1.0 Course Information

a) Catalog Listing (click HERE for credit hour assignment guidance)

<table>
<thead>
<tr>
<th>Course title (100 characters)</th>
<th>Project-Based Calculus I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transcript title (30 Characters)</td>
<td>Project-Based Calculus I</td>
</tr>
<tr>
<td>Credit hours</td>
<td>4</td>
</tr>
<tr>
<td>Prerequisite(s)**</td>
<td>grade of A- or better in COS-MATH-111, or grade of A- or better in (NTID-NMTH-275 and -220), or grade of A- or better in (NTID-NMTH-272 and -220), or grade of A- or better in (NTID-NMTH-260 and -220), or a score of at least 80% on the RIT Mathematics Placement Exam</td>
</tr>
<tr>
<td>Co-requisite(s)</td>
<td></td>
</tr>
</tbody>
</table>

b) Terms(s) offered (check at least one)

<table>
<thead>
<tr>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
</tr>
<tr>
<td>Spring</td>
</tr>
<tr>
<td>Summer</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

If “Other” is checked, explain:

Offered biennially

2.0 Course Description (as it will appear in the bulletin)

This is the first in a two-course sequence intended for students majoring in mathematics, science, or engineering. It emphasizes the understanding of concepts, and using them
to solve physical problems. The course covers functions, limits, continuity, the
derivative, rules of differentiation, applications of the derivative, Riemann sums, definite
integrals, and indefinite integrals.

3.0 Goal(s) of the Course

3.1 Develop the mathematical concept of linear approximation (local linearity), and its
application to determining rates of change

3.2 Develop the mathematical concepts and elementary techniques appropriate to
computing the aggregate total of a quantity that is distributed unevenly over an
interval

3.3 Develop the mathematical concepts and elementary techniques appropriate to
computing net change in a quantity when it varies at a non-constant rate

3.4 Learn the basic definitions, concepts, rules, vocabulary, and mathematical
notation of calculus

3.5 Develop the skills required for solving problems with differential calculus

3.6 Impart appreciation of calculus as a tool in solving technical and applied physical
problems

3.7 Provide a background in mathematics that can be used for the study of science
and engineering

4.0 Intended course learning outcomes and associated assessment methods

Include as many course-specific outcomes as appropriate, one outcome and assessment method per row. Click HERE for guidance on developing course learning outcomes and associated assessment techniques.

<table>
<thead>
<tr>
<th>Course Learning Outcome</th>
<th>Assessment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Define the basic vocabulary of calculus and demonstrate correct use of its notation</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.2 Explain elementary concepts of differential calculus (especially pertaining to linearization and optimization)</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.3 Demonstrate the skills necessary to solve problems with differential calculus</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.4 Differentiate compositions and algebraic combinations of functions</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.5 Explain elementary concepts of integral calculus (esp. Riemann sums and the definite integral)</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.6 Determine antiderivatives and indefinite integrals of simple functions (including use of the substitution technique)</td>
<td>Homework and Exams</td>
</tr>
<tr>
<td>4.7 Apply elementary techniques (including substitution) to</td>
<td>Homework and Exams</td>
</tr>
</tbody>
</table>
evaluate definite integrals

4.8 Rephrase English-language descriptions of situations as mathematical equations

4.9 Apply differential and integral calculus to real-world problems and interpret the answer in context

Homework and Exams

Topics (should be in an enumerated list or outline format)

Instructors will cover the topics listed below in the order they feel is most beneficial to students. Topics marked with an asterisk are at the instructor’s discretion.

5.1 Review of functions and their graphs
   5.1.1 Algebra of functions, including shifting and scaling, and composition
   5.1.2 Exponential functions, and hyperbolic trigonometric functions
   5.1.3 Trigonometric functions
   5.1.1 Inverse functions (incl. logarithms and inverse trigonometric functions)

5.2 Limits
   5.2.1 Rates of change and tangent lines
   5.2.2 Properties of limits
   5.2.3 One-sided limits
   5.2.4 Continuity and types of discontinuities
   5.2.5 Intermediate Value Theorem
   5.2.6 Extreme Value Theorem
   5.2.7 Limits at infinity, infinite limits and asymptotes

5.3 Differentiation
   5.3.1 Tangent lines and the derivative at a point
   5.3.2 The derivative as a function
   5.3.3 Differentiation rules for elementary functions
   5.3.4 The Product Rule and Quotient Rule
   5.3.5 The Chain Rule
   5.3.6 Implicit differentiation
   5.3.7 Derivatives of inverse functions (incl. logarithms and inverse trig functions)
   5.3.8 Linear approximations and differentials

5.4 Applications of differentiation
   5.4.1 Rate of change
   5.4.2 Related rates
   5.4.3 Critical points and Fermat’s Theorem
   5.4.4 Rolle’s Theorem and Mean Value Theorem
   5.4.5 Monotonicity, and the First Derivative Test
   5.4.6 Concavity, and the Second Derivative Test
   5.4.7 Curve sketching (synthesis of derivative information)
   5.4.8 Indeterminate forms and L’Hôpital’s Rule
   5.4.9 Optimization
   5.4.10 Newton’s Method

5.5 Integration
5.5.1 Estimating area  
5.5.2 Sigma notation and Riemann sums  
5.5.3 Antiderivatives  
5.5.4 The definite integral, area, and net change  
5.5.5 Fundamental Theorem of Calculus  
5.5.6 Indefinite integrals  
5.5.7 Substitution

6.0 Possible Resources (should be in an enumerated list or outline format)

6.1 Stewart, J., *Calculus, Early Transcendentals*, Cengage, Boston, MA

7.0 Program outcomes and/or goals supported by this course (if applicable, as an enumerated list)

7.1 Graduates will exhibit skill in, and knowledge and comprehension of a breadth of topics appropriate to the undergraduate level

7.2 Graduates can use analytical methods and computational tools to solve mathematical problems, as appropriate to the undergraduate level

8.0 Administrative Information

a) Proposal and Approval

<table>
<thead>
<tr>
<th>Course proposed by</th>
<th>School of Mathematical Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective term</td>
<td>Fall, AY18-19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required approval</th>
<th>Approval granted date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Unit Curriculum Committee</td>
<td>04/08/10 [03/06/18, revision]</td>
</tr>
<tr>
<td>Department Chair/Director/Head</td>
<td>04/08/10 [03/06/18, revision]</td>
</tr>
<tr>
<td>College Curriculum Committee</td>
<td>11/01/10</td>
</tr>
<tr>
<td>College Dean</td>
<td>11/17/10</td>
</tr>
</tbody>
</table>

b) Special designations for undergraduate courses

The appropriate Appendix (A, B and/or C) must be completed for each designation requested. IF YOU ARE NOT SEEKING SPECIAL COURSE DESIGNATION, DELETE THE ATTACHED APPENDICES BEFORE PROCEEDING WITH REVIEW AND APPROVAL PROCESSES.

<table>
<thead>
<tr>
<th>Check</th>
<th>Optional Designations</th>
<th>*** Approval date (by GEC, IWC or Honors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>General Education</td>
<td>Quarter calendar, AY 11-12</td>
</tr>
<tr>
<td></td>
<td>Writing Intensive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Honors</td>
<td></td>
</tr>
</tbody>
</table>

c) This outline is for a...

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Revised course</td>
</tr>
<tr>
<td></td>
<td>Deactivated course</td>
</tr>
</tbody>
</table>
If revised course, check all that have changed

<table>
<thead>
<tr>
<th>Course title</th>
<th>Mode of Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit hour</td>
<td>X Course Description</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Special Designation</td>
</tr>
<tr>
<td>Contact hour</td>
<td></td>
</tr>
<tr>
<td>Other (explain briefly):</td>
<td></td>
</tr>
</tbody>
</table>

d) Additional course information (check all that apply)

<table>
<thead>
<tr>
<th>X</th>
<th>Schedule Final Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeatable for Credit</td>
<td>How many times:</td>
</tr>
<tr>
<td>Allow Multiple Enrollments in a Term</td>
<td></td>
</tr>
<tr>
<td>Required course</td>
<td>For which programs:</td>
</tr>
<tr>
<td>• Applied Mathematics</td>
<td></td>
</tr>
<tr>
<td>• Applied Statistics and Actuarial Science</td>
<td></td>
</tr>
<tr>
<td>• Biomedical Engineering</td>
<td></td>
</tr>
<tr>
<td>• Biochemistry</td>
<td></td>
</tr>
<tr>
<td>• Chemical Engineering</td>
<td></td>
</tr>
<tr>
<td>• Chemistry</td>
<td></td>
</tr>
<tr>
<td>• Computational Mathematics</td>
<td></td>
</tr>
<tr>
<td>• Computer Engineering</td>
<td></td>
</tr>
<tr>
<td>• Computer Science</td>
<td></td>
</tr>
<tr>
<td>• Computing Security</td>
<td></td>
</tr>
<tr>
<td>• Electrical Engineering</td>
<td></td>
</tr>
<tr>
<td>• Imaging Science</td>
<td></td>
</tr>
<tr>
<td>• Industrial Engineering</td>
<td></td>
</tr>
<tr>
<td>• Mechanical Engineering</td>
<td></td>
</tr>
<tr>
<td>• Physics</td>
<td></td>
</tr>
<tr>
<td>• Software Engineering</td>
<td></td>
</tr>
<tr>
<td>Program elective course</td>
<td>For which programs:</td>
</tr>
</tbody>
</table>

e) Other relevant scheduling information
(e.g., special classroom, studio, or lab needs, special scheduling, media requirements)

9.0 Colleges may add additional information here if necessary
(e.g., information required by accrediting bodies)
APPENDIX A: GENERAL EDUCATION

Preliminary Notes:

According to NYSED, “The liberal arts and sciences comprise the disciplines of the humanities, natural sciences and mathematics, and social sciences.” Although decisions about the general education status of RIT courses are guided by this categorization and the details provided at the NYSED web site (click HERE), RIT recognizes that a general education course might not fit neatly into any one of these categories. Course authors from all areas are encouraged to read not only the NYSED web site, but also the mission statement at RIT’s General Education web site (click HERE).

This appendix is meant to highlight those facets of a course that are directly relevant to its General Education status, and if applicable, to provide course authors with an opportunity to elaborate on aspects of the course that locate it in one or more of the Perspective categories. The course description, course goals, and course learning outcomes (sections 2, 3, and 4 of the course outline) should clearly reflect the content of this appendix.

Information provided here will also be used to identify appropriate courses for inclusion in RIT’s General Education Outcomes assessment cycle.

I. Nature of the Course:

After reviewing the NYSED web site (click HERE) and the RIT description of general education (click HERE) describe how this course fits the definition of general education.

This is a mathematics course.

II. General Education Essential Outcomes:

The Academic Senate approved the following proposal at the meeting of 16 April, 2015.

Communication and critical thinking are essential to the general education of every student at RIT. Going forward, every course designated as general education by GEC will provide learning experiences designed to achieve at least one student learning outcome from each of these domains (Communication and Critical Thinking).

The approved student learning outcomes are listed below.

a. Communication

   a.1 Check at least one of the following student learning outcomes:

<table>
<thead>
<tr>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Express oneself effectively in common college-level written forms using standard American English</td>
</tr>
<tr>
<td>Revise and improve written products</td>
</tr>
<tr>
<td>Express oneself effectively in presentations, either in American English or American Sign language</td>
</tr>
<tr>
<td>X Demonstrate comprehension of information and ideas accessed through reading</td>
</tr>
</tbody>
</table>
a.2 In the space below, explain which aspects of this course lend themselves to the Communication outcome(s) indicated above, and how student achievement will be assessed.

Course learning outcomes include rephrasing English-language descriptions of problems in mathematical terms. This requires students to demonstrate reading comprehension. Student achievement will be assessed via homework and exams.

b. Critical Thinking
b.1 Check at least one of the following student learning outcomes:

<table>
<thead>
<tr>
<th>Student Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information</td>
</tr>
<tr>
<td>Analyze or construct arguments considering their premises, assumptions, contexts, and conclusions, and anticipating counterarguments</td>
</tr>
<tr>
<td>Reach sound conclusions based on logical analysis of evidence</td>
</tr>
<tr>
<td>Demonstrate creative and/or innovative approaches to assignments or projects</td>
</tr>
</tbody>
</table>

b.2 In the space below, explain which aspects of this course lend themselves to the Critical Thinking outcome(s) indicated above, and how student achievement will be assessed.

Learning outcomes require students to apply differential calculus to real-world problems, and to interpret their answer in context. In its application, the differential calculus is a shorthand method for quickly constructing a deductive logical argument to a situation, and arriving at a conclusion. Student achievement will be assessed via homework and exams.

III. Additional Student Learning Outcomes
Indicate which (if any) of the following student learning outcomes will be supported by and assessed in this course.

<table>
<thead>
<tr>
<th>Table A.1: Student Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Check)</td>
</tr>
<tr>
<td>Student Learning Outcomes</td>
</tr>
<tr>
<td>1. Interpret and evaluate artistic expression considering the cultural context in which it was created</td>
</tr>
<tr>
<td>2. Identify contemporary ethical questions and relevant positions</td>
</tr>
<tr>
<td>3. Examine connections among the world’s populations</td>
</tr>
<tr>
<td>4. Analyze similarities and differences in human experiences and consequent perspectives</td>
</tr>
<tr>
<td>5. Demonstrate knowledge of basic principles and concepts of one of the natural sciences</td>
</tr>
<tr>
<td>6. Apply methods of scientific inquiry and problem solving to contemporary issues or scientific questions</td>
</tr>
<tr>
<td>7. Comprehend and evaluate mathematical or statistical information</td>
</tr>
<tr>
<td>8. Perform college-level mathematical operations or apply statistical techniques</td>
</tr>
</tbody>
</table>

a. Explanation: In the space below, explain how this course supports the student learning outcomes indicated above.
b. Assessment: In the space below, explain how student achievement in the specified student learning outcomes will be assessed.

IV. Perspectives
Indicate which Perspectives (if any) this course is intended to fulfill. Keep in mind that perspectives courses are meant to be introductory in nature. Click HERE for descriptions of the General Education Perspectives and their associated student learning outcomes.

<table>
<thead>
<tr>
<th>Date Requested</th>
<th>GE Perspectives</th>
<th>Required Outcomes (see Table A.1)</th>
<th>Date Granted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artistic</td>
<td>#1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethical</td>
<td>#2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>#3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>#4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Science Inquiry</td>
<td>#5 and #6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientific Principles</td>
<td>#5 or #6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AY 11-12</td>
<td>Mathematical</td>
<td>#7 and #8</td>
<td>AY 11-12</td>
</tr>
</tbody>
</table>