

CSM #1: Calculus II & III Short Course

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Executive Summary

Freshmen and transfer students who are trying to receive credit for Calculus II & III have had trouble passing the challenge exam in previous years. This is mainly because certain sections that the Colorado School of Mines (CSM) requires are not taught at other schools. This gap in the incoming students' knowledge often forces the students to re-take a course of which the majority they already know.

We have designed an online 'short-course' in the form of a stand-alone website that teaches and reviews specific sections of Calculus II & III. Students will review the new material, which includes written lectures, examples, and practice problems. The final examination includes a standardized section as well as a short-answer section, where the students will complete problems and return their work by fax or P.D.F. file.

The website is enclosed in a Perl shell that prevents unauthorized users from gaining access to the material while at the same time keeps track of the usage by each student for later review. The site also contains an administrative page for the client to make any necessary changes for users, such as add/remove users and change passwords. This is also the page where the client can check the usage by each student.

We feel the website we created is an excellent tool used in the process of learning and reviewing material in Calculus II & III. With the site being hosted under Prof. Greivel's directory, we are confident it will be used for many years to come, and we are proud to have been able to create it.

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Abstract

Freshmen and transfer students who are trying to receive credit for Calculus II & III have had trouble passing the challenge exam in previous years. This is mainly because certain sections that the Colorado School of Mines (CSM) requires are not taught at other schools. This gap in the incoming students' knowledge often forces the students to re-take a course of which the majority they already know.

Our goal is to design an online 'short-course' that would teach and review specific sections of Calculus II & III. The students will review the new material, which will include written lectures, examples, and practice problems. The students will complete the practice problems on their own and return their work by fax or P.D.F. file.

Introduction to the Project

We have been asked by CSM, in conjunction with Gus Greivel, to develop an online 'short-course' for students wishing to get transfer credits for Calculus II & III. The course will teach these students the material that they are missing. Included will be lecture material, example problems, and practice problems for the students to work through. The student's use of the website will be monitored to determine how much time the student has spent studying. Once the material is understood, the student will then either scan, fax, or mail their completed practice problems to Gus Greivel. The challenge exam will be administered independently of the course by CSM faculty at a later date.

Requirements and Specifications

We were given a list of requirements to meet for our short-course. The course is to be as widely accessible as possible. It should be compatible with all major web browsers. Also, the website must implement a login scheme. Greivel wishes to track each student's use of the site to evaluate their efforts. This scheme should also bar people that are not enrolled in the course from viewing the online materials.

The course is to cover the following subjects:

Calculus II

- Three dimensional coordinate systems
- Vectors
- Dot and cross products
- Equations of lines and planes
- Functions and surfaces
- Cylindrical and spherical coordinates
- Vector functions and space curves
- Derivatives and integrals of vector functions
- Arc length and curvature

- Motion in space
- Parametric surfaces

Calculus III

- Vector fields
- Line integrals
- The fundamental theorem for line integrals
- Green's theorem
- Curl and divergence
- Surface integrals
- Stokes' theorem
- The divergence theorem

Each section differs in length and complexity, and an appropriate amount of material and problems have been chosen to portray the subject matter. The website has been designed to allow the student to grasp the basic concepts, eventually giving them the skills they need to pass the challenge exam to receive credit.

Design Approach

Creation of the site was broken down into four main steps:

- 1) Create the documents that cover the material.
- 2) Structure the website and upload the materials.
- 3) Implement the Perl login scheme.
- 4) Add the finished product to the Math and Computer Science (MACS) website.

First, we decided that each section should include a lecture, example problems, and practice problems page. The student will begin by reviewing the concepts in the section's lecture materials, which are laid out similar to class notes. After reviewing, the student is stepped through the completion of several examples with verbal as well as visual descriptions. Upon feeling prepared, the student will complete and submit the practice problems on their own.

All of the lectures, examples and practice problems were created with Microsoft Word, due to its simple text editing properties. Also, Word included Equation Editor, which made writing integrals and other calculus concepts equally as simple. Graphics were first drawn in Corel Draw 12, then exported into .jpg files. Once in .jpg format, these graphics were imported into our Word documents.

After all of the materials in Word were created, they needed to be converted to html format for web display. We originally had chosen to use Dreamweaver and Mozilla Composer to put the material online because of their ease of use and compatibility. However, once these programs were actually put to use, several problems arose. Neither program handled the equations or graphics well when changing them to html format. Further research led to the use of MathType, an add-on to Microsoft Word's Equation

Editor. MathType allowed quick and simple html conversion of our documents without skewing graphics or equations.

Structuring the course was the next big decision in our project design. Originally, we had considered two main platforms for the online course. We could either have chosen to integrate our site into the Blackboard system, or design a free standing website that would be added to the MACS section of CSM's website. After reviewing both options, we decided to make our own site that would be uploaded into the MACS department page. While Blackboard already included a login system as well as its own hierarchy, there were many difficulties with Blackboard. First, students who would be transferring into mines or coming in as freshmen wouldn't be issued a Blackboard login until their arrival on campus; by that time, it would be too late to attempt to transfer credits. The students requesting transfer credits would have to be issued Blackboard logins prior to officially being students at CSM, or this scheme could not work. Also, Blackboard's pre-made interface was not an intuitive answer to our online course. Blackboard is geared more towards a semester long class, with student-teacher interaction rather than the self taught approach. Many of the user interface options in the Blackboard scheme simply didn't make sense for our use.

By choosing to create a free standing website, we were given the freedom of creating our own user interface. Also, this decision makes the site more widely accessible, as anyone with an internet connection and a browser can view our website. Though the login scheme had to be created from scratch, it was fairly straightforward with the use of the programming language Perl.

The layout for our site was designed to have a very simple user interface and allow quick navigation from section to section. The site contains a frame on the left side of the page which holds the outline of our website in collapsible form (see figure 1). Both calculus II and III have subsections for the topics they contain. Each topic includes a lecture, example problems, and practice problems. The student will work the practice problems out on their own paper, and when completed, they will be submitted by P.D.F. file, fax, or U.S. mail.

When the student is ready to begin a course, they will navigate to it by clicking the link of the appropriate class.

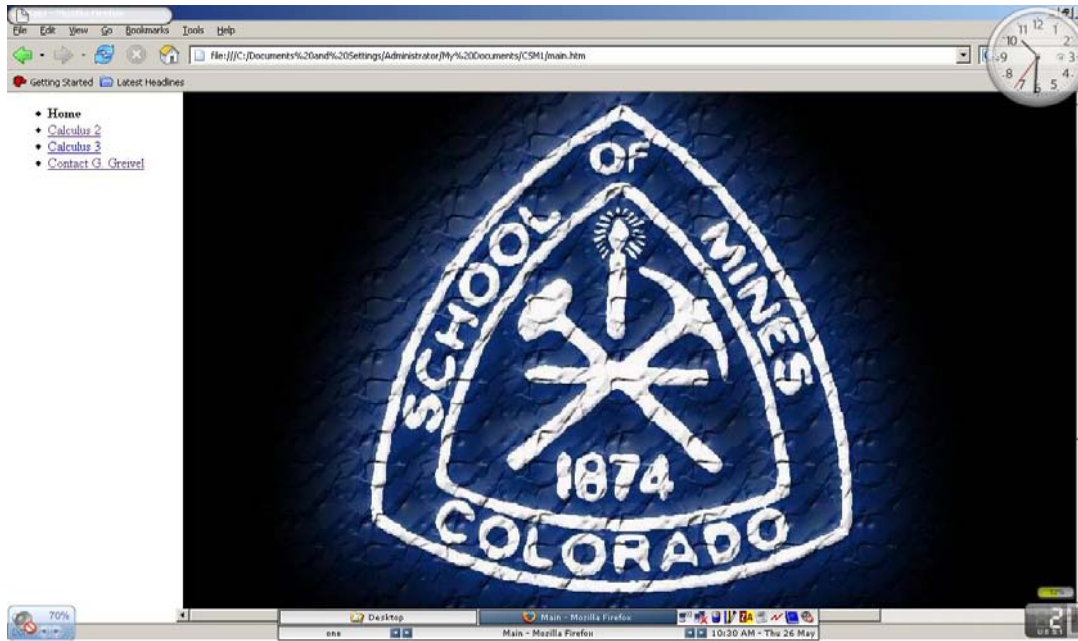


Figure 1

At that time, the class title will become bold and the list of topics for that course will be displayed. Next, the student will choose the topic they wish to study and selecting that link will open up a new submenu under the topic name with links to the lecture, example problems, and practice problems (see below).

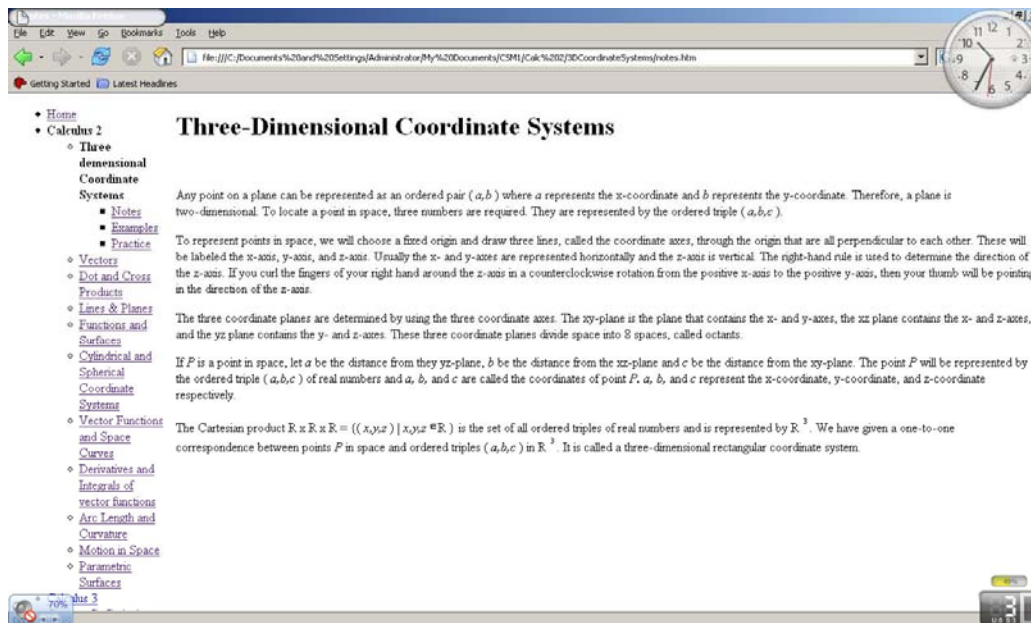


Figure 2

When any of the links are clicked, the respective web page will be loaded into the main frame on the right side of the page, where the student may begin reviewing the material. During this process of navigating through the site, the left frame will display the student's last choice. This navigation frame will only be refreshed when a link within it is selected, and won't have to be reloaded when a student is going through a lecture, for example. Figures 3 & 4 show how the page will be displayed after a student has navigated through the site and selected to work on some practice problems. Note how the left frame hasn't changed.

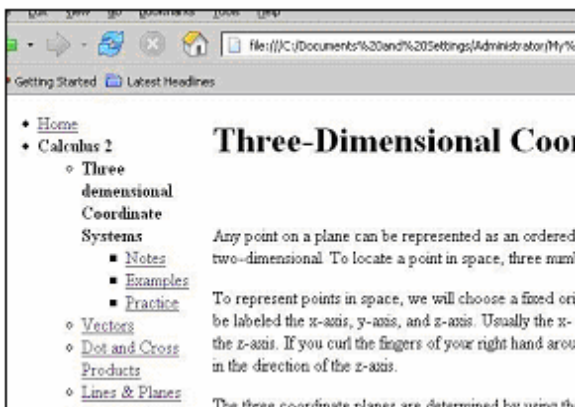


Figure 3

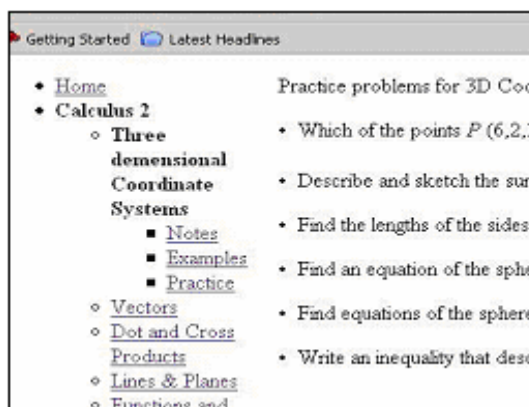


Figure 4

As the student approaches the completion of the practice problems, they will need to navigate to the "Contact G. Greivel" portion of the site (see figure 5). This link can be found at anytime and from any page within our site, and Greivel's homepage will be loaded in a new window.

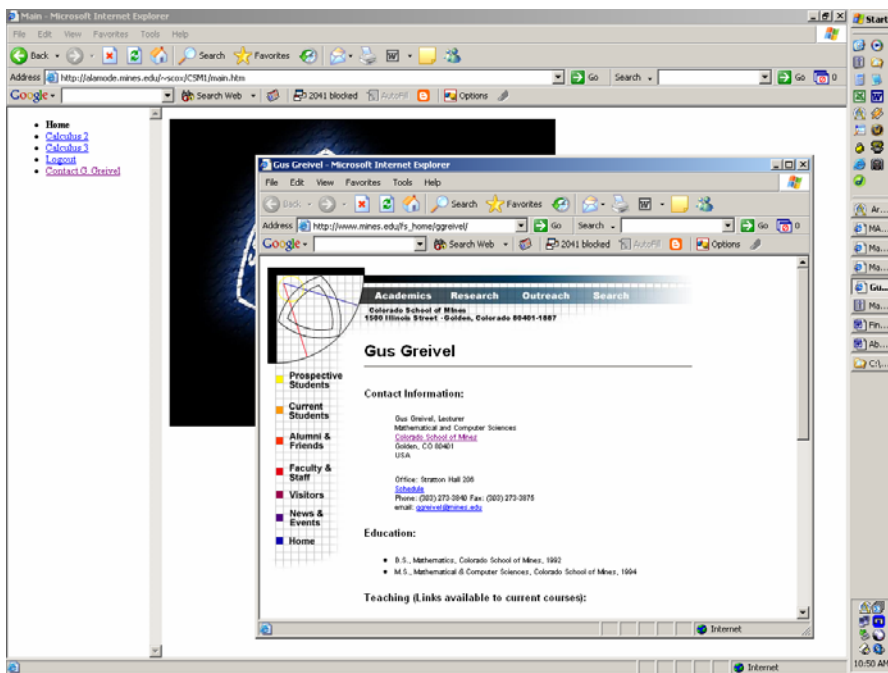


Figure 5

To prevent the material in the short course from being viewed by anyone, a login scheme was implemented. It isn't complex, but provides a barrier to those not enrolled in the course. Also, the login tracks the amount time that each student spends on the site and compiles it into a log file. This was another main goal of Greivel's, as he will use this information to help determine whether or not credits will be awarded for the course.

The scripting language Perl was used to create this functionality within our site. There are two main components: the login section and the time-tracking portion. To achieve the login capabilities, a comma separated database was implemented. When a user attempts to log in, it checks the file first to see if the login name is in the database. If it isn't, login fails. If the username is in the database, it checks to see if the password associated with that name matches the user's input. The passwords are encrypted using a built in Perl function to improve security, and when a student enters their password to gain access to the site, that entry is also encrypted. It is compared with the entry in the database, and if they match, access is granted to the site.

Upon entering the site, two cookies are created in the student's computer. One has the data about the username, the other a boolean that shows whether the user is logged in or out. Also at this time, the user's login time is written to a common log file that tracks all students' time on the site.

To prevent the user from accruing time in their log by leaving the window unattended, a JavaScript refreshes the page after 30 minutes of viewing the same page. When this automatic refresh happens, the cookies are changed; the username cookie is set to an invalid user and the login cookie is set to logged out. A logout time is printed to the log file.

Every time a page in our site is loaded, a script checks to see if the viewing computer has the two appropriate cookies. This also prevents people from directly accessing pages within our site without logging in. They are directed to the login page if their cookies don't show that a valid user is logged in.

Every time a page is loaded, the time is updated in the log file. This is helpful, because if they forget to log out, there is a general sense of the amount of time they spent on the site.

Future Directions

If and when the course needs to be updated, the process is not complex. Existing files can be edited with the combination of Microsoft Word and Equation Editor. Any .jpg file can be imported to graphically demonstrate material, whether it is found online or created by hand. Once the new document has been written, MathType will convert it directly to a webpage. The system that stores all of the files for the site is laid out in a tree format, so adding new materials means simply finding the right section and pasting the

documents that MathType creates inside. A more detailed process for editing pages is given in the user's guide.

To update all of the logins and passwords, the administrator has been given a unique login to the site. This site includes several administrator exclusive functions:

Add User: This function takes in a username and password, which will be added to the user database. From this point forward, that user will be granted access to the site as a student.

Change Password: This allows the administrator to assign any other user a new password; it takes the username whose password will be changed and the new password they will be assigned as arguments.

Check Log: When a student's username is entered, the total time that user has been on the website is displayed in hours : minutes : seconds format.

Change Admin Password: The administrator can change their password as they see fit. This function requires that the administrator type in both their current and new password to successfully update, in order to prevent accidental or unauthorized changing of the administrator password.

Remove User: This function removes one (1) user from the log file, and takes that user's name as an argument. Once executed, this prevents that user from accessing the site until re-instated by the *Add User* command. If the administrator wishes, their total time on the site can still be accessed with the *Check Log* function until *Remove All Users* is successfully run.

Remove All Users: This function clears and rewrites the log file and user database, saving only the administrator login and password. Its intended use is to clear the course after the semester is over. No other information or logins will remain after it is run. This function requires the administrator's password to be executed as to prevent accidental activation.

Results of CSM #1

After completing our task, incoming freshmen and transfer students will have a greater success rate when attempting to receive credit for Calculus II & III. Gus Greivel will also have an easier time determining acceptance of credit requests. He will be able to update the material with very minimal hardship. The ability to edit the course material is crucial, and modifying the content with new examples and practice problems seems to follow naturally.

References

Stewart, James. *Calculus: Concepts and Contexts, Second Edition*. Brooks / Cole publishers, 2001.

Finney, Ross L., Weir, Maurice D., Giordano, Frank R. *Thomas' Calculus: Early Transcendentals, Tenth Edition*. Addison Wesley Longman, 2001

Hughes-Hallett Gleason, *Calculus: Single and Multivariable*. John Wiley & Sons, 1998.

Internet & World Wide Web: How to Program , Third Edition. (New Jersey: Deitel, 2004); various code examples throughout.

The following websites provided assistance in the scripting language, Perl:

www.htmlgoodies.com

www.tiztag.com