SCHOOL OF ENGINEERING
UNIVERSITY OF GUELPH

Course Description and Outline 2010

Course No.	Name	Semester	Hours
ENGG*3160	**Biological Engineering Systems II**	**Fall**	**(3-2) [0.50]**

Prerequisites: ENGG*2230, ENGG*2660

Faculty: G.L. Hayward, Room 2339, Thornbrough Building, Ext. 53644.
Lab Technician: M. Leunissen, Room 227, Thornbrough Building, Ext. 56141.
Teaching Assistants: Luke Harris

Calendar Description: Mass transfer in biological systems: concepts; gas-liquid mass transfer; membrane transport processes; and heterogeneous reactions. Applications may include fermenter aeration, tissue perfusion, mass transfer limitations in biofilms, microbial flocs and solid tumours, protein recovery and drug delivery.

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

a) develop conceptual models of biological systems;
b) with engineering principles use these concepts to develop mathematical descriptions; and
c) use these quantitative descriptions in equipment design.

Textbook: The text for this course is Transport Phenomena in Biological Systems by Truskey, Yuan and Katz (Pearson, 2004, ISBN 0-13-042204-5). There are a lot of other references that can be used as well, for example, Biochemical Engineering Fundamentals by J.E. Bailey and D.F. Ollis is one worth looking at. The lecture material will be drawn from other sources to supplement the text. I don't intend to repeat the text orally but will aim at the methodology and tools rather than creating a cookbook full of miscellaneous facts.

Laboratory: The laboratory component will consist of three mass transfer experiments. These are to be done by groups of two students. Each member of the group will prepare a "formal" report on one of the experiments and "memo" reports for the other two. Each member will be responsible for one "formal" and two "memo" reports. The two formal reports from a group can not be for the same experiment. The labs will start on Thursday Sept. 30, 2010.

Tutorials: Tutorial sessions will be held in the lab times when the labs are not running. These will be consultation and help sessions.

In Class Quizzes: There will be 2 quizzes will be held in regular class periods. The times for quizzes will be announced in class one week in advance.

Evaluation:

Essay Assignment		10%
Assignments:		20%
Lab Reports:	Formal Report (1 x 20%)	20%
	Memo Reports (2 x 5%)	10%
In Class Quizzes:		10%
Final Exam:		30%

Notes:
-Please refer to the calendar regarding academic misconduct. The School is operating on a zero-tolerance policy in these matters.
-The laboratory reports will be graded for both their technical content and for their grammar and writing style.
- In the lab, safety is a prime concern. Look at the MSDS sheets for any chemicals you will be using. This will also be discussed in the introductory lab sessions.

ENG3160 Material To Be Covered:

Biological Mass Transfer Introduction
- -Review of growth phases and kinetics
- -Growth requirements

Mass Transfer Fundamentals
- -Diffusion, mass balances and Fick's law
- -Boundary layer flow and convection
- -Lumped approximation models and mass transfer correlations

Bubble Mechanics
- -Surface tension, Laplace's law and bubble formation
- -Drag forces, terminal velocities and holdup correlations (**a**)
- -Bubble surface mass transfer coefficients ($\mathbf{k_L}$)
- -$\mathbf{k_L a}$ correlations and measurement
- -Applications in aerobic culture operations

Agitation
- -Impellers, mixing and flow patterns
- -Power correlations for mass transfer

Membrane Processes
- -Diffusion through membranes
- -Dialysis, Pervaporation and Ultrafiltration
- -Tissue perfusion
- -Applications in oxygenation, biological product recovery and drug delivery

Sterilization Operations
- - Steam sterilization
- - Chemical sterilization and disinfection
- - Depth and porous membrane filtration
- - Bio-containment

Heterogeneous Reactions (if time permits)
- -Diffusion through porous solids with chemical reaction
- -Convection to membrane surfaces
- -Rate limitations and Thiele modulus
- -Applications in pellet fermentations, tumor necrosis and bio-films