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>4-08-10</td>
<td>4-15-10</td>
</tr>
<tr>
<td>College Curriculum Committee</td>
<td>11-01-10</td>
<td>9-20-11</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>
<td></td>
</tr>
<tr>
<td>Writing Intensive</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honors</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.0 Course information:

Course Title: Advanced Linear Algebra
Credit Hours: 3
Prerequisite(s): COS-MATH-241
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>
<td></td>
</tr>
</tbody>
</table>

2.1 Course conversion designation: (Please check which applies to this course)

- ✓ Semester Equivalent (SE) to: 1016-432
- □ 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 this course:** (by program and year, as appropriate)
Third-year students Applied Mathematics, Computational Mathematics, and Applied Statistics majors

**Students who might elect to take the course:**
Students majoring Computer Science, Chemistry, Industrial Engineering, or doing a minor in Mathematics or Statistics

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

3.1 To learn to develop and write mathematical proofs.
3.2 To develop the mathematical maturity.
3.3 To develop a conceptual grasp of the ideas of linear algebra in addition to numerical techniques.

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

**COS-MATH-341 Advanced Linear Algebra**
This course provides a further study of the fundamental concepts of linear algebra such as linear transformations, similarity, diagonalization, orthogonality, inner products, Gram-Schmidt, QR and SV Decomposition, quadratic forms, and various numerical techniques. Several applications of these ideas are also presented. (COS-MATH-241) **Class 3, Credit 3** (S)

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

5.5 David Lay, *Linear Algebra and its Applications*, Addison-Wesley, Reading, MA.
5.6 Software such as Matlab, Maple or Mathematica

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

6.1 Review of Linear Independence, Basis, Rank, Vector Spaces
6.2 Linear Transformations
   6.2.1 Matrix transformations
   6.2.2 Kernel and range
   6.2.3 Matrix of a linear transformation
   6.2.4 Algebra of linear transformations
6.2.5 Applications

6.3 Eigenvalues and Diagonalization
   6.3.1 Review of eigenvalues and eigenvectors
   6.3.2 Diagonalization
   6.3.3 Eigenvalues of linear transformations
   6.3.4 Similarity
   6.3.5 Solving systems of differential equations with $e^{At}$

6.4 Inner Product Spaces
   6.4.1 Definition and properties
   6.4.2 Orthonormal bases and Gram-Schmidt process
   6.4.3 Orthogonal subspaces
   6.4.4 Orthogonal projections and least squares solutions

6.5 Decompositions and Factorizations
   6.5.1 QR factorization
   6.5.2 Schur decomposition
   6.5.3 Singular value decomposition
   6.5.4 Spectral theorem*

6.6 Bilinear Forms
   6.6.1 Matrix representation $x^T A y$
   6.6.2 Quadratic forms $x^T A x$
   6.6.3 Positive definite quadratic forms

6.7 Optional Topics*
   6.7.1 $A^k$ and Applications
   6.7.2 Fourier series and orthogonal polynomials
   6.7.3 Fast Fourier transform

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 Construct and write mathematical proofs</td>
<td>Homework</td>
</tr>
<tr>
<td>7.2 Explain fundamental ideas of linear systems and describe methods for solving them</td>
<td>Homework</td>
</tr>
<tr>
<td>7.3 Compute eigenvalues and matrix decompositions</td>
<td>Homework</td>
</tr>
</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.
8.5 To produce graduates who can effectively use mathematics and/or statistics to model, analyze, and solve problems arising in science, engineering, business, and other disciplines.

9.0 General education learning outcomes and/or goals supported by this course:

<table>
<thead>
<tr>
<th>General Education Learning Outcomes</th>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Homework</td>
</tr>
</tbody>
</table>

9.1 Communication
- Express themselves effectively in common college-level written forms using standard American English
- Revise and improve written and visual content
- Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)
- Comprehend information accessed through reading and discussion

9.2 Intellectual Inquiry
- Review, assess, and draw conclusions about hypotheses and theories
- Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions
- Construct logical and reasonable arguments that include anticipation of counterarguments
- Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information

9.3 Ethical, Social and Global Awareness
- Analyze similarities and differences in human experiences and consequent perspectives
- Examine connections among the world’s populations
<table>
<thead>
<tr>
<th>General Education Learning Outcomes</th>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.4 <strong>Scientific, Mathematical and Technological Literacy</strong></td>
<td></td>
</tr>
<tr>
<td>Identify contemporary ethical questions and relevant stakeholder positions</td>
<td></td>
</tr>
<tr>
<td>Explain basic principles and concepts of one of the natural sciences</td>
<td></td>
</tr>
<tr>
<td>Apply methods of scientific inquiry and problem solving to contemporary issues</td>
<td></td>
</tr>
<tr>
<td>✓ Comprehend and evaluate mathematical and statistical information</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>✓ Perform college-level mathematical operations on quantitative data</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>Describe the potential and the limitations of technology</td>
<td></td>
</tr>
<tr>
<td>Use appropriate technology to achieve desired outcomes</td>
<td></td>
</tr>
<tr>
<td><strong>Creativity, Innovation and Artistic Literacy</strong></td>
<td></td>
</tr>
<tr>
<td>Demonstrate creative/innovative approaches to course-based assignments or projects</td>
<td></td>
</tr>
<tr>
<td>Interpret and evaluate artistic expression considering the cultural context in which it was created</td>
<td></td>
</tr>
</tbody>
</table>

**10.0 Other relevant information:** (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

10.1 Smart classroom

10.2 Software: Mathematics, Maple, or MATLAB