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PROPOSAL FOR A GRADUATE CONCENTRATION IN CHEMICAL AND BIOMOLECULAR ENGINEERING IN THE MASTER'S DEGREE IN BIOINFORMATICS IN THE DEPT. OF CHEMICAL AND BIOMOLECULAR ENGINEERING

SPONSORS:
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BRIEF DESCRIPTION

The Department of Chemical and Biomolecular Engineering (ChBE) proposes to establish a graduate concentration under the campus-wide M.S. degree program in Bioinformatics.

JUSTIFICATION FOR THE ChBE GRADUATE CONCENTRATION OF THE M.S. IN BIOINFORMATICS

The graduate option in Chemical and Biomolecular Engineering was approved with the bioinformatics M.S. degree proposal in January 2004. Since then graduate concentrations have been approved to show on academic transcripts. This proposal seeks to raise the option to the level of graduate concentration and receive transcript recognition.

DEGREE REQUIREMENTS FOR ChBE CONCENTRATION

Degree requirements remained unchanged from the submission in 2004. For informational purposes, the requirements are below:

The ChBE degree concentration requires a total of thirty-six hours, including at least twelve hours at the 500 level. Out of these thirty-six hours, twenty-one must be in core courses described below. If a thesis is completed, a maximum of eight hours of thesis research may be counted toward the degree.

Required Core Courses (minimum of 21 hours)

CHBE 571 (4 hours). Bioinformatics.
CHBE 572 (4 hours). Metabolic Systems Engineering.
CHBE 580 (2 hours). Lab Techs in Bioinformatics

At least one of:
MCB 400 (4 hours) Cell Structure and Functions
MCB 406 (4 hours) Gene Expression
CS 400/CSE 400 (4 hours). Data Structures, Non-CS Majors

At least one of:
CS 411 (4 hours) Database Systems
CS 450/CSE 401/ECE 491/MATH 450 (4 hours) Intro to Numerical Analysis
CS 473/CSE 414/MATH 473 (4 hours) Combinatorial Algorithms

Elective Courses and Specialized Areas (15 hours minimum)

We anticipate that students interested in this degree will come with undergraduate training in one of the following three areas: (a) mathematical and computer sciences, (b) chemical, physical, and biological sciences, (c) engineering. The proposed program is therefore designed to complement training in each of these areas with expertise from the other two areas. In consultation with an advisor, students will select appropriate electives to fulfill their graduation requirements. A compendium of currently appropriate courses is provided in the Appendix. Students may elect to specialize in one of several designated areas or simply take a set of courses best matching their interests. Some specific specialization areas are proposed below:

1. *CHBE systems bioinformatics:* CHBE 472 (Techniques in Biomolecular Eng) and CHBE 473 (Biomolecular Engineering).
2. *CS information systems:* CS 511 (Design of Database Mgmt Sys) and, upon its approval, CS 512 (Data Mining) after taking CS 411 (Database Systems).
3. *CS numerical computing:* CS 554/CSE 512 (Parallel Numerical Algorithms) after taking CS 450/CSE 401/ECE 491/MATH 450 (Numerical Analysis: A Comprehensive Introduction).
4. *CS combinatorial algorithms:* CS 571/MATH 580 (Combinatorial Mathematics) after taking CS 473/CSE 414/MATH 473 (Combinatorial Algorithms).
5. *STATISTICS stochastic modeling and statistical inference:* Choose from ANSC/STAT 448, ANSC 592, CS 446, ECE 534, IE 410, MATH 466 / STAT 456, MATH 564 / STAT 555, STAT 410, STAT 420, STAT 425, STAT 426, STAT 428, STAT 571, STAT 553, STAT 578.

Prerequisites

The minimal undergraduate background needed to enter the core courses of the program is:

- five hours of undergraduate biology (MCB 150, MCB 151);
- nine hours of general and organic undergraduate chemistry (CHEM 102, CHEM 104, CHEM 232);
- three hours of undergraduate computer science (CS 101);
- nineteen hours of mathematics and statistics (MATH 220 or MATH 221, MATH 231, MATH 225, MATH 241, MATH 385, and MATH 461).

EXPECTED ENROLLMENT

We expect that approximately ten new students will enter this degree concentration every year and that the time to graduation will be two to three semesters.

BUDGETARY AND STAFF IMPLICATIONS

a. Additional staff and dollars needed

Because it the graduate option is already in place, the change to a graduate concentration will not require any new instructional resources.

b. Internal reallocations

We do not expect significant changes in the teaching loads in courses currently offered by the department.

c. Effect on course enrollments in other departments and explanations of discussions with representatives of these departments.

None.

d. Impact on library, computer use, laboratory use, equipment, etc.

No significant impact is expected.

GUIDELINES FOR UNDERGRADUATE EDUCATION: Not applicable

EFFECTIVE DATE: **Upon approval**

CLEARANCES:

Department

School

College

Graduate College 9/20/07

Provost

STATEMENT FOR THE BULLETIN

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Graduate Degree Programs

The Department of Chemical and Biomolecular Engineering offers graduate programs leading to the master of science and the doctor of philosophy degrees. Those interested should write to the address above for application materials and a departmental brochure, which gives greater detail on programs, offerings, admission, degree requirements, and financial aid.

Admission

Candidates for advanced degrees in chemical engineering should have a background in chemistry and chemical engineering comparable to the training offered in the undergraduate chemical engineering curriculum at the University of Illinois at Urbana-Champaign. Students whose prior training is deficient in one or more basic areas of chemistry or chemical engineering will be admitted with the understanding that their deficiencies will be removed to the extent prescribed by their advisers. Graduate College admission requirements also apply. In addition, applicants must submit results from the Graduate Record Examination (GRE) general test.

International students whose native language is not English are required to have a minimum paper-based Test of English as a Foreign Language (TOEFL) score of 590 (243 on the computer-based test). In addition, teaching is a requirement in the chemical engineering graduate program and there are special requirements for applicants whose native language is not English. The University requires a minimum Test of Spoken English (TSE) score of 50 for a contact teaching assistant appointment. It is desirable for applicants whose native language is not English to provide TSE scores in order to receive full consideration for admission and financial aid.

Graduate Teaching Experience

Experience in teaching is considered a vital part of the graduate program and is required as part of the academic work of all Ph.D. candidates in this program.

Master of Science

Requirements for the master of science include 32 graduate hours of graduate credit and a thesis. At least 20 of these graduate hours must be in courses other than thesis research with a minimum of 12 graduate hours in 500-level courses; 8 of the 500-level credits must be in chemical engineering courses. The requirement may be waived in special circumstances, and in such cases, no credit is given for registration in thesis research.

Master of Science in Bioinformatics, Concentration in Chemical and Biomolecular Engineering

The explosion of genomic and other biological information has recently generated massive amounts of data. The rapidly growing field of bioinformatics deals with all aspects of collecting, analyzing, and using such data in applications involving biomolecules. The purpose of the bioinformatics

degree program is to train students in the field of bioinformatics, which lies at the interfaces among biological, chemical, computer, and engineering sciences. Students interested in this program may come with undergraduate training in one of the following three areas: (a) mathematical and computer sciences, (b) chemical, physical, and biological sciences, (c) engineering sciences. The bioinformatics program is designed to complement training in each of these areas with expertise from the other two areas. Students entering the program must have at least five hours of biology, eight hours of undergraduate general chemistry, at least sixteen hours of introductory mathematics and statistics, and at least three hours of undergraduate computer science. It is recommended that entering students also have organic chemistry and data structures.

The M.S. degree in Bioinformatics requires students to complete a minimum of thirty-six hours, including a set of core courses from engineering, biochemistry, and computer science. Students may use a Master's thesis to reduce the non-core course work requirements by eight hours.

The bioinformatics program administered by the Department of Chemical and Biomolecular Engineering has been developed in close coordination with several other units across campus, including the Departments of Animal Sciences, Bioengineering, Computer Science, Mathematics, and Statistics, and the School of Molecular and Cellular Biology.

Doctor of Philosophy

Requirements include 96 graduate hours of graduate credit, satisfactory performance on qualifying and certification examinations, and a thesis. The credit requirement includes a minimum of graduate-level courses in chemical engineering and a coherent program of four additional graduate level courses. The qualifying examination is a written test usually taken during the first year of study. The certification examination is an individual oral examination taken after the student has satisfied the course requirements. It focuses on the student's proposed thesis research.

APPENDIX: LISTING OF CURRENTLY OFFERED APPROPRIATE ELECTIVE COURSES

ANSC 448 / IB 487 / STAT 458 (3 or 4 hr). Mathematical Modeling in Life Sciences
ANSC 592 (1 to 4 hr). Adv Topics in Animal Science
BIOE 472 (3 or 4 hr). Techniques in Biomolecular Engineering
BIOP 401 (3 hr). Introduction to Biophysics
BIOP 420 / MCB 425 (3 hr). Molecular Biophysics
BIOP 541 (4 hr). Macromolecular Modeling
CS 411 (3 or 4 hr). Database Systems
CS 418 / CSE 427 (3 or 4 hr). Computer Graphics
CS 419 / CSE 428 (3 or 4 hr). Advanced Comp Graphics
CS 427 / CSE 426 (3 or 4 hr). Software Engineering, I
CS 428 / CSE 429(3 or 4 hr). Software Engineering, II
CS 438 / CSE 425 / ECE 438 (3 hr). Communication Networks
CS 446 (3 or 4 hr). Machine Learning & Pattern Rec
CS 450 / CSE 401 / ECE 491 / MATH 450 (3 or 4 hr). Intro to Numerical Analysis
CS 473 / CSE 414 / MATH 473 (3 or 4 hr). Algorithms
CS 475 / MATH 475 (3 or 4 hr). Formal Models of Computation
CS 511 (4 hr). Adv Database Mgt Systems
CS 527 / CSE 529 (4 hr). Advanced Topics in Software Engineering
CS 541 / CSE 524 / ECE 541 (4 hr). Computer Systems Analysis
CS 554 / CSE 512 (4 hr). Parallel Numerical Algorithms
CS 573 / CSE 515 (4 hr). Topics in Algorithms
CHBE 472 / BIOE 472 (3 or 4 hr). Techniques in Biomolecular Engineering
CHBE 473 (3 to 4). Biomolecular Engineering
CHEM 574 / MCB 554 (3 or 4 hr). Genomics, Proteomics, and Bioinformation
CHLH 590 / IB 592 / PATH 524 (4 hr). Biostatistics
CPSC 540 (5 hr). Applied Statistical Methods II
CPSC 541 / ANSC 541 (5 hr). Regression Analysis
CPSC 568 (2 hr). Recombinant DNA Technology Laboratory
ECE 475 / BIOE 475 (3 or 4 hr). Modeling of Biosystems
ECE 534 (4 hr). Random Processes.
ECE 579 / CS 579 / MATH 578 (4 hr). Computational Complexity
GE 531 (4 hr). Genetic Algorithm Methods
IB 402 (3 hr). Molecular Evolution
IB 504 (3 hr). Genomic Analysis of Insects
IB 467 (4 hr). Principles of Systematics
IB 591 / PATH 591 (4 hr). Design/Analysis of Biomedical Experiments
IE 400 (3 or 4 hr). Design and Analysis of Experiments
IE 410 (3 or 4 hr). Stochastic Proc and App
IE 411 (3 or 4 hr). Optimization of Large-Scale Linear Systems
IE 510 (4 hr). Applied Nonlinear Programming
IE 511 (4 hr). Integer Programming
IE 512 / CEE 516 (4 hr). Sys Method and Network Techniques
MATH 461 / STAT 461 (3 or 4 hr). Probability Theory
MATH 531 (4 hr) Analytic Theory of Numbers I
MATH 580 / C S 571 (4 hr). Combinatorial Mathematics
MCB 400 (4 hr). Cell Structure and Function
MCB 401 (3 hr). Cell and Membrane Physiology
MCB 412 / NEUR 422 (3 hr). Cellular and Molecular Neurobiology
MCB 414 / NEUR 404 (3 hr). Introduction to Neurobiology

MCB 417 / BIOP 417 / NEUR 427 (4 hr). Modeling Neural Systems
MCB 420 (3 hr). Molecular Immunology
MCB 430 (3 hr). Molecular Microbiology
MCB 432 (3 hr). Computing in Molecular Biology
MSE 473 (3 hr). Biomolecular Materials Science
MSE 485 / PHYS 466 / CSE 485 (3 or 4 hr). Atomic-Scale Simulations
MCB 552 (1 to 4 hrs). Lab Techniques in Biochemistry
MCB 555 (2 hr). Anlys Biochemical Literature
NEUR 591 / MCB 519 (1 hr). Computational Brain Theory
PHYCS 352 (3 hr). Computational Biophysics
PHYCS 451 (1 unit). Biosystems Physics
PHYS 550 / MCB 550 / BIOP 550 (4 hr). Biomolecular Physics
STAT 410 / MATH 464 (3 or 4 hr). Statistics and Probability, II
STAT 420 / MATH 469 (3 or 4 hr). Methods of Applied Statistics
STAT 425 (3 or 4 hr). Applied Regression and Design
STAT 426 (3 or 4 hr). Sampling and Categorical Data
STAT 428 / MATH 493 (3 or 4 hr). Statistical Computing
STAT 553 (4 hr). Probability and Measure, I
STAT 555 / MATH 564 (4 hr). Applied Stochastic Processes
STAT 571 (4 hr). Multivariate Analysis
STAT 578 (4 hr). Topics in Statistics