governing heat and mass transfer in biological systems
3. To understand the principles of material and energy balances in reactor design
4. To allow students to apply gain hands-on experience on the relevant transport problem (via class project).

**BE 4352 Course Topics and Class Schedule\*:**

<b>Week of</b>	<b>Lecture Topics</b>
1/16/12	Course Introduction Transport Definition, Mass Balances, Rate Basis, Problems
1/23/12	Mass Balance Problems Chemical Kinetics – For Mass Balance Computations
1/30/12	Biological Kinetics, Modeling Approaches Growth and enzyme kinetics, computations from experimental data
2/06/12	Biological - MBE Related Topics and Problems
2/13/12	Temperature Dependent Growth, Biological Heat Generation More Biological Topics, Thermo Review, Exam 1 Review
2/20/12	<b>Feb 20 – 22 (till 12:30 PM) Mardi Gras Holidays (No Tuesday Class)</b> <b>Exam 1 – February 23<sup>rd</sup> (Thursday during class)</b>
2/27/12	Energy and Energy Balances, Heat Transfer Modes 1-D Steady State and Non-Steady State Conduction and Problems
3/05/12	1-D Composite Material Conduction and Insulation Topics/Problems
3/12/12	Fourier' Law, 1-D Conduction in Radial Direction Convection and Related Topics, Project Topics, Project Report Guidelines
3/19/12	Combined Conduction and Convection (including radial) 3-D Diffusion –Derivation
3/26/12	Diffusion Related Problems, Exam Review <b>Exam 2 – March 29<sup>th</sup> (Thursday during class)</b>
4/02/12	Convection Analysis – Forced and Free Related Convection Problems 1-D Transient Conduction/convection – Heisler 1-D Transient Lumped Capacitance Approach 1-D Transient – Semi-Infinite Approach Related Problems
4/09/12	Radiation and Related Topics/Problems
4/16/12	<b>April 6-15 – Spring Break (No Tue or Thur class this week)</b>
4/23/12	Project Presentations. Mass Transfer
4/30/12	Mass Transfer, Mass Transfer Modes and Boundary Conditions Problems, Transient Mass Transfer – Heisler and Semi-Infinite Approaches and Problems. Final Exam Review. <b>May 5<sup>th</sup> - Last Day of Class.</b>
<b>Final Exam</b>	<b>Saturday May 12<sup>th</sup>, 2012; 7:30 - 9:30 AM</b>

\*Note: Instructor reserves the right to alter the schedule during the course of the semester. The instructor also reserves the right to modify the course content to include a lab or advanced topics (such as transport through membranes). However, any alterations will be clarified in the class.

**Important Dates to Remember in Spring 2012:**

Jan 24: Last day to drop w/o "W" grade.

Jan 26: Last day to add courses for credit and making section changes.

Apr 02: Final date for resigning from University and/or dropping course.

**Exam Schedule:**

*Tentative Dates for Exam I and Exam II (can change slightly based on class coverage)*

**Exam I: February 23<sup>rd</sup>, 2012.**

**Exam II: March 29<sup>th</sup>, 2012.**

According to Spring 2012 Final Exam Schedule (for classes held at 10:40-12:00 Noon on T, TH)

**Final Exam Time: Saturday, May 12<sup>th</sup>, 2012; 7:30 - 9:30 AM.**

**Grading Policy:**

1.	Homework(s), Quizzes (announced and un-announced) and Attendance/Participation*)	20%
2.	Exam I	20%
3.	Exam II	20%
4.	Project Presentation# (group)	15%
5.	Design Problem	5%
5.	Final Exam (comprehensive)	20%
	*****	
	Total	100%

\* *More emphasis will be on quizzes, followed by homework and attendance/class participation. Some or all homework assignments will be graded for completion only and the key will be discussed in class or posted on blackboard.*

# *Limited funds are available for projects. Please check with instructor before planning a project.*

**Grading Scale:**

90 - 100%	A
80 - 89%	B
70 - 79%	C
60 - 69%	D
Below 60%	F

**Course Policies:**

**Class Participation/Attendance Policy:** Attendance is expected. Regular lateness will not be allowed, unless you have a valid excuse. Class participation and attendance account for 5% of grade (can change slightly at instructor's discretion). I am expecting active class participation and just not your presence (*remember that nappers count as absent*). I am expecting you not to browse the internet or attend to other pending issues (like assignments from other classes). I am expecting you to bring your calculator and work out the problems in class. Keep in mind that this 5% can make a grade difference. Class participation grades will be as follows:

1-2 lates/absents per semester with good class participation (no disturbance)	+5
3-4 lates/absents per semester with good class participation (no disturbance)	+4
5-6 lates/absents per semester with good class participation (no disturbance)	+2
>7 lates/absents per semester with good class participation (no disturbance)	0

I strongly encourage you to let me know via email if you are going to miss a class. Letting me know in advance is very important. I will assign you a "P" (for permission). Although a "P" is not considered present, it will allow you to take a makeup quiz (if given on that day) or get a copy of class notes/handouts. In any case, you will not be marked as "present" if you are not in class.

***Submission Policy:*** Homework assignments and project report must be turned in on or before the due date announced (usually before the beginning of a class period). Due dates for project presentations (PowerPoint) will be discussed in class. Homework assignments may be graded for completion only. I do not accept late homework. If you missing class, make sure someone turns in your homework along with others (in class).

***Make-up Exam/Quiz Policy:*** No make-up exams or quizzes will be given for the scheduled exams/quizzes unless the student has a legitimate excuse documented properly (e.g. letter from court clerk that he/she must appear in a court, or a letter from a physician stating that he/she is/was sick). If you know that you will be missing a class, let me know in advance. If (If) I decide to give a makeup for someone without a valid excuse, it will be graded to a lower maximum score (like 80 or 85%). In such cases, be prepared for a longer (more questions) make up exams and quizzes. This measure is to dissuade students from deciding not to take the exam in the last minute (just because they are not well prepared). Look at the examples below. The first student demonstrates responsibility and is likely to get a make-up. I personally feel that giving a make-up exam without any penalty for the second situation is not fair for students who took the exam at the scheduled time (even though they may not be fully prepared).

Situation 1: Student has a presentation/medical procedure/wedding that he/she has to attend/undergo on Feb 23<sup>rd</sup>. He/she let me know 2 weeks ahead and discusses the option of taking the exam early or taking a make-up exam 2 days later.

Situation 2: Student does not show up for exam. Sends an email during exam time and does not have any legitimate reason for missing the exam.

***Graduate Students:*** Graduate students will work independently for the class project. They will submit an independent project report and make an independent final presentation; while the undergrad students will work in groups of 3 or 4. The graduate students may also be required to prepare a relevant presentation and/or handout that will be useful for the entire class. Depending on the topics of the graduate students' lectures, the instructor will decide if that particular material is valid for the exam.

***Academic Misconduct Policy:*** Cheating and plagiarism will not be tolerated. The LSU Code of Student Conduct has a section on academic misconduct. I suggest each of you obtain a copy of this document and be familiar with its contents (<http://saa.lsu.edu/code-student-conduct>). If you have any questions/concerns about plagiarism, feel free to ask me. It is my professional, ethical obligation, as a faculty member to uphold academic standards. I take this responsibility seriously and will forward the case to respective officials at LSU. It will be outside my control after that.

***Disruptive Behavior Policy:*** Absolutely no cell phones and pagers. Avoid going in and out during class. Any behavior that will disturb the attention of fellow students or instructor should be avoided. Additional points (beyond the allocated 5% for attendance) will be taken off for students who disturb the class (cell phones, talking during class, etc).

**Contact Numbers (While in Laboratories Working on Projects):**

Campus Safety: 578-5640 Emergency Help: 578-4357

Dr. Theegala: 578-1060

**Other Helpful Information (to understand the instructor and get better grades)**

**Very Important: This applies just for my courses (not other instructors)**

- Understand why am I am standing here?

I had exposure to the subject matter before you and may have relevant experience

My primary responsibilities as an instructor

- 1) Deliver the information in a compact format and shorten the learning curve.

Examples: STELLA Modeling – Numerical solution (no need beyond  $dx/dt$ )  
Data acquisition using DasyLAB and USB based hardware  
Final Equation Sheets (7-8 pages)

- 2) Treat all students fairly

Examples: Very fair grading. Compare if you wish policy!  
Uniform policies and no exceptions for a few selected students  
Clarifications during exams, “look up before attempting” (uniformity!)  
Review my unexcused absence and exam/quiz makeup policies.

- What can you expect from me?
  - Open door policy - but prefer you email me for an appointment if it is outside the posted office hours. I reply emails promptly.
  - Application/practicality oriented class. I will try extra hard to give you practical examples, problems, mnemonics, acronyms, and analogies to help you understand better and remember for a life-time. If I cannot find an appropriate, interesting, and practical problem from my 7-8 reference textbooks, I will create a problem (like “Chopkins Café Magic has no iodine” mnemonic, “stranded in island” analogy, and Challenge Quizes).
  - Lot of partial notes for all lectures (purposefully incomplete and 230+ pages)
  - I will first equip you with knowledge and information. Then I will challenge you. Example: No manual data recording on projects. A 30 page data acquisition self-learn tutorial with screenshots and photos will be posted on Moodle.
  - I will challenge you on your calculus skills. But on defined operations (mostly covered in class). Please don't expect an “A” without basic calculus and derivations. My views on the role of a Biological Engineer?
  - I will never ever say “Don't you know this?” I believe in proper foundation.
  - I will listen to you always. Too fast, too much, too difficult, etc. Will I act?
  - I can guarantee that I will never fail to give you an answer in the classroom. Why?
  - Artistically challenged instructor! If I say “If only I had more time...” Don't believe it.
  - I will try hard to get your names in about 6-8 class periods. Memorization and cheating allowed (for me)!
- Grading Policy and Grade Related:
  - My views on grading and the meaning of grades A, B, C, D, F
  - I do not curve at the end of the semester. However, I will bring up the test averages to ~82-84 if it is much lower.
  - Do not shoot at the low end of a particular grade (Example: shoot for 95 or higher instead of 90 for an A).

- Grades from last time I taught this course
  - Last year's grade calculator (see attachment)
  - Keep track of your grade. See grade calculator from last year. You will get an email of the actual calculator I will use this semester at a later date (in April). Also, you are required to keep graded quizzes, homework assignments, exams till the semester is over. It is your responsibility to keep it till the end of the semester.
- What I am expecting from you?
    - ◆ I want you to expect more from me!
      - Grocery analogy
      - I cannot live with the feeling of indebtedness
      - No early dismissal or cancellations (unless absolutely necessary)
    - ◆ I cannot overstress the importance of coming to class.
      - You will miss the various interactive components in a classroom, analogies and discussions
      - Class discussion will help you identify the right equation on the exam
      - Remember class participation has 5% grade. It can mean a letter grade drop!
    - ◆ On class projects – expecting you to go beyond “observations”
    - ◆ Follow through on the course material
      - 1 hour lecture will require a minimum of 1-2 hours of effort outside class
      - It will help you on quizzes and exams (one every 2-3 weeks)
  - Exam Related
    - Focus on coverage in class. All tests will be based on the material covered. Study guide for each exam will be handed to you.
    - Try to understand the concept. Not just the problem at hand.
    - Optional “suggested order” will be provided
    - It will not be a memorization exercise. I will provide you all the equations.
    - Important – pick the right equation (biggest point loss)
  - Classroom Related
    - Do not feel shy to ask a simple or basic question. I strongly believe in proper foundation.
    - Use a 1.5” or 2” ring binder for keeping class material.
    - Turn all homework assignments on time.
    - Every single point counts and will add to your grade. So pay attention to homework assignments, quizzes, exams, project presentation, and attendance.
    - Moodle/emails will be used for this course. So learn to use it (announcements, downloading course material, discussion forums, etc). Make sure Moodle has your correct email address.

**My Ongoing Research Summary and Question for me?**