School of Mathematical Sciences

✓ New  □ Revised COURSE: COS-MATH-442 Abstract Algebra II

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>
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<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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</table>

2.0 Course information:

Course Title: Abstract Algebra II
Credit Hours: 3
Prerequisite(s): COS-MATH-441
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: 1016-532
☐ 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)
None

Students who might elect to take the course:
Applied Mathematics, Applied Statistics, Computational Mathematics, and Computer Science majors and Mathematics minors

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

3.1 To learn the fundamentals of modern abstract algebra beyond the theory of groups.
3.2 To gain proficiency in writing proofs.
3.3 To acquire more familiarity with abstract mathematical reasoning and proofs in general.

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

COS-MATH-442 Abstract Algebra II
This course covers the basic theory of rings, integral domains, ideals, modules, and abstract vector spaces. It also covers the key constructions including direct sums, direct products, and field extensions. These topics serve as the foundation of mathematics behind advanced topics such as algebraic geometry and various applications such as cryptography and coding theory. (COS-MATH-441) Class 3, Credit 3 (S)

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

5.3 Nathan Jacobson, Basic Algebra I, Dover, New York, NY.

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

6.1 Rings–Basic Concepts
   6.1.1 Definitions and examples
   6.1.2 Subrings and ideals
   6.1.3 Homomorphisms and kernels
   6.1.4 Quotient rings
   6.1.5 Isomorphism theorems for rings

6.2 Special Types of Rings and Special Types of Ideals
   6.2.1 Prime ideals, primary ideals, and maximal ideals
   6.2.2 The nilradical and the Jacobson radical
   6.2.3 Examples of primary decomposition
   6.2.4 Local rings
6.2.5 Polynomial rings and their ideals
6.2.6 Principal ideal domains
6.2.7 Unique factorization domains

6.3 Definition and Examples of Modules over a Ring
6.3.1 Left-modules, right-modules and bi-modules
6.3.2 Isomorphism theorems for modules
6.3.3 Homomorphisms and kernels
6.3.4 Direct sums and direct products

6.4 Fields and Vector Spaces
6.4.1 Field of fractions of a principal ideal domain
6.4.2 Finite fields
6.4.3 Review of linear algebra
6.4.4 Field extensions: algebraic, transcendental, and finite field extensions
6.4.5 Splitting fields
6.4.6 Separable and inseparable extensions
6.4.7 Galois correspondence*

6.5 Applications*
6.5.1 Factorization in quadratic fields
6.5.2 Primes in the ring of Gaussian integers
6.5.3 Straightedge and compass constructions
6.5.4 Cyclotomic polynomials, cyclotomic fields and the Kronecker–Weber theorem.

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 Define and identify rings and develop their theory</td>
<td>✓</td>
</tr>
<tr>
<td>7.2 Define and identify modules and develop their theory</td>
<td>✓</td>
</tr>
<tr>
<td>7.3 Define and identify fields and field extensions and develop their theory</td>
<td>✓</td>
</tr>
<tr>
<td>7.4 Write proofs in abstract algebra</td>
<td>✓</td>
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<tr>
<td>7.5 Apply a range of problem solving methods</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:

<table>
<thead>
<tr>
<th>General Education Learning Outcomes</th>
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<tbody>
<tr>
<td></td>
<td>Homework</td>
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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
- Identify contemporary ethical questions and relevant stakeholder positions

9.4 Scientific, Mathematical and Technological Literacy

- Explain basic principles and concepts of one of the natural sciences
- Apply methods of scientific inquiry and problem solving to contemporary issues
<table>
<thead>
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<th>General Education Learning Outcomes</th>
<th>Assessment Methods</th>
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<tbody>
<tr>
<td>✓ Comprehend and evaluate mathematical and statistical information</td>
<td>✓ ✓</td>
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<tr>
<td>✓ Perform college-level mathematical operations on quantitative data</td>
<td>✓ ✓</td>
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<tr>
<td>Describe the potential and the limitations of technology</td>
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<tr>
<td>Use appropriate technology to achieve desired outcomes</td>
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<tr>
<td>9.5 Creativity, Innovation and Artistic Literacy</td>
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<tr>
<td>Demonstrate creative/innovative approaches to course-based assignments or projects</td>
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<tr>
<td>Interpret and evaluate artistic expression considering the cultural context in which it was created</td>
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**10.0 Other relevant information:** (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

None