Request for a New Course:

Background information: Drs. Koksal and Dshalalow (Mathematical Sciences); and Drs. van Woesik, Sinden and Carroll (Biological Sciences) have received an NSF grant titles "UBM-Group: Research and Education Program (REP) in BioMath" which started in Jan. 1, 2008. This project is to train undergraduate students from Mathematical and Biological Sciences Departments at the intersection of two disciplines. The students recruited from these departments will pursue cross disciplinary studies during their junior and senior years. Training will be through both classroom and inquiry-based research. As proposed to NSF, three new courses will be developed: **Primer for BioMath, Mathematical Methods for Biology and Ecology,** and **Biostachastics.** These courses will teach the students the different languages of mathematics and biology to facilitate cross disciplinary communication and equip them with an appropriate biological background and problem solving and modeling skills that ensure successful completion of cutting-edge interdisciplinary research. All three courses will be offered as electives to all interested students on campus and as **required electives to the UBM participants.**

The first course, "Primer for BioMath", which has been approved in Fall is currently being taught and has 19 students (mostly sophomores from mathematical and biological sciences as well as dual majors). As the second course of the series, we plan to offer "Mathematical Methods for Biology and Ecology" in Fall 2008.

Rationale: Currently, the curriculum in applied mathematics as well as mathematical sciences does not have a course on mathematical biology (biomath). This course, being the first biomath course, will introduce mathematical techniques relevant to the problems of biology and ecology (for detail content information, please refer to course syllabus). It will provide the mathematical techniques and skills needed for the students to successfully conduct interdisciplinary research in mathematical biology.

MTH 3663 MATHEMATICAL METHODS FOR BIOLOGY AND ECOLOGY

Instructors: Semen Koksal – Mathematical Sciences, Robert van Woesik, Richard Sinden and David Carroll – Biological Sciences.

Text: No text book; please see the list of books given below for references.

Course Objectives: The main objective of the course is to study and analyze mathematical models in biology and ecology. Selected topics from linear algebra, numerical analysis and theory difference and differential equations will be discussed and used in biological and ecological applications.

The course will be supported by computer algebra systems (CAS) such as *Mathematica* and MATLAB.

Prerequisites: The prerequisites for the course are Calculus II and Primer for Biomath. A background in higher level mathematics, biology and CAS is desirable but not required; the course is self-contained and necessary information for CAS will be provided.

Course Content:

PART I: Linear Algebra (3 weeks)

0. **Biological Motivation:** Size-structured models, age-structured models of population dynamics such as Leslie and Usher matrices; and microarrays for gene expression.
1. Matrix Algebra
2. Special Matrices
3. Solving Linear Systems
4. Eigenvalues and Eigenvectors
5. Sensitivity analysis

PART II: Numerical Techniques (4 weeks)

0. **Biological Motivation:** Graphical and mathematical analysis of scientific data, enzyme kinetics and defining ecological processes.
1. Library of Functions
2. Numerical Techniques for Solving Nonlinear Systems
3. Interpolation and Curve Fitting
4. Approximation Theory
5. Numerical Differential and Integration

PART III: Discrete and Continuous Dynamical Systems (7 weeks)

0. **Biological Motivation:** Mathematical models in discrete and continuous time at all spatial scales of biology from point mutations through evolution of populations.
1. Theory of Difference Equations
2. First Order Differential Equations
3. Systems of Differential Equations
4. Numerical Methods for Solving Differential Equations
5. Phase Plane and Stability Analysis
6. Bifurcation and Chaos Theory

Grading:

HW/Quizzes	30 %
Test 1	15 %
Test 2	15%
Final	40%

REFERENCES:

1. Differential Equations, Dynamical Systems & Intro to Chaos, M. W. Hirsch, S. Smale and R. L. Devaney, 2nd Ed. Elsewier Academic Press, 2004.
2. Differential Equations with *Mathematica*, K. Coombes, B.R. Hunt, P.L. Lipsman, J.E. Osborn, G.J. Stuck. John Wiley&Sons, Inc. 1995.
3. Mathematical Biology I, J.D. Murray, 3rd Ed., Springer, 2000.
4. Modeling Differential Equations in Biology, C. H. Taubes, Prentice Hall, 2001.
5. Numerical Analysis, R.L. Burden and J.D. Faires, 6th Ed., Brooks/Cole Publishing Company.
6. Mathematical Models in Biology, Leah Edelstein-Keshet, SIAM, 2005.
7. Dynamical Systems with Applications using *Mathematica*, S. Lynch, Birkhauser, 2007.

Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT MTH (*Alpha Prefix (e.g., CSE)*) COURSE NO. 3663 (*Number Choice (e.g., 1301)*) CREDIT HOURS 3 TERM TO BE ADDED TO THE FILE Fall 2008 (*e.g., Fall 2006*)

CLASS HOURS _____ LECTURE HOURS 3 LAB HOURS _____ CONTACT HOURS (CEU ONLY) _____

DEPARTMENT Mathematical Sciences (*e.g., Computer Sciences*) SCHEDULE TYPE Lecture (*e.g., Lecture, Lab or Special Project*)

- ☐ COLLEGE OF AERONAUTICS–23
- ☐ COLLEGE OF BUSINESS–24
- ☐ COLLEGE OF ENGINEERING–01
- ☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS–25
- ☒ COLLEGE OF SCIENCE–26
- ☐ UNIVERSITY COLLEGE EXTENDED STUDIES–27

COMPUTER TITLE *Restricted to 25 characters, including spaces* Methods for Biomath

CATALOG TITLE Mathematical Methods for Biology and Ecology

CATALOG DESCRIPTION OF COURSE *Limited to 350 characters, including spaces*

Examines biological processes and mathematically reformulates the biological information into linear and nonlinear systems, differential equations and studies these formulations via matrix algebra, numerical techniques, approximation theory, stability and bifurcation analysis.

In addition, you may attach a course syllabus and/or more detailed description.

RESTRICTIONS

- ☐ Prerequisite Mth 1002 (*Course Number*) ☐ Corequisite _____ (*Course Number*)
- ☐ Prerequisite Mth/Bio 2332 (*Course Number*) ☐ Corequisite _____ (*Course Number*)
- ☐ Prerequisite _____ (*Course Number*) ☐ Corequisite _____ (*Course Number*)

GRADES TO BE ISSUED

- ☒ A, B, C, D, F
- ☐ A, B, C, D, F, CEU
- ☐ CEU
- ☐ S, U
- ☐ P, F
- ☐ Other _____

ADDITIONAL RESTRICTION junior level, by instructor's approval (*e.g., Major, Class Level, Department Head Approval*)

If this course replaces a course currently offered in BANNER, please indicate old course information

SUBJECT *Alpha Prefix (e.g., CSE)* _____ COURSE NO. *(e.g., 1301)* _____

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Originator — Date: Feb. 22, 2008

Chair, Graduate Council — Date

Department Head/Program Chair — Date: 2/22/08

OR

Dean or Associate Dean — Date

Chair, Undergraduate Curriculum Committee — Date

CATALOG DIRECTOR

These changes/additions have been made for the _____ University/Extended Studies Catalog and entered into the BANNER term named above.

Catalog Director *Date*

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