# APPLIED CALCULUS ON THE WEB – AN INTERACTIVE APPROACH TO FRESHMAN CALCULUS

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**Abstract:** Teaching an Applied Calculus course imposes numerous challenges on the instructor. Students typically struggle with understanding the concepts presented to them during a lecture and often have difficulty finishing exercise sets without guidance. In an effort to remedy these problems, the authors of Applied Calculus on the Web (ACOW), a project currently under construction, have identified eleven Applied Calculus concepts that typically give students problems. For each of the identified concepts, the authors have developed, or will develop, a computer module, accessed via the internet, that contains interactive Java applets, Flash demonstrations, exercises with instant feedback, and comprehensive algorithmic quizzes. The implementation of these modules into any existing Applied Calculus course will provide students the visualization and additional practice necessary to successfully understand calculus. These modules offer flexibility to students that other components of education do not. Students can complete the modules at their own pace, at their convenience, and in any location that has an internet connection.

**Motivation:** Each year the mathematics department at Texas A&M teaches approximately 3000 Applied Calculus students. This generally makes for class sizes ranging anywhere from 90 – 120 students and often times makes it difficult for instructors to give students sufficient guided practice and feedback. In addition, time constraints in the classroom often make it impossible for instructors to appropriately use any technology that might aid students in visualizing and understanding various calculus concepts. These setbacks in effective teaching provoked the authoring team to develop a way to reach students outside the classroom and give them the guided practice, feedback, and the visualization required to master calculus.

**Courseware Components:** The ACOW courseware package will be comprised of three components; a printed workbook, a multimedia CD, and computerized modules accessed via the internet. The workbook is designed to re-teach the identified concepts; offer more examples, exercises, and practice quizzes; and guide students through each of the computerized modules. In addition, the workbook is designed for students to work independently and at their own pace. This allows the instructor to assign a due date for a particular module and have the student complete the module without further guidance from the instructor. The multimedia CD contains complete solutions, in full color PDF format, to the workbook's odd exercises and sample quizzes. Each of the computerized modules contains activities, exercises, and algorithmic quizzes. The progression of the

computerized modules follows that of the workbook, once again making it easy for students to complete the modules on their own.

**Description of Module Content:** The eleven modules and a brief description of each are listed below.

- *Algebra Preliminaries* - Contains a pre-test and post-test on basic algebraic concepts. Areas of emphasis include laws of exponents, operations on rational expressions and polynomials, and solving non-linear equations.
- *Polynomials and Modeling* – Explores linear, quadratic, and higher order polynomial functions. Uses a Java applet to perform various types of regression (see Figure 1 below).
- *Exponential and Logarithmic Functions* – Explores characteristics and applications of exponential and logarithmic functions.
- *Limits and Continuity* – Finds limits graphically, numerically, and algebraically. Investigates the continuity of piecewise defined functions.
- *Rates of Change* – Discusses average rates of change vs. instantaneous rates of change. Describes how to find the equation of a tangent line.
- *Derivative Rules* – Covers power, quotient, product, and chain rules. Discusses marginal analysis.
- *Behavior of Functions* – Discusses the relationships between given functions and their first two derivatives.
- *Optimization* – Uses Java applets to find maximum areas and volumes followed by exercises on how to algebraically find the maximum areas and volumes.
- *Indefinite Integrals* – Shows how to compute antiderivatives.
- *Definite Integrals* – Discusses Riemann sums and uses a Java applet to approximate the area under given curves (see Figure 2 below) and between two curves. Introduces the Fundamental Theorem of Calculus and demonstrates how to algebraically find the area under a given curve.
- *Multi-Variable Calculus* – Uses Java applets to graph functions of two variables (see Figure 3 below) and to show the cross section obtained when computing a partial derivative at a fixed value of $x$ or $y$.

These modules are designed to accompany any Applied Calculus textbook, regardless of author or publisher, and can be completed in any order deemed reasonable by the instructor. In addition, the navigation of the modules is very intuitive. Each webpage is split into two frames. The left frame contains all the text, exercises, and submission buttons, while the right frame holds all the Java applets, graphics, and a summary of students' results. This particular design allows the Java applets and other necessary information to remain in the students' view on the right frame, while allowing them to freely scroll through the left frame. All other types of pertinent information, such as notification of a correct or incorrect answer to individual exercises, are displayed in a pop-up window.

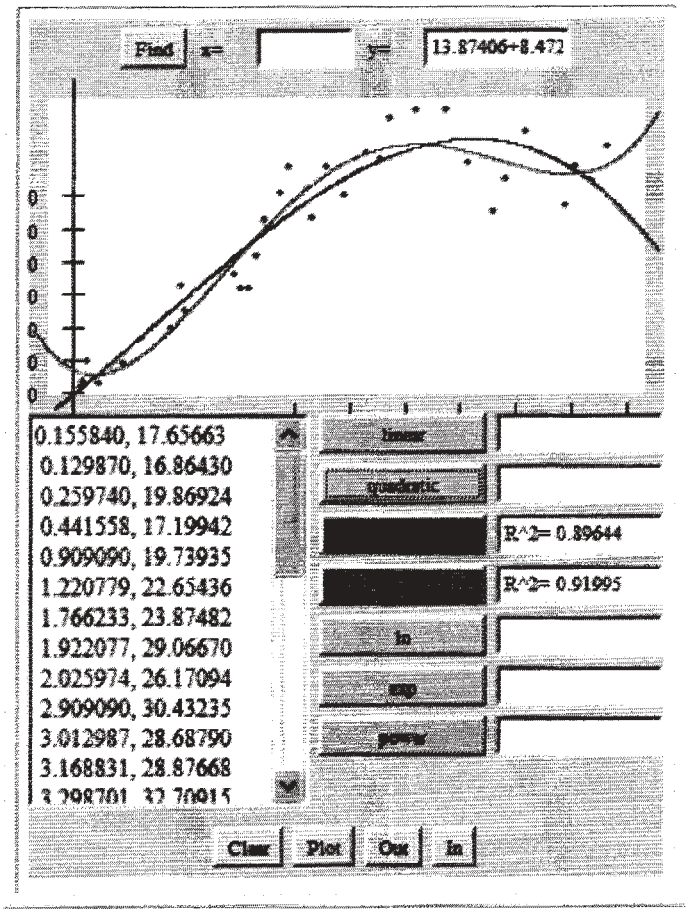


Figure 1: Modeling Applet

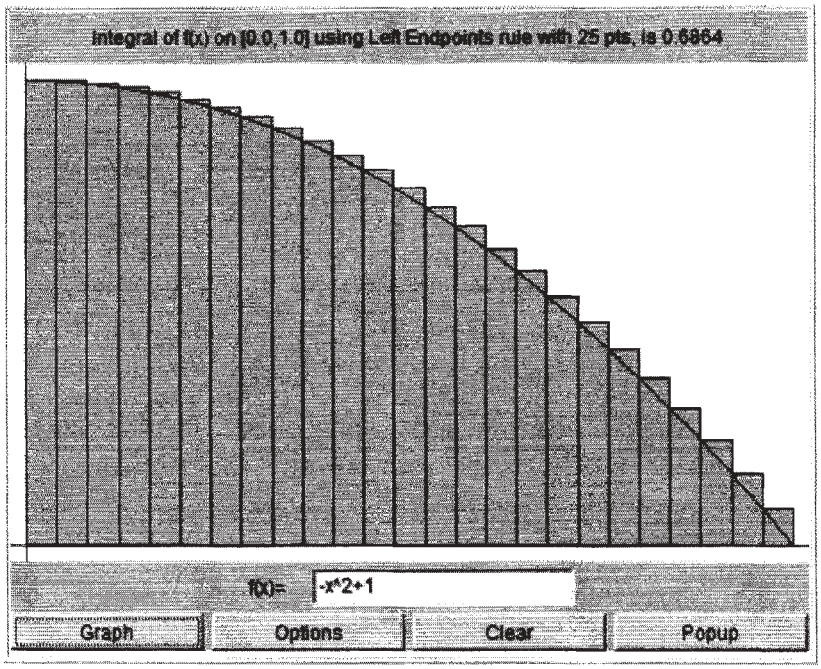


Figure 2: Riemann Sum Applet

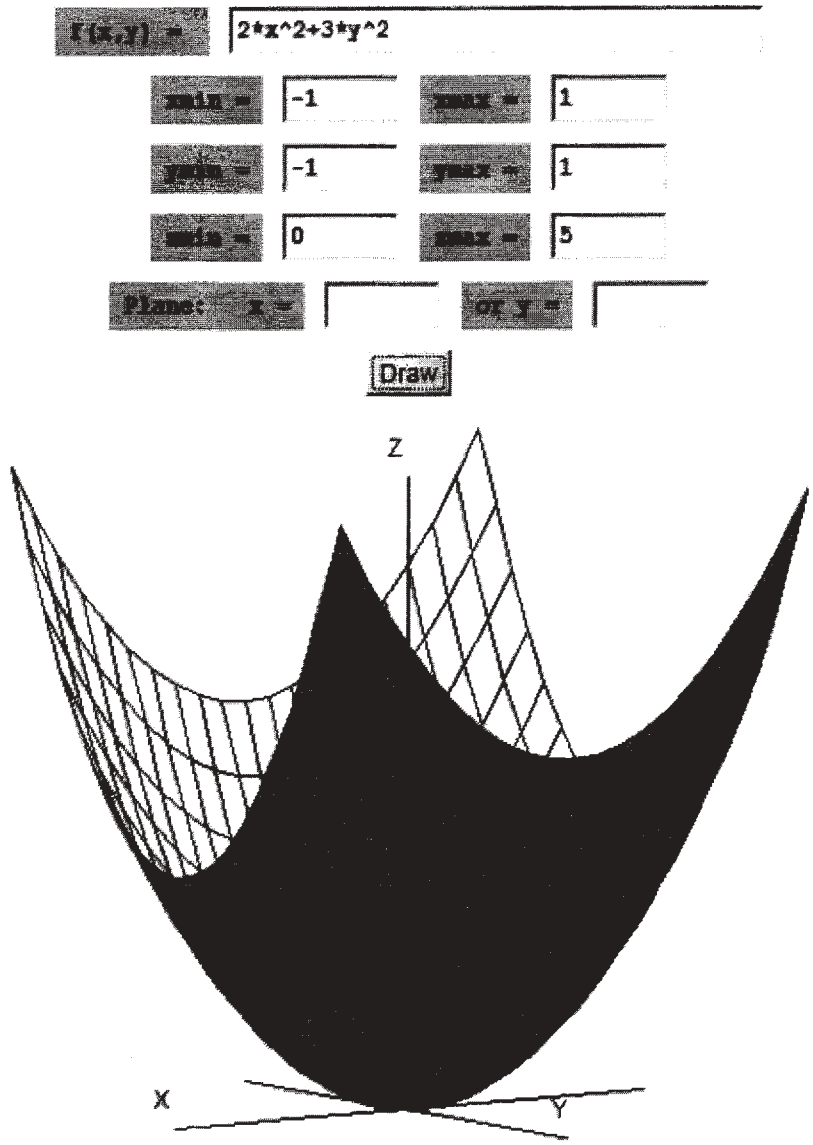


Figure 3: Function of Two Variables Graphing Applet

**Summary:** The completed modules have been implemented into a few of our Applied Calculus courses at our institution and have received positive student feedback. Students report that the interactive Java applets helped them visualize the concepts and gave them the tools necessary to better understand calculus. They found the modules easy to follow and also stated that the instant feedback was helpful in immediately identifying their mistakes. This opportunity to assess their true understanding helped better prepare the students for their required classroom exams.