Prefix, Number and Name of Course:
ACM 601 Mathematical Modeling and Applications II

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

Catalog Description:
Prerequisites: Instructor permission or admission to the program.
Mathematical modeling and applications of differential equations, simulation of dynamical systems, and partial differential equations.

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 the 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. identify opportunities and utilize principles and methods of differential equations to study phenomena and solve real life problems.	I	Group work, individual homework assignments, examinations, and projects.
2. utilize technology in the mathematical modeling process.	II	Group work, individual homework assignments, and projects.
3. identify opportunities and utilize fundamentals of partial differential equations (PDEs) and to study phenomena and solve real life problems.	III	Group work, individual homework assignments, examinations, and projects.
4. work cooperatively and communicate (both orally and in writing) as team members when solving problems, and/or presenting results.	I,II,III	Group work, projects, and presentations.

Course Content:

I. Modeling with Continuous Dynamical Systems
   A. Modeling using linear and nonlinear differential equation systems
   B. Linearization and local dynamics

C. Eigenvalue methods (continuous)
D. Qualitative analysis (e.g. phase portraits)
E. Stability analysis
F. Case studies

II. Simulations of Dynamical Systems
A. Introduction to simulation techniques
B. The Euler method
C. The Runge-Kutta methods
D. Case studies

III. Modeling with Partial Differential Equations
A. Principles of modeling: physical laws and constitutive relations
B. Modeling using heat equation
C. Modeling using wave equation
D. Modeling using Laplace's equation
E. Separation of variables

Resources:

<u>Scholarship:</u>

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

Barnes, B. and Fulford G. R., Mathematical Modelling with Case Studies, A Differential Equations Approach Using Maple and Matlab, 2nd ed., Chapman&Hall/CRC Press, 2009.

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

Blanchard, P., Devaney, R., and Hall, R.H. Differential Equations, Brooks/Cole, 2002.

Brigham, E. O., The Fast Fourier Transform And Its Applications, Prentice-Hall, Inc., 1988.

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

Evans, L. C., Partial Differential Equations, American Mathematical Society, 1998.

Gershenfeld, N., The Nature of Mathematical Modeling, 1st ed., Cambridge University Press, 1999.

John, F., Partial Differential Equations, 4th ed., Springer-Verlag, 1982.

Jost, J., Partial Differential Equations, Springer-Verlag, 2002.

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, Dover Publications, 1979.

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

Morton, K.W., Mayers, D.F. Numerical Solution of Partial Differential Equations: An Introduction. Cambridge University Press, 2005.

Pinchover, Y. and Rubinstein, J., An Introduction to Partial Differential Equations, Cambridge University Press, 2005.

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

Teschl, G., Ordinary Differential Equations and Dynamical Systems, American Mathematical Society, 2012.

Periodicals:

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

Electronic and/or Audiovisual Resources:

Interdisciplinary Lively Applications Projects. Consortium for Mathematics and Its Applications, Inc., COMAP (800-772-6627, www.comap.com)
Numerical Recipes: The Art of Scientific Computing (third edition) (www.nr.com)
Undergraduate Applications in Mathematics Modules, COMAP
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)