School of Mathematical Sciences

☑ New ☐ Revised  COURSE: COS-MATH-241 Linear Algebra

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>11-17-10</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>
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<tr>
<td>Honors</td>
<td>✓</td>
<td></td>
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</tbody>
</table>

2.0 Course information:

Course Title: Linear Algebra
Credit Hours: 3
Prerequisite(s): COS-MATH-219 or -221 or -190 or -200
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>35</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: 1016-331
☐ 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)

Students who might elect to take the course:
Students pursuing a minor in mathematics or seeking to strengthen their technical background in mathematics

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

3.1 To introduce the concepts and techniques of linear algebra
3.2 To provide students with practice developing sound logical arguments and communicating them in written form
3.3 To help students develop an understanding of the usage and application of mathematical abstraction

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

COS-MATH-241 Linear Algebra
This course is an introduction to the basic concepts of linear algebra, and techniques of matrix manipulation. Topics include linear transformations, Gaussian elimination, matrix arithmetic, determinants, Cramer’s rule, vector spaces, linear independence, basis, null space, row and column spaces of a matrix, eigenvalues, eigenvectors, change of basis, similarity and diagonalization. Various applications are studied throughout the course. (COS-MATH-219 or -221 or -190 or -200) Class 3, Credit 3 (F, S)

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

5.1 David Poole, Linear Algebra: A Modern Introduction, Brooks/Cole Pacific Grove, CA.
5.2 Howard Anton & Robert Busby, Contemporary Linear Algebra, Wiley, Hoboken, NJ.
5.3 David Lay, Linear Algebra and its Applications, Addison-Wesley, Upper Saddle River, NJ.
5.4 Software such as MATLAB, Maple or Mathematica
6.0 **Topics: (outline)** Instructors will cover the topics listed below in the order they feel is most beneficial to students.

6.1 Euclidean Space
   - 6.1.1 Vectors and their algebra in \( \mathbb{R}^n \)
   - 6.1.2 Cauchy-Schwarz inequality
   - 6.1.3 Dot product and orthogonal projections in \( \mathbb{R}^n \)

6.2 Systems of linear equations
   - 6.2.1 Gauss-Jordan elimination
   - 6.2.2 Row-echelon, and reduced row-echelon forms
   - 6.2.3 Characterization as a matrix equation

6.3 Linear Transformations and Matrices
   - 6.3.1 Definition and examples
   - 6.3.2 Kernel and range
   - 6.3.3 Matrix of a linear transformation
   - 6.3.4 Algebra of linear transformations and matrices (addition, multiplication, inverse)

6.4 Vector Spaces
   - 6.4.1 Definition and examples
   - 6.4.2 Linear independence and span
   - 6.4.3 Basis and dimension
   - 6.4.4 Subspaces (including column space, row space, null space, and the relationships among them)
   - 6.4.5 Rank-nullity theorem

6.5 Determinants
   - 6.5.1 Definition, geometric interpretation, and basic properties
   - 6.5.2 Cramer’s rule

6.6 Eigenvalues and eigenvectors
   - 6.6.1 Definitions and geometric interpretation
   - 6.6.2 Characteristic polynomial
   - 6.6.3 Change of basis, similarity, and diagonalization

6.7 Optional topics (as time permits)
   - 6.7.1 Cross product of vectors in \( \mathbb{R}^3 \)
   - 6.7.2 Gram-Schmidt orthogonalization
   - 6.7.3 QR factorization
   - 6.7.4 Gershgorin’s theorem
   - 6.7.5 Cayley-Hamilton theorem
   - 6.7.6 Quadratic forms
   - 6.7.7 \( A^k \) and 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>7.1 Define the basic vocabulary and use the mathematical notation of linear algebra</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>7.2 Explain elementary concepts of linear algebra</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>7.3 Demonstrate the skills necessary to solve linear systems of equations, including algebraic skills with matrices</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>7.4 Determine bases for given subspaces, including column space and null space</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>7.5 Compute the diagonalization of a matrix</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>7.6 Apply definitions to determine the validity of elementary mathematical statements</td>
<td>✓ ✓ ✓</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.

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>9.1 Communication</td>
<td></td>
</tr>
<tr>
<td>Express themselves effectively in common college-level written forms using standard American English</td>
<td></td>
</tr>
<tr>
<td>Revise and improve written and visual content</td>
<td></td>
</tr>
<tr>
<td>General Education Learning Outcomes</td>
<td>Assessment Methods</td>
</tr>
<tr>
<td>-------------------------------------</td>
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</tr>
<tr>
<td>Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)</td>
<td>Homework</td>
</tr>
<tr>
<td>Comprehend information accessed through reading and discussion</td>
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</tbody>
</table>

### Intellectual Inquiry

9.2

- 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

### Ethical, Social and Global Awareness

9.3

- Analyze similarities and differences in human experiences and consequent perspectives
- Examine connections among the world’s populations
- Identify contemporary ethical questions and relevant stakeholder positions

### Scientific, Mathematical and Technological Literacy

9.4

- Explain basic principles and concepts of one of the natural sciences
- Apply methods of scientific inquiry and problem solving to contemporary issues
- ✓ Comprehend and evaluate mathematical and statistical information ✓ ✓
- ✓ Perform college-level mathematical operations on quantitative data ✓ ✓ ✓
- Describe the potential and the limitations of technology
- Use appropriate technology to achieve desired outcomes

### Creativity, Innovation and Artistic Literacy

9.5

- Demonstrate creative/innovative approaches to course-based assignments or projects
- Interpret and evaluate artistic expression considering the cultural context in which it was created
10.0 Other relevant information: (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

None