New Revised COURSE: COS-MATH-645 Graph Theory

1.0 Course Designations and Approvals:

<table>
<thead>
<tr>
<th>Required Course Approvals:</th>
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<tbody>
<tr>
<td>Academic Unit Curriculum Committee</td>
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<tr>
<td>College Curriculum Committee</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Optional Course Designations:</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>General Education</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Writing Intensive</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Honors</td>
<td>✓</td>
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2.0 Course information:

**Course Title:** Graph Theory  
**Credit Hours:** 3  
**Prerequisite(s):** Permission of instructor  
**Co-requisite(s):** None  
**Course proposed by:** School of Mathematical Sciences  
**Effective date:** August 2014

<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 (seminar)</td>
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2.1 Course Conversion Designation: (Please check which applies to this course)

- ✓ Semester Equivalent (SE) to: 1016-768  
- 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, computer science, imaging science, and engineering.

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

3.1 To provide a rigorous introduction to concepts in graph theory
3.2 To provide a foundation for further study in applied mathematics
3.3 To identify possible thesis topics

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

COS-MATH-645 Graph Theory
This course introduces the fundamental concepts of graph theory. Topics to be studied include graph isomorphism, trees, network flows, connectivity in graphs, matchings, graph colorings, and planar graphs. Applications such as traffic routing and scheduling problems will be considered. (Permission of instructor) Class 3, Credit 3 (F)

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

5.1 D. West, Introduction to Graph Theory, Prentice Hall, Upper Saddle River, NJ.
5.2 G. Chartrand, L. Lesniak, P. Zhang, Graphs & Digraphs, Chapman & Hall/CRC, Boca Raton, FL.
5.3 J. A. Bondy, and U.S.R. Murty, Graph Theory, Springer, New York, NY
5.4 R. Diestel, Graph Theory, Springer, New York, NY

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

6.1 Fundamental Concepts in Graph Theory
   6.1.1 Representations of graphs
   6.1.2 Isomorphism
   6.1.3 Paths, cycles and trails
   6.1.4 Extremal problems
   6.1.5 Graphic sequences
   6.1.6 Orientations and tournaments
6.2 Trees
   6.2.1 Distance in trees and graphs
   6.2.2 Enumeration and spanning trees
   6.2.3 Minimal spanning trees
6.3 Connectivity & Paths
   6.3.1 Cuts and connectivity
   6.3.2 Blocks
   6.3.3 k-connected graphs
   6.3.4 Menger’s theorem
   6.3.5 Network flow problems
   6.3.6 Ford-Fulkerson algorithm

6.4 Matchings
   6.4.1 Matching and covers
   6.4.2 Berge’s theorem
   6.4.3 Hall’s matching condition
   6.4.4 Min-Max theorems (König-Egerváry theorem)
   6.4.5 Independent sets
   6.4.6 Maximum bipartite matching
   6.4.7 Weighted bipartite and stable matchings*
   6.4.8 Tutte’s 1-factor theorem

6.5 Vertex Colorings
   6.5.1 Upper bounds
   6.5.2 Brooks’ Theorem
   6.5.3 k-chromatic graphs, Turán’s theorem and Mycielski’s construction

6.6 Planar Graphs
   6.6.1 Dual graphs & Euler’s formula
   6.6.2 Kuratowski’s theorem
   6.6.3 Colorings of planar graphs, five color theorem and four color theorem

6.7 Edge Colorings*
   6.7.1 Edge chromatic number
   6.7.2 Vizing’s theorem
   6.7.3 The timetabling problem

6.8 Hamiltonian Cycles*

7.0 Intended learning outcomes and associated assessment methods of those outcomes:
## Learning Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Assessment Methods</th>
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<tbody>
<tr>
<td>Homework</td>
<td></td>
</tr>
<tr>
<td>Quiz/Exam/Final</td>
<td>✓</td>
</tr>
<tr>
<td>Project</td>
<td></td>
</tr>
<tr>
<td>Computer Work</td>
<td></td>
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<tr>
<td>Class Presentation</td>
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| 7.1 Use the basic vocabulary and definitions of graph theory     | ✓                  |
| 7.2 Apply techniques of graph theory to solve applied problems  | ✓                  |
| 7.3 Establish relationships between concepts in graph theory by writing formal, rigorous mathematical proofs | ✓                  |

### 8.0 Program goals supported by this course:

8.1 To develop students’ 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.