BEE 2600 Principles in Biological Engineering
TR 10:10 – 11:25 a.m. 125 Riley-Robb Hall
Syllabus Fall 2009

Instructor: Prof. Antje Baeumner
318 Riley-Robb Hall Office hours: by appointment
ajb23@cornell.edu

Teaching assistants will be available:
Monday 7 - 9 p.m.: 403 Phillips
Friday 2:30 - 4:30 p.m.: 407 Phillips
Sunday 2 - 4 p.m.: 403 Phillips
Sunday 7 - 9 p.m.: 403 Phillips
(If you have a question, please arrive at least 20 minutes before end of the office hours, because the TAs will only be available at the hours indicated above, not longer. Keep in mind that the TAs are not allowed to tell you whether your final result is correct. Instead, TAs will provide you with support so that you can find the correct methods for solving the assignments.)

Head teaching assistant: Lauren Matlock (lem44) administrative questions
Office hours see above and by appointment

Course web-site information
Homework problems and solution sets will be posted at http://blackboard.cornell.edu.

Course description and objectives
Case studies and homework sets extracted from the area of biological engineering including bioprocess engineering, biomedical engineering and food engineering are used to illustrate how mathematics, physical and engineering sciences and biology are used to solve real life technical problems.

The instructor expects to accomplish the following objectives:
1. To help students develop the ability to formulate differential equations for biological systems using basic principles of energy and mass balances, and reaction kinetics.
2. To help students develop their abilities to think critically about engineering problems and solutions, including the ability to identify and develop alternatives.
3. To illustrate to students, in a small way, some of the rich and challenging opportunities available for integrating biology and engineering to address major engineering problems.
There is no single textbook available that covers the range of scientific and engineering concepts explored in this course. Handouts for each class were bound as a text that can be purchased for $25 at the Campus store. Please keep in mind, since there is no complete text, attendance at lecture is very important.

Assignments
There will be 6 homework assignments and 4 case studies, as indicated in the detailed course outline. Assignments are due the day indicated at the beginning of class. You will be given one week to complete homework assignments and about two weeks to complete case studies. Homework assignments count for 25 points each (6 x 25 = 150) and Case Studies 1 – 4 will count for 100, 75, 150 and 100 points respectively. Because of grading logistics, no late homework and case studies will be accepted, thus a 25 point penalty will be assigned for each day a case study is late, 2 points will be subtracted for each day a homework problem set is late. Assignments handed in after class are considered 1 day late.

N.B: It is expected all work you submit must be your own work – not a duplicate of someone else’s work. For case study 1 and 4 you will be working in prearranged groups of three. You may continue to work in groups to discuss methods, equation solutions and results, however, the write-up for case studies 2 and 3 (as well as for all of the homework problem sets) are to be your own – which means that you generate your own analysis, designs, results and presentations. If there is evidence that you have copied work from another student, all parties involved will receive a zero for that assignment. (Please also refer to the section of academic integrity in this syllabus for more information)

Exams
There will be two in class prelim exam (100 points each) and a final exam (220 points).

Prelim I: October 1st, 2009 10.10 – 11.25 a.m. 125 Riley-Robb Hall
Prelim II: November 19th, 2009, 10.10 – 11.25 a.m. 125 Riley-Robb Hall
Final exam: December 16th, 2009, 2.00 – 4.30 p.m. room TBD

If you have a conflict with the timing of the BEE 260 final exam, you can sign up for a make up time with Prof. Baeumner by September 4th, 2009. The rooms are not assigned yet.
Final Make up time: December 15th, 2009, 9 – 11.30 a.m.

Academic Integrity
Your individual work is expected in exams, homework assignments and case studies. Misuse of information is a serious university offense and is regarded as a violation of academic integrity.

“A Cornell student's submission of work for academic credit indicates that the work is the student's own. All outside assistance should be acknowledged, and the student's academic position truthfully reported at all times. In addition, Cornell students have a right to expect academic integrity from each of their peers. (from the Cornell University Statement of Academic Integrity). If you have any questions on Cornell’s code of academic integrity, please refer to the following website:
http://cuinfo.cornell.edu/Academic/AIC.html
Grading: Point System:

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
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<tbody>
<tr>
<td>Homework</td>
<td>150 (6x25)</td>
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<tr>
<td>Case Studies</td>
<td>425 (100, 75, 150, 100)</td>
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<tr>
<td>Prelim Exams</td>
<td>200</td>
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<td>Final Exam</td>
<td>220</td>
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<tr>
<td>Class Part.</td>
<td>5</td>
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<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
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Grade Disputes: If there is a dispute over the grading of an exam or case study, I reserve the right to reevaluate the entire work. A written explanation of the dispute will have to be turned in to Lauren Matlock. Appropriate changes will be made and explained to the student. You have to submit your grade dispute **within 1 week** after your graded assignment has been returned in class.

Class Participation

Class participation is an integral part of the learning process and I encourage you to speak up. I will frequently elicit answers to questions in class and may randomly select students to answer. It is a way for me to assess how you are learning and in general makes class time more fun. If you actively participate in class, you'll get your 5 points. In addition, I will pass around attendance sheets on a few days throughout the semester to be fair to all quiet students attending every time.

List of Case Studies (subject to slight modification during the semester)

Case Study #1: (team project) Antibiotic action and diffusion in a bacterial biofilm.

*Staphylococcus aureus* is one of the most common causes of post-surgical wound infections especially in orthopedic implants. You are an engineer working with a team to develop and analyze new treatments for such infections at a pharmaceutical company conducting a clinical study. We will model the concentration of an antibiotic in the body and will monitor the changes in concentration over time.

Case Study #2: (mini-write up) *Listeria monocytogenes* food poisoning can occur when food is not stored properly, even when kept at 4 °C. We will discuss heat transfer and growth kinetics.

Case Study #3: Enzyme kinetics: Investigation of Weight Loss Aids. We will investigate how enzyme kinetics and their inhibitions affect concentration of components in the body. We will learn how a modeling of the reactions provides an understanding of their biological mechanisms.

Case Study #4: (team project) Design of a biosensor for pathogen detection. This final case study will introduce the process of engineering design including aspects of user need, design specifications, conceptual design, detail design, production, sales and removal. As background for this study we will discuss the principle of biosensors and pathogenic organisms in food safety and clinical diagnostics.
Detailed course outline: Fall 2009

Week 1  Introduction and Discussion of Syllabus, Introduction to Mass Balances
        R 08/27        (#1) Introduction to BEE 260

Week 2  Introduction to Mass Balances, Derivation of rate equations,
        T 09/01        (#2) Homework 1 out, TA office hours begin
        R 09/03        (#3)

Week 3  Mass balances continued, Material transformation, First order kinetics,
        Optimization of a bioreactor, Regression analysis, use of MATLAB
        T 09/08        (#4) Homework 1 due, Homework 2 out
        R 09/10        (#5)

Week 4  Pharmacokinetic modeling, Diffusion
        T 09/15        (#6) Homework 2 due, Homework 3 out
        R 09/17        (#7)

Week 5  Case study preparation, Biofilms, diffusion equations, Immobilization
        T 09/22        (#8) Homework 3 due, Homework 4 out, Case Study 1 out
        R 09/24        (#9)

Week 6  Immobilization, Prelim
        T 09/29        (#9B) Homework 4 due
        R 10/01        First Prelim

Week 7  Heat and energy transport, Food sterilization,
        T 10/06        (#10) Case Study 1 due, HW5 out
        R 10/08        Prof. Kathryn Boor

Week 8  Food sterilization continued
        T 10/13        FALL BREAK
        R 10/15        (#11)

Week 9  Case Study preparation, Enzyme kinetics, Parameter Estimation
        T 10/20        (#12) HW5 due, Case Study 2 out
        R 10/22        (#13)

Week 10 How does a pesticide work?, Introduction to Biosensors
        T 10/27        (#14)
        R 10/29        (#15)

Week 11 Biosensors continued,
        T 11/03        (#16) Case Study 2 due, Homework 6 out Case Study 3 out
        R 11/05        Mann Library (more information to follow)
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<tr>
<td><strong>T</strong> 11/10</td>
<td>(#17) Homework 6 due</td>
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<td><strong>R</strong> 11/12</td>
<td>(#18) Dr. Richard Montagna, guest lecture</td>
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<th>Special Topics: Nanobiotechnology</th>
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<th>Nanobiotechnology</th>
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<td><strong>R</strong> 12/03</td>
<td>(#20) Case study 4 design presentations, Case study 4 due</td>
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