1. Summary

This proposal seeks support to design and develop an integrated, visualization software based notes and applications package for use in the courses 1016-420 and 1016-720 (Complex Variables).

Complex analysis plays an important role in the mathematics curriculum, containing basic results both on the theoretical and on the applied side of mathematics. Lately, the education of calculus and ordinary differential equations has been improved greatly by laying more emphasis on visual understanding of basic concepts.

My vision is that a similar endeavor can be undertaken for complex analysis. With the widespread use of computers and especially visualization softwares, fundamentally important areas of the material could be taught in a visually oriented way. As the results for calculus and differential equations showed, this approach can be very beneficial to students as the material becomes more accessible to them.

My goal is to ease the understanding and enhance the learning experience in complex analysis by employing these methods. The objective of the proposal is to create a blended notes and visual software applications package. As I mentioned, this was done for other areas in the basic mathematics curriculum, but it is yet to be worked out for complex analysis and applications.

2. Targeted Learners

This project primarily targets electrical engineering students taking 1016-420: Complex Variables. This is a required course for all electrical engineering stu-
students (approximately 150 students/year); it is also an elective course for students pursuing a minor in mathematics and for students in mathematics, science and engineering programs seeking to strengthen their technical background in mathematics (approximately 30 students/year). It will also benefit students who take 1016-720: Complex Variables and instructors teaching these courses.

3. Anticipated Impact on Teaching and Learning

Complex analysis is an involved area of mathematics, where students often get lost in the material as it is fairly dry and formula-driven. Visualization helps an enormous amount in understanding the subject. The innovative approach is based on the use of visualization software created images at strategic points in the material. They can be used for example in the study of the geometry of the complex plane, the properties of analytic functions, conformal mappings, the residue theorem etc. The problem with visualization in the study of complex analysis is primarily a dimensional problem: we should be able to create four dimensional pictures to understand complex maps. With the introduction of mathematical softwares (like MAPLE or Mathematica), dynamic figures (small movies) can be created to illustrate the effect of complex mappings. This creates a really powerful visual understanding of the subject matter.

The use of these softwares and visualization packages does not only have an impact on communicating the material, but it also gives a hands-on approach for students: they can create these images on their own by using the above mentioned mathematical algebra systems, thus broadening their learning experience.

4. Impact on Student Success

Successful implementation of visualization has helped students master mathematical concepts and ideas in calculus and ordinary differential equations tremendously. This proposal aims to ensure the same result in the area of complex analysis. Gaining an understanding of the basic concepts from a different point of view will strengthen the command of the material and will result in a more successful completion rate in the course.

5. Measuring the Impact and Disseminating the Results

Because the covered material will be an extension of the existing curriculum, a comparative study will be performed by testing students with exams used in the
traditional course to measure the impact of the project. Also, the usual evaluation methods will be employed, conducting student surveys and interviews.

The results will be disseminated in the following ways:

- Publications in peer reviewed journals (such as PRIMUS) about the design and implementation of the course and the consequent experiences at RIT.
- A project website with easily downloadable materials for possible implementations of the course for similar curricula.
- Training sessions for mathematics educators interested in this approach.

6. Rationale for the Project

(a) The course 1016-420 (Complex Variables) is a required course for students majoring in Electrical Engineering and an elective course for students pursuing a minor in mathematics and as such, it is a service course for the Department of Mathematics and Statistics. The department (and the College of Science) is unable to assign its resources to support curricular development of this service course. Thus the proposed project is ideally suited for the Provost’s Learning Innovations Grants Program.

(b) Visualization is a proven, powerful technique in other areas of mathematics. It helps students to grasp and master the material in a profound way. It is also a tremendous aid for students with learning disabilities who might get lost early in the algebraic approach to complex analysis. This new aid to the course material will contribute to the success and retention of our electrical engineering students.

(c) These integrated notes and software packages will be available as a resource for the faculty teaching the subject matter. I plan to share these packages and will invite faculty to evaluate and improve them and to implement them in their teaching as well.

(d) Tamas Wiandt is an Assistant Professor in the Department of Mathematics and Statistics. His research area is dynamical systems and differential equations. He is the recipient of the University of Minnesota IT Student Board’s “Outstanding TA” award. He was also a G.C. Evans Instructor at Rice University in Houston, TX. As a mathematics educator with more than 10 years of experience
in the field, he collected methods and materials which could serve as a basis to create a visual complex analysis course at RIT.

(e) Complex analysis is a well-established area of mathematics with beautiful pure mathematical results and extremely useful applications in various areas of the physical sciences. This innovative approach in the teaching of the subject relies heavily on newly available mathematical softwares in the visualization of certain parts of the material.

7. Timetable for the Project

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<thead>
<tr>
<th>Quarter</th>
<th>Year</th>
<th>Activity Description</th>
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<tbody>
<tr>
<td>Summer quarter</td>
<td>2005-4</td>
<td>Course design (outline, readings and materials) and programming of visualization software.</td>
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<tr>
<td>Fall quarter</td>
<td>2006-1</td>
<td>Pilot the course for one section of 1016-420.</td>
</tr>
<tr>
<td>Winter quarter</td>
<td>2006-2</td>
<td>Evaluation and fine-tuning of course materials, full implementation.</td>
</tr>
<tr>
<td>Spring quarter</td>
<td>2006-3</td>
<td>Dissemination of results and experiences through publications in peer-reviewed journals.</td>
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