New Revised COURSE: COS-MATH-601 Methods of Applied Mathematics

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>
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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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2.0 Course information:

Course Title: Methods of Applied Mathematics
Credit Hours: 3
Prerequisite(s): COS-MATH-221, -231 or 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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</table>

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

✓ Semester Equivalent (SE) to: 1016-802
☐ 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 general techniques that have applications in various areas of applied mathematics.

3.2 To provide a foundation for further study in applied mathematics.

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

COS-MATH-601 Methods of Applied Mathematics
This course is an introduction to classical techniques used in applied mathematics. Models arising in physics and engineering are introduced. Topics include dimensional analysis, scaling techniques, regular and singular perturbation theory and calculus of variations. (COS-MATH-221, -231 or permission of instructor) Class 3, Credit 3 (S)

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


5.3 Hans Sagan, Introduction to the Calculus of Variations, Dover, New York, NY.


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

6.1 Calculus of Variations

6.1.1 Review of the theory of finite-dimensional optimization of smooth functions

6.1.2 Partial and directional derivatives

6.1.3 Lagrange multipliers - multivariable setting

6.1.4 Hessian matrices

6.1.5 Function spaces

6.1.6 Functionals

6.1.7 Frechet and Gateaux variations

6.1.8 Second variations

6.1.9 Euler-Lagrange equations

6.1.10 Lagrange multipliers
6.1.11 Hamilton-Jacobi theory

6.2 Dimensional Analysis and Scaling
   6.2.1 Nondimensionalization
   6.2.2 The Buckingham Pi theorem
   6.2.3 Characteristic scales
   6.2.4 Scaling known functions
   6.2.5 Applications

6.3 Regular Perturbation Theory
   6.3.1 Asymptotic series
   6.3.2 Poincaré-Lindstedt method
   6.3.3 Characteristic scales
   6.3.4 Scaling known functions
   6.3.5 Applications

6.4 Singular Perturbations
   6.4.1 Inner and outer expansions and matching
   6.4.2 Boundary layers
   6.4.3 Applications

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></td>
<td>Homework</td>
</tr>
<tr>
<td>7.1 Develop the theory of the Calculus of Variations and use it to solve problems</td>
<td>✓</td>
</tr>
<tr>
<td>7.2 Find nondimensionalized forms of equations</td>
<td>✓</td>
</tr>
<tr>
<td>7.3 Identify characteristic scales in models</td>
<td>✓</td>
</tr>
<tr>
<td>7.4 Develop perturbation theory and use it to solve 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