07-68

GRADUATE

NEW/REVISED/DELETED GRADUATE PROGRAMS COVER SHEET
(Degree Programs, Sequences, Graduate-Level Certificates)
Graduate Curriculum Committee
2006-07

Deadlines for receipt by Graduate Curriculum Committee:
Revised Degree Program, Sequence, Graduate Certificates: October 2, 2006, for inclusion in 2007-08 catalog.
New Sequence, New Graduate Certificate: September 15, 2006, for inclusion in 2007-08 catalog.
New Degree Program: February 9, 2007, for inclusion in 2008-09 catalog.

DEPARTMENT/SCHOOL MATHEMATICS DATE 12-08-2006
TITLE OF DEGREE, SEQUENCE, OR CERTIFICATE BIOMATHEMATICS

Proposed Action: (Refer to Part I, Section C of *GCC Proposal Guidelines and Procedures*.)

__x__ New* (Check one):
- _____ Degree Program** (goes beyond Graduate Curriculum Committee)
- __x__ Sequence (goes beyond Graduate Curriculum Committee)
- _____ Post-Master's Graduate Certificate (goes beyond Graduate Curriculum Committee)
- _____ Post-Baccalaureate Graduate Certificate (goes beyond Graduate Curriculum Committee)
- _____ Graduate Certificate

_____ Change in requirements for: (Check one.)
_____ Degree Program _____ Sequence _____ Certificate

_____ Other program revisions

_____ Deletion of: (Check one.)
- _____ Degree Program (goes beyond Graduate Curriculum Committee)
- _____ Sequence (goes beyond Graduate Curriculum Committee)
- _____ Post-Master's Graduate Certificate (goes beyond Graduate Curriculum Committee)
- _____ Post-Baccalaureate Graduate Certificate (goes beyond Graduate Curriculum Committee)
- _____ Graduate Certificate

*Attach approved *Request for New Program Approval: Reporting of Financial Implications* form (available at www.academicsenate.ilstu.edu/documents.html).
**Obtain the New Program Request (NEPR) format from the Office of the Provost.

Summary of proposed action. For all proposals, provide current title and current catalog copy. Provide new title and new catalog copy for new programs, and for revised programs if catalog copy/title is altered. For revised programs, provide a summary of the changes. (Refer to New/Revised/Deleted Programs checklist in *GCC Guidelines and Procedures*.)

M.S. Sequence in Biomathematics.

Current title and catalog copy are attached.

Routing and action summary:

1. _____ _____
Dept./School Curriculum Committee Chair — Date Approved

2. _____ _____
Department Chair/School Director — Date Approved

3. _____ _____
College Curriculum Committee Chair — Date Approved

4. _____ _____
College Dean — Date Approved

5. _____ _____
Teacher Education Council Chair — Date Approved
(28 copies to Dean of College of Education)

6. _____ _____
Graduate School — Date Approved

Submit 10 copies of proposal to the Graduate Curriculum Committee. In addition, for new and deleted degree programs, sequences, and Post-Baccalaureate and Post-Master's certificates, submit an electronic version (MS Word format). These proposals are routed by GCC to the Academic Senate. The Senate requires electronic submission of all materials for posting to the Senate Web site.

REQUEST FOR APPROVAL OF A SEQUENCE OF A DEGREE PROGRAM

Institution: Illinois State University.

Responsible Department/School or Administrative Unit: Department of Mathematics.

Proposed Program Title: M.S. Sequence in Biomathematics.

Previous Program Title (if applicable): N.A.

CIPS Classification (applicable to new program):

Date of Implementation: June 2007.

Background for Sequence Justification: Mathematics is widely used across the physical and life sciences, and in particular is increasingly essential to biology. Quantitative biological research utilizes mathematical techniques, ranging from applied statistical methods to mathematical modeling typically involving difference or differential equations, and often involves computing-intensive methods or other advanced mathematical tools. In particular the growing field of bioinformatics applies statistics, probability theory, and graph theory, along with computing intensive methods, to detect and interpret patterns in massive data sets.

At some level all biologists make use of mathematical tools, but it is increasingly obvious that there is a prominent research role for scientists working at the interface of Biology and Mathematics, having greater mathematical sophistication than the typical biologist, and greater knowledge of biology than the typical mathematician. Consequently, interdisciplinary biomathematical programs are being introduced in increasing numbers nationwide. The increasing application of mathematics to biological problems has led us to develop an M.S. sequence in Biomathematics. This M.S. sequence will enable mathematicians actively to pursue interdisciplinary research careers in collaboration with biologists.

Description of Proposed Program: We propose that graduate students in the M.S. Sequence in Biomathematics will take a set of core courses that will provide the students with the mathematical knowledge and skills appropriate for applications of mathematics to biology. We propose this M.S. sequence through the Department of Mathematics because all sequences are administrated within a department. It parallels an M.S. in Biomathematics proposed by the Department of Biological Sciences. The sequences will be interdisciplinary, and will start with core courses from the Departments of Mathematics and Biological Sciences to provide the students with a strong foundation in both disciplines.

After the core courses the students can choose from two sets of electives that provide training which emphasizes either *Biostatistics and Modeling* or *Computation and Bioinformatics*. The need for additional courses will be determined by the faculty advisor, the student and the Departmental Master's Committee.

The objectives of the proposed sequence include: (1) to provide a cross-disciplinary but focused learning environment for students enrolled in the Sequence in Biomathematics through participation in a cohesive curriculum designed to develop the students' knowledge and skills in applications of mathematics to biological problems. (2) To demonstrate to prospective students that this is a unique training opportunity offered by collaborating ISU faculty who work at the interface of these fields. (3) To enhance the effectiveness of the graduate training sequence by creating a 'cohort' experience for new graduate students. (4) To provide cohesive and focused research, learning, and training for students in the program.

M.S. Sequence in Biomathematics. 30 sem. hrs. required[1], including thesis (minimum of 4 sem. hrs. MAT 499).

Sequence structure: In addition to the core courses, the sequence requires a thesis, and at least 14 hours of coursework chosen from the electives listed below. A minimum of 13 hours outside the core must be at the 400 level. At least 12 hours of Biological Sciences courses outside the core must be included. Transfer credit may be granted for MAT 340, 350, or 351, provided that at least 2 Mathematics courses are taken while in residence at ISU.

- *Prerequisites:* Three[2] semesters of calculus, 1 semester of linear algebra, and 4 additional appropriate mathematical and/or biological courses.

- *Core courses* (taken by all M.S. students in the sequence): BSC 420.36[3] Seminar in Biomathematics (1 sem. hr., taken twice for total 2 sem. hrs.); MAT 499 (4 sem. hrs.); MAT 340 Differential Equations I (3 sem. hrs.); MAT 350 Applied Probability Models (4 sem. hrs.); MAT 351 Statistics and Data Analysis (4 sem. hrs.); MAT 442[4] Quantitative Biomathematics (3 sem. hrs.) .

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[1] Most students in this sequence will be required to take 33 hours, 3 more than the minimum required for an M.S. in Mathematics. This added requirement reflects the interdisciplinary nature of this sequence: M.S. students in this sequence must have a firm grounding in mathematics, including difference and differential equations (vital for modeling) and statistical theory (vital for statistical approaches to biological research). They must also have sufficient knowledge of biology. This small increase in hours is justified because without it, students would not have appropriate training and knowledge of both mathematics and advanced biology. Therefore the core of our program requires 4 mathematics courses at the 300-level which will give a mathematics graduate student the necessary background to pursue successfully research at the interface of biology and mathematics. Students who have a stronger undergraduate training in mathematics will likely not need to take all of the mathematics classes in the core and thus could complete their degree within 30 credit hours. The addition of 3 hours (i.e., one additional course) should not delay students inordinately in the pursuit of their degree.

[2] With permission of the Program Director, students with two semesters of calculus may be provisionally admitted to the program.

[3] Currently proposed as a part of the M.S. Sequence in Biomathematics by the Department of Biological Sciences.

[4] MAT 442 is a purpose-designed new course proposed along with this Sequence (see attachment). In earlier discussions with faculty in the Department of Biological Sciences it was anticipated that MATH 341 Differential Equations II be a core component of this Sequence and the corresponding proposal from that Department has recently gone forward to College Curriculum Committee. However in the light of subsequent discussions within the Department of Mathematics, MAT 442 is proposed as a more appropriate component for this Sequence, and could be regarded as a standard substitute for MAT 341 for this purpose.

- *Emphases and advisement:* Each student in the sequence selects one of the following emphases: (1) Biological Statistics and Modeling, or (2) Computation and Bioinformatics. Each student's graduate advisor will guide the research and choice of courses outside of the core and if any additional courses are necessary for the particular student's project.

Electives for *Emphasis in Biostatistics and Modeling*: MAT 353 Regression and Time Series (4 sem. hrs.); MAT 356 Stat. Computing (4 sem. hrs.); MAT 362 Linear Program (2-4 sem. hrs.); MAT 378 Mathematical Modeling (4 sem. hrs.); MAT 450 Finite Sampling (3-4 sem. hrs.); MAT 453 Regression (3-4 sem. hrs.); MAT 455 Stochastic Processes (3-4 sem. hrs.); MAT 456 Multivariate Statistics (3-4 sem. hrs.); MAT 458 Design of Experiments (3-4 sem. hrs.) and BSC 343 Neurobiology (3 sem. hrs.); BSC 403 Plant Ecology (4 sem. hrs.); BSC 404 Population Ecology (4 sem. hrs.); BSC 405 Community Ecology (4 sem. hrs.); BSC 450.37 Advanced studies in Biostatistics (3 sem. hrs.); BSC 471 Evolutionary Population Genetics (3 sem. hrs.); BSC 486 Ethology (4 sem. hrs.).

Electives for *Emphasis in Computation and Bioinformatics*: MAT 356 Statistical Computing (4 sem. hrs.); MAT 361 Discrete Math (2-4 sem. hrs.); MAT 363 Graph Theory (4 sem. hrs.); MAT 461 Advanced Topics in Discrete Math (3-4 sem. hrs.)and BSC 350 Molecular Biology (3 sem. hrs.); BSC 353 Biotechnology Laboratory I: DNA (3 sem. hrs.); BSC 355 Genomics & Bioinformatics (3 sem. hrs.); BSC 415 Advanced Cell Biology (3 sem. hrs.); BSC 419 Molecular Biology of the Gene (4 sem. hrs.); BSC 467 Microbial Genetics (4 sem. hrs.); BSC 470 Evolution (3 sem. hrs.); BSC 471 Evolutionary Population Genetics (3 sem. hrs.).

Catalog Copy:

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Master's Degree Programs

The student must meet the general university requirements listed elsewhere in this catalog for the Master of Science degree. In addition, the student must complete either Option I in Mathematics, Option II in Mathematics, the sequence in Elementary and Middle School Mathematics Education, or the sequence in Biomathematics described below.

Biomathematics: Students in the Department of Mathematics may elect to pursue a sequence in Biomathematics, a course of study that provides a cutting-edge cross-disciplinary training in mathematics and biology. The sequence is designed first to give students a solid foundation in mathematics (core courses), then training in one of two biomathematical emphases that use specific types of mathematical applications to address biological questions. Before entering the sequence students should have 3 semesters of calculus (or 2 semesters with Program Director's approval) and 1 semester of linear algebra. This program requires a minimum of 30 sem. hrs. including the research thesis. The research thesis MAT 499 yields 4 sem. hrs. credit. All students are required to take the sequence core courses of 20 sem. hrs. (MAT 340, MAT 350, MAT 351, MAT 442, BSC 420.36, MAT 499), where the seminar BSC 420.36 will be taken twice. If corresponding courses have already been taken,

electives may be substituted. In addition students will choose from two areas of emphasis for 14 sem. hrs., with a minimum of 12 sem. hrs. from the Department of Biological Sciences. A minimum of 13 sem. hrs. outside of the core courses must be at the 400 level. The areas of emphasis and their courses are:

Emphasis in Biostatistics and Modeling: A choice of courses from MAT 353, MAT 356, MAT 362, MAT 378, MAT 450, MAT 453, MAT 455, MAT 456, MAT 458 and BSC 343, BSC 403, BSC 404, BSC 405, BSC 450.37, BSC 471, BSC 486.

Emphasis in Computation and Bioinformatics: A choice of courses from MAT 356, MAT 361, MAT 363, MAT 461 and BSC 350, BSC 353, BSC 355, BSC 415, BSC 419, BSC 467, BSC 470, BSC 471.

[End of Catalog Copy]

Rationale for Proposal: We see the sequence serving several purposes: to provide the opportunity for cross-disciplinary training for graduate students in this rapidly growing field; to assist in recruiting high quality M.S. students to ISU; and to stimulate interdisciplinary collaboration and research between the Departments of Mathematics and Biological Sciences.

Expected Impact of Proposal on Existing Programs: The proposed Biomathematics M.S. Sequence will not negatively affect other existing ISU programs. We anticipate that the creation of the sequence will attract a modest number of high quality M.S. students.

Curricular Changes Including New Courses: There will be one new course MAT 442 Quantitative Biomathematics (3 sem. hrs.) focusing on biological applications of linear and non-linear difference equations, ordinary differential equations including linear systems and partial differential equations (see attached proposal). Additionally the Department of Biological Sciences proposes a seminar course BSC 420.36 (1 sem. hr.), which focuses on readings in current research in Biomathematics. This seminar provides an interdisciplinary focus. It will be the cornerstone of the proposed program in Biomathematics, and will be required of all students in the sequence.

Anticipated Staffing Arrangements: Except for MAT 442, all courses required in the sequence are already being taught, hence are already integrated into regular course schedules and teaching assignments. Several current faculty members could teach the new course MAT 442, which would not be offered more than once a year.

Anticipated Funding Needs and Source of Funds: This program was selected to receive one of the Dean's $20,000 Program of Excellence Awards in College-wide competition with a number of other cross-disciplinary proposals. These funds will be used in recruitment of high-caliber research-oriented M.S. students via summer research fellowships. No additional new funding is necessary to establish the sequence.

Sample Plans of Study

For a student with an *Emphasis in Biostatistics and Modeling*:

Core – MAT 340 (3 sem. hrs.), MAT 350 (4 sem. hrs.), MAT 351 (4 sem. hrs.), MAT 442 (3 sem. hrs.) MAT 499 (4 sem. hrs.), and 2 semesters of the seminar BSC 420 (1 sem. hr x 2). Electives for the emphasis and Biology requirement – MAT 453 (3 sem. hrs.), BSC 404 (4 sem. hrs.), BSC 405 (4 sem. hrs.), and BSC 486 (4 sem. hrs.).

For a student with an *Emphasis in Computation and Bioinformatics*:

Core – MAT 340 (3 sem. hrs.), MAT 350 (4 sem. hrs.) and MAT 351 (4 sem. hrs.) MAT 442 (3 sem. hrs.), MAT 499 (4 sem. hrs.) and 2 semesters of the seminar BSC 420 (1 sem. hr x 2). Electives for the emphasis and Biology requirement – BSC 415 (3 sem. hrs.), BSC 419 (4 sem. hrs.), BSC 467 (4 sem. hrs.), and BSC 470 (3 sem. hrs.).