Prefix, Number and Name of Course: ACM 622   Modeling Change with Dynamical Systems

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

Catalog Description:
Prerequisites: (MAT 162 and MAT 202) or equivalents
Difference equations; systems of differential equations; Euler and Runge-Kutta methods; error analyses; logistic models; applications to ecology, finance, conflicts, natural and social sciences.

Reasons for Addition or Revision:
To create a one-semester-hour core module for the graduate Professional Applied and Computational Mathematics program where students will formulate and solve systems of equations that relate changing quantities selected from a wide variety of real-world situations.

<table>
<thead>
<tr>
<th>Student Learning Outcomes:</th>
<th>Course Content References:</th>
<th>Assessment:</th>
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<tbody>
<tr>
<td>Students will:</td>
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<tr>
<td>1. construct theoretical models for quantities that vary over time.</td>
<td>IV, V</td>
<td>1. Group work in class, individual homework assignments, exams.</td>
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<tr>
<td>2. analyze, compare and contrast numerical methods for solving systems of difference/differential equations.</td>
<td>I, II, III</td>
<td>2. Group work in class, individual homework assignments, exams, and computer projects.</td>
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<tr>
<td>3. write and select appropriate computer programs for implementing the Euler and Runge-Kutta methods.</td>
<td>II, III</td>
<td>3. Group work in class, individual homework assignments, and computer projects.</td>
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<tr>
<td>I. Approximating discrete change</td>
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<tr>
<td>A. Difference equations/dynamical systems</td>
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<tr>
<td>B. Models for births, deaths and resources</td>
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</table>
C. Equilibrium values
D. Systems of difference equations
E. Sensitivity analysis and long-term behavior

II. Approximating continuous change
   A. The derivative as a rate of change
   B. Autonomous differential equations
   C. Population growth and exponential decay models
   D. Stable and unstable equilibria
   E. Euler method for initial value problems
   F. Runge-Kutta method
   G. Exact methods (optional)

III. Systems of differential equations
   A. Reducing to systems of first-order equations
   B. Ecological models: predator-prey
   C. Euler’s method for systems of initial value problems
   D. Runge-Kutta method for systems
   E. Error analyses

IV. Miscellaneous discrete applications
   A. Financial models
   B. Modeling ecosystems
   C. Conflict analysis

V. Selected continuous applications
   A. Approximating irrational numbers
   B. Modeling the spread of disease
   C. Acceleration-velocity models
   D. Logistic models with harvesting
   E. Electrical circuits
   F. Mechanical Applications

Resources:

Scholarships in the Field:


Periodicals:
*Advances in Difference Equations*
*Advances in Differential Equations*
*Differential Equations and Applications*
*Differential Equations and Dynamical Systems*
*Electronic Journal of Differential Equations*
*International Journal of Difference Equations*
*International Journal of Differential Equations and Applications*
*Journal of Differential Equations*
*Journal of Difference Equations and Applications*

Electronic and/or Audiovisual Resources:


Undergraduate Applications in Mathematics Modules, COMAP.