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:** Number Theory
- **Credit Hours:** 3
- **Prerequisite(s):** COS-MATH-190 or -200, 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>
<td></td>
</tr>
</tbody>
</table>

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

- ✓ Semester Equivalent (SE) to: 1016-485
- ☐ 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:**

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

3.1 To introduce the study of integers in a rigorous way.
3.2 To raise proficiency in writing proofs.
3.3 To cultivate a greater range of problem solving methods.
3.4 To point the way to applications of number theory in areas such as factorization algorithms, primality testing, and coding theory.

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

**COS-MATH-371 Number Theory**
This course provides an introduction to the study of the set of integers and their algebraic properties. Topics include prime factorization and divisibility, linear Diophantine equations, congruences, arithmetic functions, primitive roots, and quadratic residues. (COS-MATH-190 or -200, or permission of instructor) **Class 3, Credit 3 (S)**

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

5.4 Kenneth H. Rosen, *Elementary Number Theory & its applications*, Addison-Wesley, Reading, MA.
5.5 David Burton, *Elementary Number Theory*, McGraw-Hill, Columbus, OH.

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

6.1 Divisibility
   6.1.1 Prime numbers
   6.1.2 Unique factorization
   6.1.3 Overview of the prime number theorem
   6.1.4 Linear Diophantine equations

6.2 Congruences
   6.2.1 Notation and properties of congruence arithmetic
6.2.2 Systems of linear congruences
6.2.3 Wilson’s theorem
6.2.4 Fermat’s theorem

6.3 Arithmetic Functions
6.3.1 Greatest integer function
6.3.2 Euler’s totient function
6.3.3 Chinese remainder theorem
6.3.4 Möbius function and Möbius inversion
6.3.5 Divisor function

6.4 Quadratic Residues
6.4.1 Legendre and Jacobi symbols
6.4.2 Quadratic reciprocity

6.5 Primitive Roots
6.5.1 Order of an integer
6.5.2 Existence of primitive roots
6.5.3 Index arithmetic

6.6 Applications*
6.6.1 Pythagorean triples
6.6.2 Sums of two squares and four squares
6.6.3 Tests for divisibility and primality
6.6.4 Modular exponentiation and the repeated squaring method
6.6.5 Factoring large numbers of particular forms
6.6.6 Continued fractions
6.6.7 Cryptosystems based on modular arithmetic and primitive roots

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 Describe the basic properties of integers in a rigorous way</td>
<td>✓</td>
</tr>
<tr>
<td>7.2 Develop the theory of congruences</td>
<td>✓</td>
</tr>
<tr>
<td>7.3 Develop the arithmetic functions</td>
<td>✓</td>
</tr>
<tr>
<td>7.4 Apply quadratic residues</td>
<td>✓</td>
</tr>
<tr>
<td>7.5 Develop problem solving skills</td>
<td>✓</td>
</tr>
<tr>
<td>7.6 Apply number theory to factorization algorithms, primality testing, and cryptography</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></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
- Identify contemporary ethical questions and relevant stakeholder positions

9.4 Scientific, Mathematical and Technological Literacy

Page 4 of 5
### General Education Learning Outcomes

<table>
<thead>
<tr>
<th>Assessment Methods</th>
<th>Homework</th>
<th>Quiz/Exam/Final</th>
<th>Project</th>
<th>Computer Work</th>
<th>Class Presentation</th>
</tr>
</thead>
</table>

| 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

<table>
<thead>
<tr>
<th>Assessment Methods</th>
<th>Homework</th>
<th>Quiz/Exam/Final</th>
<th>Project</th>
<th>Computer Work</th>
<th>Class Presentation</th>
</tr>
</thead>
</table>

| 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