Appendix:

Biomolecular Engineering option for Chemical Engineers

Integration of the life sciences into Chemical Engineering at Notre Dame

Overview

To develop a world class bioengineering teaching and research program, the department of chemical engineering at Notre Dame is following a strategic plan to *integrate* an understanding of Life Sciences throughout the curriculum, and to create new elective courses in fundamental topics of bioengineering that emphasize a rigorous application of engineering analysis and design principles. The goal is to train engineers who are prepared to manufacture for the public, exciting new *life-science inspired* products, just as chemical engineers have done for chemical compounds for the past century.

The chemical engineering department will initiate a *Biomolecular Engineering* Option that fits within the fully accredited Bachelor of Science in Chemical Engineering degree. The details of this option are given on the next page. Students who complete this program, *Biomolecular Engineers*, will have a strong understanding of structure and function of biologically active molecules and how they interface with both living systems and inanimate chemical systems. The application of chemical engineering mathematics, analysis, and computation will enable graduates in this field to develop new products using molecular biology, analyze and design process systems ranging from the microscopic to macroscopic scale, and integrate their new bioproducts into existing materials. Such products include artificial skin, blood, organs, and tissues, advanced delivery systems for essential pharmaceuticals, new drugs based on knowledge obtained from the human genome, revolutionary sensors that rapidly and sensitively detect bacteria, in people and in products designed for human use and consumption. A key part of this program, that is not discernable from just the curricular sheet, will be the incorporation of life science example problems into many of the core chemical engineering courses.

Biomolecular Engineering Option

FIRST YEAR

First Semester	Cr.	Second Semester	Cr.
MATH 125, Calculus I	4	MATH 126, Calculus II	4
CHEM 11X, Gen Chem	4	CHEM 11X, Intro toCell/Mol Bio	3
Arts and Letters (A&L,I)	3	Univ. Sem180/ENG110 (A&L, III)	3
EG111	3	EG112	3
ENGL 110/Univ. Sem. 180 (A&L II)	3	PHYS 131, Gen Phys I	4
	17		17

SOPHOMORE YEAR

First Semester	Cr.	Second Semester	Cr.
MATH 225, Calculus III	3.5	MATH 228, Linear Algebra & ODE's	3.5
CHEM 223,Org Chem I	3	CHEM 224, Org Chem II	3
CHEM 223L, Organic Chem Lab I	1	Arts and Letters V	3
PHYS 132, Gen Phys II	4	CHEG 258, Computer Mtds	3
CHEG 255, Intro Chem Eng	3	CHEG 256, Thermodynamics	4
Arts and Letters IV	3		
	17		16.5

JUNIOR YEAR

First Semester	Cr.	Second Semester	Cr.
MATH 325, Diff Eqns	3	CHEM 324, Physical Chem	3
CHEM 333, Analytical Chem	2	CHEG 356, Transport Phen II	3
CHEM 333L, Analytical Chem Lab	2	CHEG 438, Chem Proc Control	3
Arts and Letters VI	3	CHEG 358, Chem Eng Lab I	3
ChEg 225, Materials	3	CHEM 420 Biochemistry	3
CHEG 355, Transport Phen I	3	Arts and Letters VII	3
	16		18

SENIOR YEAR

First Semester	Cr.	Second Semester	Cr.
CHEG 471/571 Biomedical Eng Transport Phen[@]	3	CHEG 448, Proc Design	3
CHEG 459, Chem Eng Lab II	3	Engineering elective	3
CHEG 443, Separation Proc	3	CHEG 474 Bioprocess Eng.[@]	3
CHEG 445, Chem Rxn Eng	3	Advanced Biology Elective	3
Advanced Biology Elective[+]	3	Arts and Letters VIII	3
	15		15

total:132 credits

The 8 Arts and Letters slots are for: 2 Phil, 2 Theo, 1 Hist., 1 Soc. Sci, 1 Fine Arts/Lit., ENGL 110.

[#] A list of courses that fulfill the Advanced Science elective is available in chemical engineering advising handbook

[+] Suggested biology electives are Cell biology [341], Developmental biology[342], Molecular biology[501], Microbiology[401] and Genetics[303].

[@] Or other bioengineering electives in chemical engineering such as ChEg 473, Biomaterials.

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Current Chemical Engineering Department Bioengineering electives

ChEg 471/571 Biomedical Engineering Transport Phenomena CRH: 3.0

Course Instructor: Andre Palmer, offered every Fall

Level: senior undergraduate students/graduate students

Description:

This course brings together fundamental engineering and life science principles, and provides a focused coverage of key concepts in biomedical engineering transport phenomena. The emphasis is on chemical and physical transport processes with applications toward the development of drug delivery systems, artificial organs, bioartificial organs, and tissue engineering.

ChEg 473/573 Biomaterials Engineering CRH: 3.0

Course Instructor: Agnes Ostafin, offered every other Spring

Level: senior undergraduate students/graduate students

Description:

Biomaterials Engineering is the application of engineering principles to design, develop, and analyze materials that involve biological molecules. These may be materials of biological origin that are used in medical, biological, or chemical applications, and materials of chemical origin that are used with biological systems or their components. In this course you learn about the basic principles involved in the choice of material properties, the nature of the interaction of biological materials with their surroundings, and modern applications in science, medicine and engineering. Issues relating to marketing, packaging and storage, regulation, and ethics will also be discussed. Students will have an opportunity to apply mathematical-based engineering analysis of complex biomaterials systems.

ChEg 474/574 Bioprocess Engineering CRH: 3.0
Course Instructor: AgnesOstafin, offered every other Spring
Level: senior undergraduate students/graduate students

Description:

Bioprocess Engineering is the application of engineering principles todesign, develop, and analyze processes that use biocatalysts. These may be in the form of a living cell, its substructures, or their chemical components. In this course you learn concepts of cellular biology, and be introduced to mathematical-based engineering analysis of complex biological systems. By the end of this course you should be able to understand basic structure and function of cells, homogeneous and heterogeneous enzyme kinetics, the regulation of cell growth, the design and operation of bioreactors, recovery and characterization of products, and methods in genetic engineering and molecular cloning.

Research

Research activities in the area of bioengineering are detailed on the chemical engineering web site at http://www.nd.edu/~chegdept/Bioengineering.html. Professors Agnes Ostafin (http://www.nd.edu/~chegdept/Ostafin.html),and Andre Palmer (http://www.nd.edu/~chegdept/Palmer.html), both of whom have joined the department in the past 3 years, have initiated extensive research activities, primarily in the synthesis and characterization of new biomaterials.

Several other faculty have growing interests in bioengineering areas. Professor Leighton has been working on separation of mixtures of proteins, Dr. Chang has worked on blood flow-blood pressure modeling and Professor Miller has continuing efforts on the development of biosensors. Dr. Hill is looking at the properties of artificial cartilage. Dr. Saddawi is looking at growth behavior of "Sulfur-Eating" bacteria. Professor Strieder has conducted theoretical studies of cell communication and cell growth. Professor McCready has initiated a new project with Professor Ostafin on transport of nanoparticles in bone tissue. As part of his microfluidic work Professor Leighton is working on electrophoretic separation of proteins.