SCHOOL CURRICULUM COMMITTEE ACTION (if applicable)

Chair, School Curriculum Committee — Date

SNSS SOE SAH SOP
School (Circle One)

DEAN'S ACTION

Approved with confirmation that all necessary laboratories, studios, resources, facilities and qualified faculty for support of this course are available.

Karen O'Connor — 4/11/14
Signature, Office of Dean (both Deans' Offices if course is cross-listed) — Date

COLLEGE SENATE ACTION

1. **Received**, logged, and electronic packet and hard copies forwarded to the College Senate Office. Course title and description submitted to the *College Bulletin*.

Vincent Mann — 4-14-14
Signature, College Senate Office — Date

1314135
Log Number

2. **Action** for Intellectual Foundations' Designation

_____ Recommend approval

_____ Recommend disapproval

Signature, Assistant Dean of Intellectual Foundations — Date

3. **Action** of the College Senate Curriculum Committee

X Approved and forwarded to College Senate

_____ Disapproved and returned to department

Karen Sacks — 4/7/15
Signature, Chair of College Senate Curriculum Committee — Date

ACTION OF THE OFFICE OF ACADEMIC AFFAIRS

X Approved and forwarded to President

_____ Disapproved and returned to Department

[signature] — 4/9/15
Signature, Office of Academic Affairs — Date

Prefix, Number and Name of Course: ACM 600 Mathematical Modeling and Applications I

Credit Hours: 1
In Class Instructional Hours: 1 **Labs/Studio:** 0 **Field Work:** 0

Catalog Description:
Prerequisites: Instructor permission or admission to the Professional Applied and Computational Mathematics (PACM) Program.
Processes of mathematical modeling, use of dimensional analysis, scaling, and elementary perturbation methods; constrained and unconstrained optimization, sensitivity analysis, derivation and analysis of system of discrete dynamical models.

Reasons for Addition:
This 5-week course focuses on the practical aspects of the methods used in applied mathematics. The Professional Applied and Computational Mathematics (PACM) Master's Program was developed to be flexible and adopt curriculum changes based on the needs of graduate students as well as the industry/business involved with the program. Topics are selected and examples are incorporated in order to satisfy those requirements. Applications to areas include biology, fluid dynamics, chemistry, ecology, and finance. Emphasis is on team building and group management through problem solving activities. The course will engage students with mathematical modeling concepts and techniques that will provide hands-on experience as well as prepare students for a variety of possible future courses in the program and at the workplaces thereafter.

Student Learning Outcomes Students will	**Course Content References:**	**Assessment:**
1. formulate, analyze, and interpret mathematical models (such as optimization and difference models) in the study of real life problems.	I, II, III	Problem sets, individual homework assignments, and examinations.
2. create and explore numerical simulations of developed mathematical models using computer technology.	II, III	Projects.
3. work cooperatively and communicate (both orally and in writing) as team members when solving problems, and/or presenting results.	II, III	in-class, small group activities and projects will utilize rubrics to assess Johnson & Johnson's 5 essential components of cooperative learning including individual accountability and positive interdependence as well as taking on different roles within the group problem solving environment; oral presentation rubric; writing assessment rubric

Course Content:

I. Introduction to Mathematical Modeling
- A. Modeling process: The five-step method
- B. Overview of mathematical models
- C. Dimensional analysis
- D. Model robustness

II. Constrained and Unconstrained Optimization Models
- A. Modeling with single and multivariable optimization
- B. Lagrange multipliers
- C. Sensitivity analysis
- D. Computational methods for optimization (with Excel/Mathematica)
- E. Case studies

III. Modeling with Discrete Dynamical Systems
- A. Modeling using linear and nonlinear difference equation systems
- B. Linearization and local dynamics
- C. Eigenvalue methods (discrete)
- D. Qualitative analysis (e.g. cobwebbing)
- E. Stability analysis
- F. Bifurcation analysis and chaos
- G. Computational methods
- H. Case studies

Resources

Scholarship:

Allman, S.E. and Rhodes, A.J., *Mathematical Models in Biology, an Introduction*, Cambridge University Press, 2004.

Basmadjian, D. and Farnood, R., *The Art of Modeling in Science and Engineering with Mathematica, 2nd ed.,* Chapman & Hall/CRC., 2007.

Caldwell, J. and Ng, K.S.D., *Mathematical Modelling, Case Studies and Projects*, Kluwer Academic Publishers, 2004.

Dym, L. C., *Principles of Mathematical Modeling, 2nd ed.*, Elsevier Academic Press, 2004.

Edwards, C. H. and Penney, D. E., *Differential Equations and Boundary Value Problems: Computing and Modeling, 2nd ed.,* New Jersey: Prentice-Hall Inc., 2000.

Giordano, M., Jaye, M., and Weir, M., The Use of Dimensional Analysis in Mathematical Modeling, UMAP module 632, 1986.

Howison, S., *Practical Applied Mathematics, Modelling, Analysis, Approximation*, Cambridge University Press, 2005.

Lebedev, N.N., Skalskaya, I.P. and Uflyand, Y.S., *Worked Problems In Applied Mathematics*, New York: Dover Publications, 1979.

Marotto, R. F., *Introduction to Mathematical Modeling Using Discrete Dynamical Systems*, Thomson Brooks/Cole, 2006.

Meerschaert, M.M. *Mathematical Modeling, 4th ed.,* Elsevier Academic Press, 2013.

Strikwerda, J. *Finite Difference Schemes and Partial Differential Equations*. Society for Industrial and Applied Mathematics (SIAM), 2004.

Periodicals:

The American Mathematical Monthly
College Mathematics Journal
Differential Equations and Applications
Differential Equations and Dynamical Systems
Mathematics Magazine
Notices of the American Mathematical Society
SIAM Journal of Optimization

Electronic and/or Audiovisual Resources:

An introduction and tutorial on the development of mathematical models of dynamical systems (http://cs.brown.edu/research/ai/dynamics/tutorial/home.html).

Interdisciplinary Lively Applications Projects. Consortium for Mathematics and Its Applications, Inc., COMAP (800-772-6627, www.comap.com)

Lecture notes by Gerald Teschl. Ordinary Differential Equations and Dynamical Systems (http://www.mat.univie.ac.at/~gerald/ftp/book-ode/)

Numerical Recipes: The Art of Scientific Computing (third edition) (www.nr.com)
Scientific computing FAQ (http://mathcom.com/corpdir/techinfo.mdir/index.html)

The Scientist and Engineer's Guide to Digital Signal Processing (by Steven W. Smith, Ph.D. http://www.dspguide.com/pdfbook.html)

Undergraduate Applications in Mathematics Modules, COMAP (www.comap.com)