UNIVERSITY OF GUELPH

ENGG*4380 BIOREACTOR DESIGN (3,2)

Winter 2008

Instructor: V.J. Davidson **Office**: Room 2333, Thornbrough
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Lectures: Tues./Thurs. 10:00 am - 11:20 am (MACK 235)
Design Lab: Thursday 2:30 – 4:20 pm (Thornbrough 2196)
Assignments/Due dates: See "Assessment"section

Course Description:
Bioreactor design is an integral part of bioprocess engineering. Bioreactors are controlled environments for microbiological and biochemical reactions to produce value-added products or to treat waste streams. Typical processes include fermentations to produce antibiotics, wine and yoghurt, enzymatic reactors to create ingredients such as high fructose corn syrup and natural bio-systems such as composting operations and biofilters. Design of bioreactors requires integration of microbiology, biochemistry, process engineering and economic analysis. The aim of bioreactor design is to produce product(s) with specific quality attributes at minimum cost.

ENGG*4380 introduces biological engineering students to modelling and design of batch and continuous bioreactors based on biological growth kinetics and mass balances. Additional design topics include: aeration and agitation; instrumentation and control.
Prerequisite: ENGG*3160 Biological Engineering Systems II

Objectives:
Students who successfully complete this course will be able to:

1. Describe and specify reactors used in industrial bioprocesses.
2. Develop mathematical models for bioreactors, analyse their behaviour (dynamic and steady state) and specify operating parameters.
3. Design complete bioreactor systems integrated with upstream and downstream processing operations.
4. Use modelling and simulation tools to evaluate sustainability of an overall process.

Topics:

1. Introduction to reactor design

2. Modelling reaction kinetics
   - autocatalysis
   - microbial kinetics – lag phase, growth, lethality
   - enzyme kinetics
   - estimating kinetic parameters

3. Ideal bioreactors
   - stirred tank reactors
     - batch operation
     - continuous (reactors in series, reactors with recycle)
   - plug flow reactors

4. Industrial operations
   - process design & scale-up
     - large-scale reactors
     - sterilization & containment
     - gas transfer
     - instrumentation & control
   - process CAD software
   - economics
   -GMP and process validation

5. Biotech industries – traditional and new

Textbook:
Students are encouraged to make use of textbooks used in earlier courses as well as textbooks that are available from the instructor (short-term loans will be allowed).

Suggested References

Bioprocess Engineering Principles Pauline Doran, Academic Press, London, 1995.
Bioprocess Engineering Basic Concepts (2nd edition) 2002. Michael L. Shuler and Fikret Kargi, Prentice Hall, Upper Saddle River, NJ
Biochemical Engineering. Harvey W. Blanch and Douglas S. Clark. Marcel Dekker, Inc. 1997.
Biochemical Engineering Fundamentals. 2nd edition. James E. Bailey and David F Ollis. McGraw-Hill 1986.
Chemical Reaction Engineering. 2nd edition. O. Levenspiel. John Wiley and Sons, Inc., New York 1972.
Basic Bioreactor Design. K. van't Riet and J. Tramper. Marcel Dekker, Inc., New York 1991.

Assessment:
Assignments: There will be four assignments that include calculations for different aspects of bioreactor analysis and design. Design lab time is available to work on the assignments, consult with the instructor and make use of software tools on the School's network. Assignments are due on the following dates: **January 18, February 1, February 15 and March 14**.

Term test: There will be a term test on Thursday **March 27** during the design lab time 2:30 – 4:20 pm.

Case study (small groups): Use modelling and simulation tools to evaluate sustainability

(including economic and environmental) of a commercial-scale bioprocess. Assignment due date: **Thursday April 3**.

Design assignments (4)	60 %
Case study	20 %
Term test	20 %
TOTAL	100 %

Note:
Requests for academic consideration because of illness or of a compassionate nature must be made in writing and accompanied by certification whenever possible.