School of Mathematical Sciences

✓ New  □ Revised COURSE: COS-MATH-611 Numerical Analysis

1.0 Course Designations and Approvals:

<table>
<thead>
<tr>
<th>Required Course Approvals:</th>
<th>Approval Request Date</th>
<th>Approval Grant Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Unit Curriculum Committee</td>
<td>10-20-10</td>
<td>10-27-10</td>
</tr>
<tr>
<td>College Curriculum Committee</td>
<td>11-01-10</td>
<td>1-25-11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Course Designations:</th>
<th>Yes</th>
<th>No</th>
<th>Approval Request Date</th>
<th>Approval Grant Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Writing Intensive</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Honors</td>
<td>✓</td>
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</table>

2.0 Course information:

Course Title: Numerical Analysis  
Credit Hours: 3  
Prerequisite(s): Permission of instructor  
Co-requisite(s): None  
Course proposed by: School of Mathematical Sciences  
Effective date: Fall 2013

<table>
<thead>
<tr>
<th>Contact Hours</th>
<th>Maximum Students/section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td>3</td>
</tr>
<tr>
<td>Lab</td>
<td></td>
</tr>
<tr>
<td>Workshop</td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
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</tbody>
</table>

2.1 Course Conversion Designation: (Please check which applies to this course)

✓ Semester Equivalent (SE) to: 1016-711  
☐ Semester Replacement (SR) to:  
☐ New

2.2 Semester(s) offered:

✓ Fall  ☐ Spring  ☐ Summer  
☐ Offered every other year only  ☐ Other
2.3 Student Requirements:

Students required to take the course:
Applied and Computational Mathematics graduate students

Students who might elect to take the course:
Graduate students and advanced undergraduate students in mathematics, physics, imaging science, or engineering

3.0 Goals of the course: (including rationale for the course, when appropriate)

3.1 To introduce the techniques for the numerical solution of mathematical problems.
3.2 To analyse the errors produced in the numerical solution of mathematical problems.

4.0 Course description: (as it will appear in the RIT Catalog, including pre- and co-requisites, semesters offered)

COS-MATH-611 Numerical Analysis
This course covers numerical techniques for the solution of nonlinear equations, interpolation, differentiation, integration, and solutions of initial value problems. (Permission of instructor) Class 3, Credit 3 (F)

5.0 Possible resources: (texts, references, computer packages, etc.)

5.2 David Kincaid and Ward Cheney, Numerical Analysis, Brooks/Cole, Pacific Grove, CA.

6.0 Topics: (outline) Topics with an asterisk(*) are at the instructor’s discretion, as time permits

6.1 Principles of Finite Precision Computation
6.1.1 Floating point arithmetic
6.1.2 Forward and backward error analysis
6.2 Properties of and Standards for Evaluating Algorithms
6.2.1 Stability
6.2.2 Accuracy
6.2.3 Efficiency by convergence rates and operation counts
6.3 Solutions of Nonlinear Equations
6.3.1 Basic fixed-points methods
6.3.2 Newton’s method, the secant method, and variations
6.3.3 Newton’s method for nonlinear systems
6.4 Interpolation and Approximation of Functions
6.4.1 Lagrange interpolation
6.4.2 Divided differences
6.4.3 Cubic splines
6.4.4 Bezier polynomials
6.4.5 Trigonometric interpolation and fast Fourier transform
6.4.6 Least-squares approximations

6.5 Numerical Integration
6.5.1 Newton-Cotes formulae
6.5.2 Gaussian quadrature
6.5.3 Adaptive integration
6.5.4 Romberg integration

6.6 Initial Value Problems for Ordinary Differential Equations
6.6.1 One-step methods: Euler, Taylor and Runge-Kutta
6.6.2 Multi-step methods: Adams-Bashforth, Adams-Moulton
6.6.3 Stability
6.6.4 Stiffness
6.6.5 Backward difference formulae

6.7 Boundary Value Problems for Ordinary Differential Equations
6.7.1 Shooting methods

7.0 Intended learning outcomes and associated assessment methods of those outcomes:

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Develop principles of finite precision computation</td>
<td>✔</td>
</tr>
<tr>
<td>7.2 Compute solutions of nonlinear equations</td>
<td>✔</td>
</tr>
<tr>
<td>7.3 Compute interpolation and approximation of functions</td>
<td>✔</td>
</tr>
<tr>
<td>7.4 Develop Gaussian integration and its error</td>
<td>✔</td>
</tr>
<tr>
<td>7.5 Apply multi-step methods such as Adams-Bashforth and Adams-Moulton to initial value problems</td>
<td>✔</td>
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</tbody>
</table>

8.0 Program goals supported by this course:

8.1 To develop an understanding of the mathematical framework that supports engineering, science, and mathematics.
8.2 To develop critical and analytical thinking.
8.3 To develop an appropriate level of mathematical literacy and competency.
8.4 To provide an acquaintance with mathematical notation used to express physical and natural laws.

9.0 General education learning outcomes and/or goals supported by this course: Not applicable

10.0 Other relevant information: (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)
None