Mathematics Program

Program Review for the
2008-2009 Academic Year
(Final draft: February 12, 2011)

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Executive Summary

The Mathematics Program within the Department of Mathematics, Physics, and Computer Science offers both B.A. and B.S. degrees in mathematics. All required coursework for majors is taught by full-time faculty, whose collective competencies cover that expected for a university level major in mathematics. Degree requirements are similar to comparison institutions, and majors are required to complete a senior project and pass a comprehensive exam to graduate. The number of majors over the past five years has fluctuated between 1 and 4 per year, but is projected to increase over the short term due to a bolus of recent new admits after the time period covered by this review. Ethnic diversity is typical of the ULV student population for Hispanics, but has been historically extremely low with respect to African-American populations. The majors are all advised by full-time faculty (at least after the matriculation process), and the mean class size for major level courses is about 12.

The learning outcomes for the mathematics major include acquiring core theoretical and applied knowledge in specific topical areas, developing abilities and attitudes related to problem solving and mathematical exploration, learning to communicate mathematical information effectively both in oral and written forms, developing a sense of the consistency, organization, and beauty inherent in mathematics, developing a sense of the interconnectedness among various branches of mathematics and universality of techniques, and preparing for positions in teaching, graduate school, or industry/government.

The assessment procedures included analysis of alumni surveys, course enrollments, senior exit exams, senior projects, course evaluations, course syllabi, and programs at our peer institutions.

The findings suggest the following:

1. Students receive solid training in the fundamental mathematical topics covered by the core courses for the major, although there is room for improvement in Linear Algebra and Abstract Algebra, which are of a more advanced nature, as well as a need for instruction in scientific computing.
2. Graduates are able to successfully seek out careers in the teaching of mathematics (primarily at high school level), in industry (non-teaching jobs), and to pursue graduate studies in mathematics for the highly qualified.
3. Students are quite happy with the small nature of their upper division classes, and for the most part, with the dedication, availability, and approachability of the faculty and the way that they feel included in the mathematical community here.
4. There is some dissatisfaction with how senior projects and comprehensive exams are currently handled. A structured senior project class (as opposed to a directed study format) and a dropping of the GRE exam are requested, as well as the opportunity to review in a more formal way for the comprehensive exams.
5. Students seek more specific preparation for, counseling, and information regarding entering the non-teaching workforce, perhaps via Career Night.

6. A computer laboratory dedicated to mathematics classes is necessary in order to keep students current in their technology skills; the C.S. labs no longer have sufficient availability. More (and nicer) dedicated space for daily student interaction is necessary.

Selected major recommendations for action are as follows:

1. Seek to obtain a computer lab dedicated to mathematics classes, so entire classes could be either taught in such a lab, or taken in as needed for demonstrations and work on sophisticated mathematical software. Also increase the available space (MA 54) for mathematics and physical science majors to gather and collaborate with each other with appropriate computing facilities at hand.
2. Continue to apply for a full-time tenure track faculty position in Math Education who could teach all sections of MATH 389 Developmental Mathematics for preparing K-8 teachers of mathematics, and a full-time non-tenure track position of instructor or lecturer to teach a eight remedial mathematics classes per year (Intermediate Algebra, College Algebra, Precalculus) and organize and administer lab sections for said classes.
3. Introduce a mandatory structured MATH 499 Senior Project class that would be taken for 4 units, but would only meet one hour per week, in order to force students to keep on schedule with their independent work and to give them a forum to discuss their work and practice presenting with other students. Publish a Senior Project Handbook in conjunction with this new course.
4. Determine whether or not to continue requiring the GRE Advanced Subject Mathematics Exam for all mathematics majors, and whether to revise the in-house departmental exam.
5. Institute required corequisite 1-unit lab courses for MATH 001, 102, 104, and possibly 170 and 105; staffing strategy unknown at this time, but could possibly be incorporated into the non-tenure track lecturer or instructor position mentioned in (2) above, in return for a load reduction.
6. Keep faculty and department web pages more up to date, more informative, and more interesting to our students.
7. Consider implementing some type of review course or workshop for students to help prepare for their senior comprehensive exam in order to boost scores and reduce first-attempt failures; also consider a workshop for CSET preparation.
8. Determine whether courses such as MATH 315 Differential Equations, MATH 328 Abstract Algebra, MATH 410 Real Analysis, MATH 351 Probability, and MATH 352 Statistical Theory should be required core classes for all mathematics majors.
9. Institute a Career Night when former alumni could return to campus and speak to majors about employment opportunities for bachelor's degree holders. It might be possible to combine this with information about graduate schools from former or current graduate students in mathematics. Provide opportunities for mathematics students to obtain internships.
10. Revisit the decision to not apply for the state subject matter program in mathematics, and either affirm the previous negative decision, or else start the application process.

I. Program Mission

The mission of the Mathematics Program is provide a basic foundation in the theory and applications within a spectrum of mathematical knowledge which will enable students to enter the workplace or graduate school with the information and tools necessary to successfully fulfill their professional aspirations. In addition, we seek to foster an appreciation of the beauty of mathematics and to demonstrate the pervasive nature of human searching for patterns and order in the world. A more detailed formal mission statement appears in Appendix A.

II. Program Goals and Learning Outcomes

Graduates of the Mathematics Program will have

1. Acquired core knowledge in:
   a. single and multivariable differential and integral calculus
   b. standard techniques of mathematical proof and their application within a framework of mathematical logic and quantifier theory
   c. fundamental set theory, function theory, and various concepts of abstraction in mathematics related to cardinality, sequences, basic probability and combinatorics
   d. linear algebra
   e. differential equations
   f. a high level computer programming language (such as C++) and a comprehensive mathematical software package (such as Mathematica, Maple, or Matlab), including significant experience with a computer algebra system (such as Mathematica or Maple)
2. Developed abilities and attitudes related to solving problems and conducting mathematical explorations, including:
   a. an attitude of persistence and a willingness to explore a variety of problem solution methods,
   b. appropriate use of technology while being mindful of inherent limitations,
   c. the ability to independently learn mathematics from written sources, and through individual mathematical investigation,
   d. the ability to work collaboratively in a group setting,
   e. the ability to apply mathematical theory and techniques to solve problems arising in diverse areas such as computer graphics, cryptography, population and epidemic modeling, biomathematics, network flows, and fluid dynamics
3. Learned to effectively communicate mathematical information both orally and in written form,
4. Developed a sense of the consistency, organization, and beauty inherent in mathematics,
5. Developed a sense of the interconnectedness of concepts in seemingly disparate fields of mathematics, as well as how techniques in one area of mathematics can be applied to solve problems in another area,

6. Prepared themselves for a position in
   a. teaching, or
   b. graduate school, or
   c. industry or government.

III. Program Description

A. Organization

The Mathematics program offers B.S. and B.A. degrees in mathematics. It is housed within the Department of Mathematics, Physics, and Computer Science, which, in turn, is part of the Natural Science Division of the College of Arts and Sciences. While budgetary matters are managed at the department level, the mathematics program is essentially autonomous and independent of the physics and computer science programs with respect to academic advising and the design and implementation of courses, degree requirements, etc., although the three programs do meet monthly to coordinate and discuss issues which impact more than one program. The Department Chair reports to the Division Chair, as well as the Dean of the College of Arts and Sciences. This division structure is unique in the university to the sciences, and is considered to be a major reason for the very close and supportive working relationships enjoyed by the included departments.

B. Faculty

Currently (2008-09) the Mathematics Program has 4 full-time and five part-time (adjunct) faculty. All of the four regular faculty have earned doctorates, (three Ph.D. and one D.A.). During the five academic years of fall 2003-spring 2008, adjunct faculty taught 137 (58%) of the 236 offered mathematics courses, significantly greater than the Arts and Sciences mean of approximately 1/3.

Faculty competencies include expertise in fluid dynamics, chaotic dynamical systems and their applications, physics of semiconductors, theoretical and computational mechanics, pedagogical issues and innovative techniques in mathematics education, real and complex function approximation theory, best rational approximations, interpolations, curve-matching, spline functions, integral computation, convergence of L1 approximations to isotonic functions, and mathematical modeling in microfluidics, fuel cells, atmospheric phenomena, biology, and environmental/wildlife/conservation problems.

C. Students and majors, minors

The number of mathematics majors has held steady over the past five years, with the exception of a decline in the last year. Table 1 below shows the numbers of both declared majors and graduates over the last five years. Over the 2003-08 period, the population of mathematics majors averaged 23.4 students and experienced a slight decline in the last year.

	2003-04	2004-05	2005-06	2006-07	2007-08
Majors*	25	25	23	24	20

Graduates	2	3	4	1	3

Table 1: 5-year enrollment and graduation numbers for ULV mathematics majors
*Unduplicated undergraduate headcount (source: ULV fact book)

The number of mathematics graduates in the last five years (13) was almost as large as for any other five-year period since 1987, with the exception of the 1991-95 period, with 14 graduates. The 15-year trend in the number of mathematics graduates is shown in Figure 1.

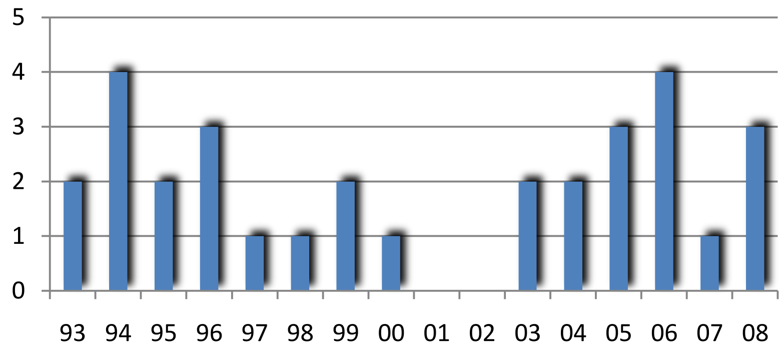

Figure 1: 15-year history of graduation rates for ULV mathematics majors
(source: ULV registrar's office)

There were 12 students graduating during this period of 5 academic years. Of the 12, nine (four B.S. and five B.A.) were female, and three (all B.A.) were male. Three were Hispanic, and the rest Caucasian.

The B.A. degree in mathematics requires completion of 41-44 semester units of mathematics courses and an additional 10 semester units of supportive requirements physics for a total of 51-54 units, as well as the completion of the second semester of a foreign language. The B.S. degree requires one more upper-division course, resulting in a total of 55-59 units (see Appendix B). Thus, students majoring in mathematics must take a total of 51-59 semester hours of mathematics and science classes. Both degrees require students to conduct a senior research project (MATH 499) and pass a senior comprehensive exam administered within the department at a preset level. Students are also required to take the GRE Advanced Subject Exam in Mathematics, although there is no minimum score required on that exam for graduation. It serves to provide a long-term assessment of the Mathematics Program. A minor is available in mathematics, with the requirements given in Appendix C.

D. Course Offerings and Schedules

Courses offered by the mathematics program may be divided into three categories: upper-division courses for mathematics majors, lower-division courses that are for both mathematics majors and that also serve as supportive requirements for other science majors, and General Education and remedial courses that service the broader ULV student population. Appendix D summarizes all the courses taught by faculty in the mathematics program. Multiple sections of remedial/General Education service courses and two sections of Precalculus and Calculus I are taught each semester, while a single section of Calculus II is offered each semester. Calculus III and Transition to Advanced

Mathematics are taught once per year, and all other upper division courses are taught once every two years (with the exception of the Senior Project, which is offered once per year).

The limited scheduling of most upper division mathematics courses is dictated by the relatively small size of the program, as there simply would not be enough students for a normal class if offered any more frequently. This does not, however, pose problems for students to complete the program within four years, as the schedule of which courses are offered in fall and spring of odd and even years is distributed to advisees and adhered to. This schedule may be found in Appendix E. A representative program of study for completion of a mathematics major within a four year time frame, with variations dependent on whether the first major course, Calculus I, is taken in the fall or spring of an odd or even year, is given in Appendix F.

E. Enrollment History

Appendix G presents the five-year enrollment history of mathematics classes. Appendix H distills some of the major trends from Appendix G to give a set of summary statistics. Overall, the average class size of the mathematics program over the last five years was 17 students. The program enrolled an average of 822 students per year and 90% (215/238) of the classes had 7 or more students. The total enrollment figures mirror rather closely the overall undergraduate university enrollment figures for this period, peaking in 2004-05 followed by a decline for several years, although the average class size in the entire program has remained steady at about 18.

F. Advising

Traditional-age mathematics majors are normally advised by regular mathematics faculty members, however a few receive their initial advising by the Academic Advising office, the Learning Enhancement Center (if matriculating with deficiencies), or Honors faculty. CAPA students have two advisors: one full-time mathematics faculty advisor who advises on all issues related to the major, and advisor from the CAPA program who advises on all other courses. New entering or transfer students are often advised by the chair during the summer months, and are told to select a new advisor later at their discretion once they get to know a faculty member better. The chair advises around 13 students, and the remainder divided roughly evenly between the other three full-time faculty.

G. Computer Labs, Library, and Other Resources

There are three primary spaces where computers are available for students to use: a computer lab in FH 206 with 12 computers, a computer lab in FH 207 with 24 computers, and a student study area in MA 54 with 4 computers. All computers are maintained by the Office of Information Technology (OIT) and so are at most three years old, and all have access to primary mathematical software such as Maple, Mathematica, Matlab, and Derive.

In addition, two high-powered workstations have been installed in an area where faculty will have full access, and mathematics students will have supervised access. The computers will facilitate faculty research into areas of fluid dynamics, microfluidics modeling, and chaotic dynamical systems which would otherwise not be practical due to the immense RAM memory and processor speeds required to carry out computations in a reasonable and practical amount of time. This research also promises to become cross-disciplinary with physics faculty in terms of granular flow and mixing studies. Mathematics students will have access to these machines in order to use them in both an exploratory mode with high resolution graphics (for example, determining and plotting the solution families of entire classes of polynomials, or delving into the relatively unexplored fractal universe of polynomial recursion formulas of degree three or higher), as well as bringing the full power of these high-powered workstations to bear on specific problems related to senior project research. The workstations will also be used to provide visual and hands-on demonstrations for classes of potential mathematicians, to showcase the clarity, elegance, and sheer ephemeral beauty of the visualization of mathematics at its finest, producing images which although they possess stunning visual impact (and insight, with the proper interpreter), generally require enormous amounts of computational power and memory to generate. These computers were made possible by STEM funds from a Title V grant.

Although the world wide web has quickly become the repository of first choice for almost all knowledge, including mathematical, there is still a very important place for mathematics books, and the mathematics holdings in Wilson Library have expanded in two ways: through continued (although declining) ordering of new books, and through expansion of the Link+ services which provide free and speedy access to millions of volume sin academic and public libraries across California. Over the past 20 years, some 420 books (list available upon request) have been requested by mathematics faculty for purchase by the library, of which at least 90% have in fact been obtained, although the numbers have dropped off to only about 15 orders in the past 5 years, due to the easy access to a multitude of books through Link+. A policy in the recent past for not ordering new books widely available through Link+ has been changed, which should lead to the acquisition of more mathematics books being ordered and residing in the local campus library here.

Finally, the student study space alluded to previously with four computers in it is actually a vital gathering place for mathematics (and physics and chemistry) majors. Equipped with old couches and chairs and a large table, it serves as a focal point for physical science and mathematics students to study together, interface with each other, brainstorm, and have the opportunity to form and be a part of a community, an act which is so critical for retention. As the need for more physics lab space grows, particularly for dealing with the nano-related work of Dr. Preisler and for more applied math/physics research space related to high-speed photography and experiments in fluid dynamics, microfluidics, and granular flows, the student study space in the front part of MA 54 may need to be taken over for lab space adjoin the current optics lab in the rear of MA 54. If this happens, it is absolutely vital that a similar student area reappear for students in another appropriate local space.

H. Update on 2004-2009 Mathematics Program Goals and Spring 2003 External Program Review Recommendations

Appendix T contains listings of both the Mathematics Program strategic planning goals for the 2004-2009 time period, and the recommendations of the last external program review team in Spring 2003, as well as responses regarding the status of each goal or recommendation.

IV. Assessing Student Attainment of Learning Objectives.

The following methods were used to assess the mathematics program learning outcomes:

A. Senior Exit Survey

A senior exit survey instrument had not existed prior to the current program review process, and one was developed during the program review year (see Appendix I), but the three mathematics students who “graduated” this year in the sense of walking in the commencement ceremony in May 2009 are all still completing their senior projects and/or senior comprehensive exams at the time of writing of this document. Since a portion of the survey includes feedback on these two aspects of the mathematics major experience, they will not be administered until the students have completed all requirements, and the results will appear on the next program review, although they will be available in a short time for the review of the mathematics faculty. No results are available for prior years since the survey is new this year.

B. Alumni Survey

All twelve alumni who graduated from 2003 to 2008 were contacted by mail in early July 2009 and asked to fill out a survey on the strengths and weaknesses of the mathematics program. We received five responses by the end of August, 2009, a 42% response rate. Early responders were entered in a drawing for a $50 Barnes and Noble gift certificate, so it is not known if the low response rate was due to some mailing addresses (obtained from the University Advancement office) being invalid, or simply low interest in responding. A copy of the survey is included in Appendix J. An analysis of both the numerical rankings and written responses performed by Michael Frantz is included in Appendix K.

C. Senior Comprehensive Exam Performance

Graduating seniors are currently required to take two different comprehensive exit exams, and to pass one of them at a minimum level in order to receive a diploma. Appendix L contains a summary analysis of the performance of graduating seniors from 1987 to 2008 on the two exams, namely, the Mathematics Subject Exam of the Graduate Record Exam (GRE), and an internal departmental exam adapted from a nationwide exam developed at Kalamazoo College. The latter exam must be passed at a minimal level for a student to be awarded a mathematics degree. An item analysis of the internal departmental exams given over the past 22 years was performed by a graduate student under the supervision of Dr. Aghop Der Karabetian, and appears in Appendix M.

D. Senior Projects

Every graduating senior must complete a MATH 499 Senior Project course, mentored by a full-time mathematics faculty member. Students may register for the course for from 1-4 units, depending on the number of units available in their schedule for that particular semester without exceeding the maximum allowed (18). Regardless of the number of units registered and paid for, there is an explicit understanding between faculty advisor and student that 4 semester units worth of work is expected. A more recent policy stipulates that students must register for the course in the fall of their senior year, rather than the more common practice in the past of taking it in the spring of the senior year. This gives the student more time to fully complete the project before the graduation ceremony in May, and also provides a better opportunity for the student to have progressed to the point where he or she is able to present a poster session on the project at the regional meeting of the Mathematical Association of America, usually occurring in March.

There are three basic types of senior projects which are presently carried out by mathematics majors. The most common situation is one in which a student explores some area of mathematics of interest which is new to the student, perhaps a subject area alluded to in a class, and which is of sufficient interest that the student is willing to devote significant time to learning more about it independently. An expository paper completely covering the mathematics learned is written and presented to an audience of mathematics majors and faculty.

A second type involves the selection of a mathematical problem of sufficiently high level which the student frames, gathers information about, and then applies both mathematical techniques learned from major courses as well as new information from independent sources in an attempt to bring about a solution to the problem. This often would take the form of a modeling problem, rather than an exercise as a pure mathematical problem. As before, a detailed and thorough paper describing the work and an oral presentation of the results are required.

Finally, perhaps one student every year or two is qualified and desires to continue their mathematical study in a graduate program, seeking either a master's degree or a doctorate. Since virtually every such program requires an undergraduate course in real analysis, which is normally not taught in the classroom here due to the small number of students requesting it as an elective, then these few students are encouraged to complete a course independently in Real Analysis for their senior project, with heavy assistance and guidance from a faculty member. Significant amounts of homework problems are assigned, and like the other two types of projects, students are required to make an oral presentation on their work and also are subjected in a questioning period to what amounts to a rather thorough oral examination. Appendix N contains a list of recent senior projects and their abstracts. Appendix O contains the instrument used to evaluate the senior project presentations of students.

At present, by decision of the mathematics faculty, there is no evaluation rubric for the written paper associated with the senior project. That portion of the evaluation of the course is left entirely up to the advisor, who works most closely with the student. In the past year, several cases have arisen where the depth, breadth, appropriateness, and overall quality of the mathematical content has been called into some question by some faculty, and it has been suggested that some kind of group faculty vetting process for senior projects might needed and appropriate.

E. Program Curriculum Comparison with Peer Institutions

ULV's mathematics program was compared with those of five peer institutions. Appendix Q presents a table comparing ULV mathematics program's core and elective classes, supportive classes and total units required with those of the comparison institutions. A summary of the major similarities and differences and possible curriculum changes to be considered is provided at the end of the appendix.

F. Curriculum Map

Courses for mathematics majors were analyzed to produce a curriculum map that shows course coverage of all the mathematics learning objectives. The curriculum map is given in Appendix R.

G. Course Evaluation Content Analysis

Dr. Aghop Der-Karabetian supervised a team of Psy. D. doctoral students to produce a content analysis of student evaluations for a randomly selected set of student responses in Fall 2006 through Spring 2008 mathematics courses. Six categories were utilized: positive and negative personal teacher characteristics, positive and negative course structure and presentation characteristics, classroom environment and student factors, and general unspecified positive and negative comments. Themes were identified within each category. Of a total of 1037 thematic responses identified, approximately 65% were positive and 35% were negative, figures which have been observed in other such content analyses.

Professors were characterized as caring, positive, nurturing, approachable, and helpful, although they had a limited variety of teaching techniques. Courses utilized helpful assignments and activities and successfully communicated content to students, but the assignments were also characterized as overly rigorous, grading was harsh, there was too much material to cover, and the pace was too fast. Other negative environmental and student factors included "other students". The full report is given in Appendix S.

H. Adjunct Faculty Survey

Appendix V contains a survey instrument administered to adjunct faculty designed to elicit information about various aspects of the teaching experience from the point of view of a part-time faculty member. It also contains a complete summary of the responses from all four participants. In summary, most comments and responses were very positive related to the warmth, smallness, and caring environment experienced at La Verne. The few negative comments focused on the lack of fringe benefits, the scarcity of parking, the lack of air conditioning in some classrooms, and various difficulties with the PT computers related to printing and passwords. When asked to rate the degree to which students developed attributes and abilities related to the mathematics learning outcomes, the faculty responded in most cases with estimates of "somewhat" to "adequate" development, but in all fairness, all of them teach courses in general education, while the learning outcomes were designed as goals for mathematics majors.

I. Examples of Professional Papers and Presentations by Faculty and Students; Grants
Appendix T contains a listing of professional papers and presentations given from faculty and students during the interval 2003 – 2009. Outcomes of selected grant submissions are also included.

J. Syllabi and Syllabus Review
An internal syllabus review was not undertaken at this time. A collection of syllabi for courses currently offered is provided in Appendix W.

K. Examples of Professional Papers and Presentations by Faculty and Students; Grants
Appendix T contains a listing of professional papers and presentations given from faculty and students during the interval 2003 – 2009. Outcomes of selected grant submissions are also included.

V. Findings

A. Learning outcome 1: Mathematics students will have acquired core knowledge in single and multivariable differential and integral calculus; standard techniques of mathematical proof and their application within a framework of mathematical logic and quantifier theory; fundamental set theory, function theory, and various concepts of abstraction in mathematics related to cardinality, sequences, basic probability and combinatorics; linear algebra; differential equations; a high level computer programming language (such as C++) and a comprehensive mathematical software package (such as Mathematica, Maple, or Matlab), including significant experience with a computer algebra system (such as Mathematica or Maple).

Graduates clearly perceive that they are acquiring core knowledge in single and multivariable differential and integral calculus and linear algebra, as self-reported on the alumni survey. The departmental senior comprehensive exam indicates that the level of knowledge, at least when tested at the end of four years of classes, may not be as extensive as perceived in these areas. There are certain mathematical topics listed above which are not tested directly by exam at the conclusion of the major, but for which it is, of course, necessary to become competent in to pass the required core courses for a mathematics major. If the departmental senior comprehensive exam is re-written, it is suggested that the questions be expanded to cover all of the mathematical topics listed in Learning Outcome 1, and that some demonstration of programming ability and use of sophisticated mathematical software be required in some fashion. There were also indications from graduates that the C++ programming course currently required does not extend deeply enough for the programming needs for mathematics majors, and that there is a need for a scientific programming course in which students would learn to use and too program in standard high-level mathematical software packages such as Matlab, Mathematics, or Maple.

B. Learning outcome 2: Mathematics students will have developed abilities and attitudes related to solving problems and conducting mathematical explorations, including: an attitude of persistence and a willingness to explore a variety of problem solution methods; appropriate use of technology while being mindful of inherent limitations; the ability to independently learn mathematics from written sources, and through individual mathematical investigation; the ability to work collaboratively in a group setting; the ability to apply mathematical theory and techniques to solve problems arising in diverse areas such as computer graphics, cryptography, population and epidemic modeling, biomathematics, network flows, and fluid dynamics.

This outcome was the one most strongly responded to by alumni in a positive fashion. It appears that the mix of required courses for the major, and the methods by which they are being taught, are satisfactorily accomplishing the goal of developing these abilities and attitudes in the students.

C. Learning outcome 3: Mathematics students will learn to effectively communicate mathematical information both orally and in written form.

Although all students must achieve this learning outcome in the process of passing MATH 305 Introduction to Advanced Mathematics, the key test of these abilities lies in the writing of a paper and the presentation of the work for the senior project. Recent senior project presentations indicate that in some cases there is still room for improvement in these areas. A structured senior project class which required students to present drafts of their work before the final presentation would certainly assist in maximizing results for this learning outcome.

D. Learning outcome 4: Mathematics majors will have developed a sense of the consistency, organization, and beauty inherent in mathematics.

Alumni self-reporting on these aspects of Learning Outcome 4 was very positive, with four of five respondents “strongly” agreeing that they had developed these three senses, and only one “somewhat” agreeing. Strong faculty advising to place mathematics majors into the interdisciplinary course CORE 320 The Mysterious Dance of Art, Mathematics, and Music would go a long way toward exposing students to the beauty inherent in mathematics on many different levels. Recent years have seen most majors enroll in that course, although it would be inadvisable to require it as a major course.

E. *Learning outcome 5: Mathematics students will have developed a sense of the interconnectedness of concepts in seemingly disparate fields of mathematics, as well as how techniques in one area of mathematics can be applied to solve problems in another area.*

This learning outcome was not directly addressed by any student examination or survey form, and most likely a question needs to be added on the survey for graduating seniors, as well as the alumni survey form, as it is not the type of sense or ability that can easily be tested for. There really is no finding available at this time for this outcome.

F. Learning outcome 6: Mathematics students will have prepared themselves for a position in teaching, or graduate school, or industry or government.

Of the 15 mathematics graduates in the 2003-2008 time period, two are currently enrolled in Ph.D. programs at U.C. Irvine and Claremont Graduate University, one is finishing an M.B.A. degree at Cal State Fullerton, one is employed by the financial consulting arm of a major bank, one is employed in the engineering division of an international gaming corporation in of Las Vegas, 8 are teaching in high schools both locally and outside of the state, one is employed by an architecture firm, and one is of unknown employment status. Having two students be accepted by Ph.D. programs in mathematics within just a two year period is quite an improvement over the four students who had gone on to earn master's degrees in the previous 20 year period. Although this is a record of placement that is quite enviable for our program, there were a few comments from alumni about better preparation needed for students to enter the mathematics workplace. It is not clear if this was aimed at better career information being needed, or courses more focused on specific mathematical areas of more utility for graduates seeking jobs in the workplace with just a bachelor's degree in mathematics.

VI. Recommendations for Action

11. Seek to obtain a computer lab dedicated to mathematics classes, so entire classes could be either taught in such a lab, or taken in as needed for demonstrations and work on sophisticated mathematical software. Also increase the available space (MA 54) for mathematics and physical science majors to gather and collaborate with each other with appropriate computing facilities at hand. The first of these requests is tantamount to a request for a new science building, since there is currently no possibility for such space.

12. Continue to apply for a full-time tenure track faculty position in Math Education who could teach all sections of MATH 389 Developmental Mathematics for preparing K-8 teachers of mathematics, and a full-time non-tenure track position of instructor or lecturer to teach a eight remedial mathematics classes per year (Intermediate Algebra, College Algebra, Precalculus) and organize and administer lab sections for said classes.

13. Introduce a mandatory structured MATH 499 Senior Project class that would be taken for 4 units, but would only meet one hour per week, in order to force students to keep on schedule with their independent work and to give them a forum to discuss their work and practice presenting with other students. It would help build confidence in the students' ability to work independently in mathematics, and could also serve as a forum for faculty to disseminate career and graduate school information. Publish a Senior Project Handbook in conjunction with this new course.

14. Determine whether or not to continue requiring the GRE Advanced Subject Mathematics Exam for all mathematics majors, and whether or not to re-write the in-house departmental exam.

15. Institute required corequisite 1-unit lab courses for MATH 001, 102, 104, and possibly 170 and 105; staffing strategy unknown at this time, but could possibly be incorporated into the non-tenure track lecturer or instructor position mentioned in (2) above, in return for a load reduction.

16. Keep faculty and department web pages more up to date, more informative, and more interesting to our students.

17. Obtain easy access for all (part-time and full-time) faculty to check math placement test scores for students in remedial math classes.

18. Re-examine the Calculus II-III sequencing to make sure that it is serving our students as well as possible.

19. Actively seek out possibilities for enhancing the success of incoming STEM freshmen by being willing to participate in summer math camp activities

20. Consider whether or not to require probability and statistics in some form for mathematics majors.

21. Reexamine all prerequisites for mathematics courses, particularly courses for majors, such as possibly recruiting MATH 311 Calculus III students for MATH 351 Probability.

22. Consider developing a new general education mathematics (quantitative reasoning) course, or changing the content of MATH 104 to a more modeling-based curriculum, centered on environmental concerns.

23. Seek out ways to obtain tutors for more advanced mathematics classes, and/or work with professors to make them easier to talk to.

24. Work to maintain high MATH 170 enrollments as the most appropriate general education mathematics course for most students.

25. Consider implementing some type of review course or workshop for students to help prepare for their senior comprehensive exam in order to boost scores and reduce first-attempt failures; also consider a workshop for CSET preparation.

26. Determine whether MATH 315 Differential Equations, MATH 328 Abstract Algebra, and MATH 410 Real Analysis should be required core classes for all mathematics majors.

27. Institute a Career Night when former alumni could return to campus and speak to majors about employment opportunities for bachelor’s degree holders. It might be possible to combine this with information about graduate schools from former or current graduate students in mathematics. Provide opportunities for mathematics students to obtain internships.

28. Forcefully recommend that all students take CORE/INTD 320 The Mysterious Dance of Art, Mathematics, and Music.

29. Determine how to better evaluate learning outcome 5 on the interconnectedness of subfields within mathematics, perhaps via questions on the graduating senior surveys or alumni surveys.

30. Make it a habit to select several goals each May or August to focus on addressing for the upcoming academic year.

31. Institute an annual retreat of mathematics faculty to discuss key issues related to the program.

32. Encourage faculty to seek out course release time from the administration for research projects and curriculum development during the year or summer.

33. Revisit the decision to not apply for the state subject matter program in mathematics, and either affirm the previous negative decision, or else start the application process.

34. Keep evaluating web-based online tutoring systems to see whether they might be appropriate for use by the Learning Enhancement Center, and encourage experimentation by faculty of online-based homework systems.

35. Promote collegial visits by faculty within the program, low-stress, with no written report, and a follow-up lunch to discuss the visit.

APPENDICES

Appendix A: Mathematics Program Mission Statement

Mathematics is a universal language, a part of the common base of knowledge through which people of different races, nationalities, and cultures can communicate.

While acknowledging that some students may never make use of all of the specific mathematical techniques learned in our courses, and others will use very few techniques, we also recognize that mathematics has historically been a central part of the liberal arts. The educated person studies mathematics for the discipline it brings to one's thinking and because knowledge of mathematics enables one to better comprehend an increasingly technological world and to understand those who speak the scientific languages of nature and technology.

In our liberal arts mathematics courses for non-majors, we emphasize basic skills, as well as applications of mathematics in various career areas. An underlying philosophy of our teaching is that students enjoy more, and derive more benefit from, that which is fun, and well as from that which they clearly see a need to investigate.

In all of our courses we try to foster an appreciation of the beauty of mathematics and to demonstrate the nature of human searching for patterns and order in the world.
y upholding certain standards while remaining sympathetic to the difficulty many students have in mathematics, we stress ethics and disciplined study, as well as humanity.

In small classes and directed studies, we encourage students to take on increased responsibility for their own education, to seek knowledge actively, rather than to receive it passively.

Those who major in mathematics may not spend their lives as professional mathematicians, so we teach skills and attitudes which are transferable, which will serve students well in any situation requiring problem-solving, synthesis and persistence. We encourage students to wonder and ask not only “how?” but also “why?” At the same time, we provide a solid grounding in a core of mathematics, to enable those who are singularly motivated to pursue graduate studies.

Many ULV mathematics majors are motivated to serve society through teaching, while others have taken technical positions in industry. Many mathematics majors also seek a second area of concentration. Recent graduates have done significant course work in biology, computer science, economics, physics, and even psychology.

Appendix B: Mathematics B.A. and B.S. Degree Requirements

Core Requirements

MATH 201 Calculus I (4 units)
MATH 202 Calculus II (4 units)
MATH 311 Calculus III (4 units)
MATH 305 Transition to Advanced Mathematics (4 units)
MATH 320 Linear Algebra (4 units)

Supportive Requirements

CMPS 367 Object Oriented Programming Using C++ (4 units) (prereq.: CMPS 301)
PHYS 203 Physics I (with lab, 203L -- 5 units)
PHYS 204 Physics II (with lab, 204L -- 5 units)
Second semester of a foreign language

Additional Requirements for the B.A. (one each of the following two pairs)

MATH 319 Vector Calculus (4 units)
or
MATH 328 Abstract Algebra (4 units)

MATH 325 Number Theory (4 units)
or
MATH 351 Probability (4 units)

Electives for the B.A.: A minimum of 8 semester units in upper-division mathematics courses.

Additional Requirements for the B.S.

MATH 315 Differential Equations (4 units)
MATH 328 Abstract Algebra (4 units)

Electives for the B.S.: A minimum of 12 semester units in upper-division mathematics courses.

Culminating Requirements:

MATH 499 Senior Project (1-4 units)
Comprehensive Examinations – Departmental Exam *and* GRE Advanced Subject Exam in Mathematics (0 units)

Total unit requirements: 41-44 units for the B.A., or 45-48 units for the B.S., plus 10 units for supporting courses (not including foreign language units).

Appendix C: Mathematics Minor Requirements

Suggested Option 1		**Suggested Option 2**	
Math 201	Calculus I		
Math 202	Calculus II		
Math 311	Calculus III	Math 311	Calculus III
Math 305	Transition to Advanced Math.	Math 305	Transition to Advanced Math.
Math 320	Linear Algebra	Math 320	Linear Algebra
or		***or***	
Math 328	Abstract Algebra	Math 328	Abstract Algebra

Plus 1 upper division elective (4 units)

Total: 24 semester hours, including 16 hours of upper division work.

Plus 2 upper division electives (8 units)

Total: 20 semester hours of upper division work.

Notes:

- The exact program of courses must be worked out ***with the approval of a faculty member in the department***. A minor contract must be filed with the Registrar.
- Courses included on the major contract cannot be used on the minor contract.
- Other combinations of courses are possible, subject to appropriate approval.

Appendix D: Mathematics Courses Currently Offered

MATH 001: Math Workshop
MATH 102: Intermediate Algebra
MATH 104: College Algebra
MATH 105: Precalculus
MATH 150: Elementary Statistics
MATH 170: Mathematics in Society
MATH 172: Mathematical Methods for Business and Economics
MATH 172L: Mathematical Methods for Business and Economics Lab
MATH 201: Calculus I
MATH 202: Calculus II
MATH 305: Transition to Advanced Mathematics
MATH 311: Calculus III
MATH 315: Differential Equations
MATH 319: Vector Calculus
MATH 320: Linear Algebra
MATH 325: Number Theory
MATH 327: Discrete Mathematics
MATH 328: Abstract Algebra
MATH 330: Foundations of Geometry (by Directed Study only)
MATH 351: Probability
MATH 352: Statistical Theory (by Directed Study only)
MATH 362: Numerical Algorithms
MATH 375: Mathematical Modeling
MATH 389: Developmental Mathematics
MATH 410: Real Analysis (by Directed Study only)
MATH 412: Complex Analysis (by Directed Study only)
MATH 418: Advanced Engineering Mathematics (by Directed Study only)
MATH 482: History of Mathematics
CORE 320: The Mysterious Dance of Art, Mathematics and Music

Appendix E: Two-Year Cycle for Mathematics Courses; Course Rotation Plan

Offered Fall Even Years (Fall, 2010)	**Offered Fall Odd Years (Fall, 2009)**
1. MATH 001: Math Workshop	1. MATH 001: Math Workshop
2. MATH 102: Intermediate Algebra	2. MATH 102: Intermediate Algebra
3. MATH 104: College Algebra	3. MATH 104: College Algebra
4. MATH 105: Precalculus	4. MATH 105: Precalculus
5. MATH 170: Mathematics in Society	5. MATH 170: Mathematics in Society
6. MATH 172: Math. Methods in Bus/Econ	6. MATH 172: Math. Methods in Bus/Econ
7. MATH 201: Calculus I	7. MATH 201: Calculus I
8. MATH 202: Calculus II	8. MATH 202: Calculus II
9. MATH 210: Intro. to Computer Utilization	9. MATH 210: Intro. to Computer Utilization
10. MATH 301: Programming Concepts	10. MATH 301: Programming Concepts
11. MATH 311: Calculus III	11. MATH 311: Calculus III
12. MATH 328: Abstract Algebra	12. MATH 320: Linear Algebra
13. MATH 482: History of Mathematics	13. MATH 375: Mathematical Modeling
14. MATH 489: Developmental Math	14. MATH 489: Developmental Math
15. MATH 499: Senior Project, Exams	15. MATH 499: Senior Project, Exams
Offered January Odd Years (Jan., 2011)	**Offered January Even Years (Jan., 2010)**
1. MATH 170: Mathematics in Society	1. MATH 170: Mathematics in Society
Offered Spring Odd Years (Spring, 2011)	**Offered Spring Even Years (Spring, 2010)**
1. MATH 001: Math Workshop	1. MATH 001: Math Workshop
2. MATH 102: Intermediate Algebra	2. MATH 102: Intermediate Algebra
3. MATH 104: College Algebra	3. MATH 104: College Algebra
4. MATH 105: Precalculus	4. MATH 105: Precalculus
5. MATH 170: Mathematics in Society	5. MATH 170: Mathematics in Society
6. MATH 172: Math. Methods in Bus/Econ	6. MATH 172: Math. Methods in Bus/Econ
7. MATH 201: Calculus I	7. MATH 201: Calculus I
8. MATH 202: Calculus II	8. MATH 202: Calculus II
9. MATH 210: Intro. to Computer Utilization	9. MATH 210: Intro. to Computer Utilization
10. MATH 301: Programming Concepts	10. MATH 301: Programming Concepts
11. MATH 305: Transition to Advanced Math.	11. MATH 305: Transition to Advanced Math.
12. MATH 315: Differential Equations	12. MATH 327: Discrete Mathematics
13. MATH 327: Discrete Mathematics	13. MATH 319: Vector Calculus
14. MATH 351: Probability	14. MATH 325: Number Theory
15. MATH 489: Developmental Math	15. MATH 489: Developmental Math
16. MATH 499: Senior Project, Exams	16. MATH 499: Senior Project, Exams

red = core requirement for all math majors; green = required course for the B.S. in math; blue = one of several choices of required courses for the B.A.: one of Vector Calculus or Abstract Algebra, and one of Number Theory or Probability. Senior comprehensive exams are required for all students. Note that CMPS 367 C++ (with a prerequisite of CMPS 301) and PHYS 203/204 Engineering Physics I and II are also required as supporting courses, and should be worked in during lighter semesters. CMPS 301 and CMPS 367 are each offered every fall and spring. PHYS 203 and PHYS 204 are offered every fall and spring, respectively. Two additional elective courses (8 units) are required for the B.A., and three additional elective courses (12 units) are required for the B.S. Selected other (electives) are in parentheses. Other classes not listed, such as Foundations of Geometry, or Mathematical Statistics, may be taken as directed studies, or may be offered if a sufficient number of students show an interest.

Four Year Course Rotation Plan

Subject	Course	Title	Fall 1	Spring 1	Fall 2	Spring 2	Fall 3	Spring 3	Fall 4	Spring 4
MATH	001	Mathematics Workshop	1	0	1	0	1	0	1	0
MATH	102	Intermediate Algebra	6	3	6	3	6	3	6	3
MATH	104	College Algebra	7	5	7	5	7	5	7	5
MATH	105	Precalculus	2	2	2	2	2	2	2	2
MATH	170	Mathematics in Society	1	0	1	0	1	0	1	0
MATH	172	Math Methods for Bus & Econ	3	2	3	2	3	2	3	2
MATH	201	Calculus I	2	2	2	2	2	2	2	2
MATH	202	Calculus II	1	1	1	1	1	1	1	1
MATH	305	Transition to Advanced Math	0	1	0	1	0	1	0	1
MATH	311	Calculus III	1	0	1	0	1	0	1	0
MATH	315	Differential Equations	0	0	0	1	0	0	0	1
MATH	319	Vector Calculus	0	1	0	0	0	1	0	0
MATH	320	Linear Algebra	1	0	0	0	1	0	0	0
MATH	325	Number Theory	0	1	0	0	0	1	0	0
MATH	327	Discrete Mathematics	0	1	0	1	0	1	0	1
MATH	328	Abstract Algebra	0	0	1	0	0	0	1	0
MATH	330	Foundations of Geometry	DS	DS	DS	DS	DS	DS	DS	DS
MATH	342	Analytical Mechanics (see PHYS 342)	1	0	0	0	1	0	0	0
MATH	351	Probability	0	0	0	1	0	0	0	1
MATH	352	Statistical Theory	DS	DS	DS	DS	DS	DS	DS	DS
MATH	362	Numerical Algorithms	DS	DS	DS	DS	DS	DS	DS	DS
MATH	375	Mathematical Modeling	1	0	0	0	1	0	0	0
MATH	389	Developmental Math	2	2	2	2	2	2	2	2
MATH	482	History of Mathematics	0	0	1	0	0	0	1	0
MATH	499	Senior Project	DS	DS	DS	DS	DS	DS	DS	DS

Appendix F: Four-Year Suggested Schedules for Math Majors

Fall Even Year 1 Calculus I	**Fall Odd Year 1** Calculus I	**Spring Even Year 1** Calculus I	**Spring Odd Year 1** Calculus I
January Odd Year 1 non-math electives	**January Even Year 1** non-math electives	**Fall Even Year 2** Calculus II (History of Math)	**Fall Odd Year 2** Calculus II
Spring Odd Year 1 Calculus II	**Spring Even Year 1** Calculus II	**January Odd Year 2** non-math electives	**January Even Year 2** non-math electives
Fall Odd Year 2 Calculus III	**Fall Even Year 2** Calculus III (History of Math)	**Spring Odd Year 2** Trans. to Adv. Math (Probability)	**Spring Even Year 2** Trans. to Adv. Math
January Even Year 2 non-math electives	**January Odd Year 2** non-math electives	**Fall Odd Year 3** Calculus III Linear Algebra (Math. Modeling)	**Fall Even Year 3** Calculus III (Abstract Algebra) (History of Math)
Spring Even Year 2 Trans. to Adv. Math (Vector Calculus) (Number Theory) (Discrete Math)	**Spring Odd Year 2** Trans. to Adv. Math (Differential Eqns) (Probability) (Discrete Math)	**January Even Year 3** non-math electives	**January Odd Year 3** non-math electives
Fall Even Year 3 (Abstract Algebra) (History of Math)	**Fall Odd Year 3** Linear Algebra (Math. Modeling)	**Spring Even Year 3** (Vector Calculus) (Number Theory) (Discrete Math)	**Spring Odd Year 3** (Differential Eqns) (Probability) (Discrete Math)
January Odd Year 3 non-math electives	**January Even Year 3** non-math electives	**Fall Even Year 4** (Abstract Algebra) (History of Math)	**Fall Odd Year 4** Linear Algebra (Math. Modeling)
Spring Odd Year 3 (Differential Eqns) (Probability) (Discrete Math)	**Spring Even Year 3** (Vector Calculus) (Number Theory) (Discrete Math)	**January Odd Year 4** non-math electives	**January Even Year 4** non-math electives
Fall Odd Year 4 Linear Algebra (Math. Modeling)	**Fall Even Year 4** (Abstract Algebra) (History of Math)	**Spring Odd Year 4** Senior Project, Exams (Differential Eqns) (Probability) (Discrete Math)	**Spring Even Year 4** Senior Project, Exams (Vector Calculus) (Number Theory) (Discrete Math)
January Even Year 4 non-math electives	**January Odd Year 4** non-math electives		
Spring Even Year 4 Senior Project, Exams (Vector Calculus) (Number Theory) (Discrete Math)	**Spring Odd Year 4** Senior Project, Exams (Differential Eqns) (Probability) (Discrete Math)		

red = core requirement for all math majors; green = required course for the B.S. in math; blue = one of several choices of required courses for the B.A.: one of Vector Calculus or Abstract Algebra, and one of Number Theory or Probability. Senior comprehensive exams are required for all students. Note that CMPS 367 C++ (with a prerequisite of CMPS 301) and PHYS 203/204 Engineering Physics I and II are also required as supporting courses, and should be worked in during lighter semesters. CMPS 301 and CMPS 367 are each offered every fall and spring. PHYS 203 and PHYS 204 are offered every fall and spring, respectively. Two additional elective courses (8 units) are required for the B.A., and three additional elective courses (12 units) are required for the B.S. Selected other (electives) are in parentheses. Other classes not listed, such as Foundations of Geometry, or Mathematical Statistics, may be taken as directed studies, or may be offered if a sufficient number of students show an interest.

Appendix G: Main Campus Class Enrollments (Fall 2003 - May 2008)

	units	2003-2004			2004-2005			2005-2006			2006-2007			2007-2008			Avg per:	
		F	J	S	F	J	S	F	J	S	F	J	S	F	J	S	cls	yr
General Education / Service																		
MATH 001 Mathematics Workshop	2	9			10			16			9		12	13			12	14
MATH 102 Intermediate Algebra (1)	4	11		16	23		13	16		9	20		22	25		22	18	151
MATH 102 Intermediate Algebra (2)	4	20		19	24		13	23		7	21		21	25		24		
MATH 102 Intermediate Algebra (3)	4	16			18		21	23		11	25			23				
MATH 102 Intermediate Algebra (4)	4	23			23			19		12	25			19				
MATH 102 Intermediate Algebra (5)	4	11			20			19			18			19				
MATH 102 Intermediate Algebra (6)	4	11			16			10										
MATH 104 College Algebra (1)	4	25		23	25		19	32		21	18		17	20		26	23	278
MATH 104 College Algebra (2)	4	26		29	29		21	23		33	26		20	26		27		
MATH 104 College Algebra (3)	4	30			31		29	11		24	29		25	24		26		
MATH 104 College Algebra (4)	4	20		15	28		33	30		17	24		27	29		19		
MATH 104 College Algebra (5)	4	20		18	30		20	28		15	26		19	25		21		
MATH 104 College Algebra (6)	4	25		12	23		17	27			11			27				
MATH 104 College Algebra (7)	4	18			15			27			10							
MATH 105 Precalculus (1)	4	26		8	26		9	26		17	27		18	14		6	18	76
MATH 105 Precalculus (2)	4	18		17	16		16	31		19	28		4	28		7		
MATH 105 Precalculus (3)	4													18				
MATH 170 Math in Society	4	8	6		9	4		12						13			9	13
MATH 172 Business Methods (1)	4	24		17	32		24	28		22	22		20	23		15	21	86
MATH 172 Business Methods (2)	4	13			25		13	25		11	9		21	21		26		
MATH 172 Business Methods (3)	4										16			24				
Total Enrollment		354	6	174	423	4	248	426	0	218	364	0	226	416	0	219	100	
Average Class Size		19	6	17	22	4	19	22		17	20		19	22		20	17	
Lower Division																		
MATH 201 Calculus I (1)	4	18		10	24		7	24		5	16		4	13		6	14	57
MATH 201 Calculus I (2)	4	12		11	16		20	12		24	22		20	14		9		
MATH 202 Calculus II	4	10		14	11		14	5		9	7		6	10		13	10	20
Total Enrollment		40	0	35	51	0	41	41	0	38	45	0	30	37	0	28	24	77
Average Class Size		13		12	17		14	14		13	15		10	12		9	12	39
Upper Division																		
MATH 305 Transition to Adv. Math	4			6			7			7			7			3	6	6
MATH 311 Calculus III	4	4			8			7			8			6			7	7
MATH 315 Differential Equations	4						3						6				5	5
MATH 319 Vector Calculus	4			4						9						5	6	6
MATH 320 Linear Algebra	4	9						7						10			9	9
MATH 325 Number Theory	4			3												8	6	6
MATH 327 Discrete Mathematics	4			29			16			12			12			7	15	15
MATH 328 Abstract Algebra	4				4						7						6	6
MATH 351 Probability	4						7						2				5	5
MATH 375 Mathematical Modeling	4	2						5									4	4
MATH 389 Developmental Math (1)	4	22		14	27		21	15		22	26		25	17		21	18	81
MATH 389 Developmental Math (2)	4	20		9	24		21	18		19	19		24	19		10		
MATH 389 Developmental Math (3)	4	3					7											
MATH 482 History of Mathematics	4		10								2						6	6
Total Enrollment		60	10	65	63	0	82	52	0	69	62	0	76	52	0	54	90	153
Average Class Size		10	10	11	16		12	10		14	12		13	13		9	8	13
Totals For All Classes																		
Total Enrollment for All Classes		454	16	274	537	4	371	519	0	325	471	0	332	505	0	301		822
Average Class Size		16	8	14	21	4	16	19		15	18		16	19		15		
Total Enrollment by Year			744			912			844			803			806			822
Average Class Size by Year			15			18			18			17			18			17

Appendix H: Summary Statistics of Course Enrollments

Total Enrollment

	2003-04	2004-05	2005-06	2006-07	2007-08
GE/Service	534	675	644	590	635
Lower division	75	92	79	75	65
Upper division	135	145	121	138	106
Total	**744**	**912**	**844**	**803**	**806**

Average Class Size

	2003-04	2004-05	2005-06	2006-07	2007-08
GE/Service	18	21	20	20	21
Lower division	13	16	14	13	11
Upper division	11	14	12	13	11
Total	**15**	**18**	**18**	**17**	**18**

Number of Classes with 7 or More Students

	2003-04	2004-05	2005-06	2006-07	2007-08
GE/Service	29	32	32	29	29
Lower division	6	6	4	4	5
Upper division	6	9	9	8	7
Total	**41**	**47**	**45**	**41**	**41**

Number of Classes with Less than 7 Students

	2003-04	2004-05	2005-06	2006-07	2007-08
GE/Service	1	1	0	1	1
Lower division	0	0	2	2	1
Upper division	5	2	1	3	3
Total	**6**	**3**	**3**	**6**	**5**

Number of Directed Studies and Senior Projects

	2003-04	2004-05	2005-06	2006-07	2007-08
Directed Studies	5	4	5	8	2
Senior Projects	3	3	4	4	6

Appendix I: Senior Exit Survey Form

Survey for Seniors Graduating from the ULV Mathematics Program

1. **Educational Background**
   In which year and where did you obtain your high school degree? (Optional)
   Year___________ School_______________________________

   How many years did it take you to complete your college degree program?
   (Optional) _______

1. **Academic Program**
   Rate the extent to which you agree or disagree with the following statements concerning your education in the mathematics program at the University of La Verne.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Not Applicable
1	I was satisfied with the academic standards of the mathematics program.						
2	My math courses typically had a sufficient number of examples of real world applications.						
3	I was satisfied with the mathematical knowledge of the faculty.						
4	I had supportive faculty available to supervise and help me.						
5	I feel that the mathematics program prepared me appropriately for a career or further study in mathematics.						

Feel free to comment on any of the above questions.

____
____
____
____
____

List two of your favorite mathematics courses and comment on why they were your favorites: (1)_____________________________ (2)_____________________________

____
____
____
____
____

List two mathematics courses that you found the least interesting, and explain why.
(1)________________________________ (2)________________________________
____
____
____
____

3. Academic Environment

Rate the extent to which the following academic facilities and services were adequate for your needs during the program. Please indicate if you did not use or need the facility or service.

	Very Adequate	Adequate	Inadequate	Very Inadequate	Not Applicable
Wilson Library facilities/space					
Computer facilities (hardware, software, hours of accessibility)					
Availability of help with computer facilities					
Access to tutors for mathematics related problems					

4. Learning about the Mathematics Program

How did you learn about the mathematics program at the University of La Verne?

	Newspaper advertisement
	The university website
	From a friend
	From a faculty member of the department
	Through other means (please specify):

Please explain briefly your reasons for choosing this program at the University of La Verne.
____
____
____

5. Challenges to Completing the Program

What obstacles did you encounter while pursuing your mathematics program?
(Please mark all that apply.)

	Lack of support from my family
	Lack of support from my friends
	Lack of time due to job or other activities
	Inadequate mathematical preparation
	More difficult mathematical content than expected
	Other (please specify):
	I did not face any difficulties

Comments:

____
____
____
____

6. Would you recommend this mathematics program to a friend or a prospective student?

[ ] Yes [ ] No

Comments:

____
____
____
____

7. Summary Questions

	Excellent	Satisfactory	Poor
How would you rate your overall experience with the mathematics program?			
How would you rate your overall experience at the University of La Verne?			

	definitely yes	maybe	definitely no
Would you choose to do the same program if you had it to do all over again? If not, state the major or school you would be more interested in. ________________________ ____			

Comments on any aspects of your responses to the above three questions:

____
____
____
____

List up to three topics you would have liked included in your math program.

1. ____
2. ____
3. ____

If you could change one thing related to the mathematics program that would have made your experience more successful or fulfilling, what would it be?

____
____
____
____

If you have any additional suggestions for improving the mathematics program to help future graduates, please share them with us.

Thank you for your participation. If you have any other comments that you wish to add, please feel free to write them out on the back or on a separate sheet of paper and attach it to this form.

5/12/10

Appendix J: Mathematics Alumni Survey Form

Survey for Alumni Graduating from the ULV Mathematics Program

Greetings, and thank you very much for taking the time to respond to the questions below. The purpose of this survey is to seek your feedback on various aspects of the mathematics program you experienced while you earned your mathematics degree. This will help us to identify features and characteristics that should be retained and to also identify areas that need strengthening, modifying, or eliminating. Please return this page with your responses in the enclosed pre-addressed, stamped envelope. The Natural Sciences secretary will remove the responses and discard the envelopes, so unless you choose to identify yourself, there will be no way for the mathematics faculty to know the identity of any respondents. We would like to have the responses mailed back to the office within two weeks of when you receive this. As a little incentive, we will hold a drawing for a $50 gift certificate from Barnes and Noble bookstore for anybody whose response we receive by July 24. Since this is going out to just 12 “relatively recent” graduates, your odds are pretty good for actually winning this contest – do the math! [How will we know if you should be entered in the drawing? The science office coordinator will assign a random number to your form (see upper right corner of this paper); only <u>she</u> will know the bijection linking the names and numbers, and she will give us the numbers returned by July 24 (as well as record the responses) and we will hold the drawing, at which point she will tell us who won, and we will mail you your certificate.] In your responses, please consider all aspects of the program, including the faculty, advising, core courses required, elective mathematics classes, directed studies, senior projects, comprehensive exams, relationships to faculty and other mathematics majors; i.e., the whole spectrum of what it means to be a mathematics major at ULV. The time you spend reflecting on your experience, and your honest answers, will help us to make the experience and outcome better for future mathematics students. You can help us to do this!

Please respond to the following statements related to the ULV mathematics program, circling the number which most closely matches your feelings, based on the scale

1=strongly <u>disagree</u> 2=disagree somewhat 3= neutral opinion 4= agree somewhat 5=strongly <u>agree</u>

1 2 3 4 5 1. I acquired core knowledge in calculus and other fundamental subjects, including techniques of proof.

1 2 3 4 5 2. My ULV math courses helped me develop an attitude of persistence (not giving up too easily) and a willingness to explore a variety of problem-solving methods.

1 2 3 4 5 3. I feel like I gained a sense of the consistency, organization, and beauty inherent in mathematics.

1 2 3 4 5 4. The University of La Verne prepared me mathematically for my future.

1 2 3 4 5 5. While at ULV, I learned <u>how</u> to use technology (such as calculators and computers) appropriately in solving problems and also gained an appreciation of the <u>limitations</u> of technology.

1 2 3 4 5 6. I feel like the ULV mathematics program helped me learn to read and explore mathematics by myself.

(Please be as specific as possible in answering the following questions. Attach extra pages if necessary.)

7. What were your expectations of the mathematics program when you first enrolled?

8. Were these expectations met? If not, why not?

9. What are the <u>strengths</u> of the ULV mathematics program?

10. What are the <u>weaknesses</u> of the ULV mathematics program?

11. With regard to the mathematics course load, and how many math courses you took each semester, was the program too hard, too easy, or about right?

12. Which courses do <u>you</u> think should be required for all math majors, and which ones should be available as electives?

13. Which current classroom courses should be offered directed study, and which currently offered only by directed study should be classroom courses?

14. Overall, how do you feel about your experience with the ULV mathematics program?

15. What other comments do you have about the ULV mathematics program, including (but not limited to) the questions posed above? (Please feel free to make additional specific comments on questions 1-6, as well as the other questions.)

Once again, thank you very much for your participation. If you have any other comments that you wish to add, please feel free to write them out on the back or on a separate sheet of paper and attach it to this form.

Sincerely,

Michael Frantz
Chair, Math/Physics/Computer Science Department

Appendix K: Summary of Alumni Survey Results for 2003-2008 Alumni

This survey was conducted in the summer of 2009. Just five of twelve surveys mailed out were returned, even with the enticement of entry into a drawing for a $50 Barnes and Noble gift certificate for each returned survey. The entire set of responses is at the end of this appendix, for reference.

The responses regarding success in achieving six aspects of the learning outcomes all fell into the “somewhat agree” and “strongly agree” categories, which although gratifying, is perhaps less helpful due to the imprecise nature of the word “somewhat”, and perhaps the scale should be adjusted the next time the survey is done. Ideally, all responses would have fallen into the “strongly agree” category. How to achieve this? The questions with the most (3) “somewhat agree” responses referred to (1) preparing students mathematically for their futures, and to (2) preparing students to read and learn mathematics independently. This may indicate a need to adjust required courses to make the mathematics more meaningful for the bachelor’s degree job market (more experience in computational programming? statistics?) or more dissemination of career information. It may also indicate a need to increase independent solo projects within regular upper division mathematics classes, and perhaps more directed guidance and less hand-holding through the senior project so that students emerge from the experience with more confidence in their ability to attack new mathematical ground on their own.

Positive noteworthy responses included total agreement that the small size of classes and the dedication of the faculty were key strengths of the program, and were not seen to be as much of a detriment as faculty sometime feel. Students perceived various weakness in the program as well, including the lack of classes to prepare students for graduate school, the scheduling issues that arise from teaching upper division classes only every two years, and the inapproachability of certain faculty, with an indicated need for tutors for more advanced classes for those situations when a student is not comfortable in speaking to a professor.

The program was judged to be at about the right level of difficulty with respect to the mathematics course load and number of classes per semester. An assortment of classes not now required were proposed to be required for the mathematics major, but only Differential Equations and Abstract Algebra received more than one vote, with three votes each. There was no real consensus as to whether any courses now taught as classroom courses should be offered only as directed study, or vice versa. The overall experience was judged to be quite positive, with the exception of one respondent who had difficulties in communication and expectations with their advisor during the senior project. Final general comments (1) indicated the need for a senior project class that meets once a week, (2) questioned the need for the senior project and comprehensive exams, and (3) requested refresher classes before the comprehensive exam and a class to help prepare students to pass the CSET exams.

Alumni Survey Form Results

Please respond to the following statements related to the ULV mathematics program, circling the number, which most closely matches your feelings, based on the scale

1=strongly disagree 2=disagree somewhat 3= no opinion 4= agree somewhat 5=strongly agree

1. I acquired core knowledge in calculus and other fundamental subjects, including techniques of proof.
   4, 5, 5, 5, 4

2. My ULV math courses helped me develop an attitude of persistence (not giving up too easily) and a willingness to explore a variety of problem-solving methods.
   5, 5, 5, 5, 5

3. I feel like I gained a sense of the consistency, organization, and beauty inherent in mathematics.
   5, 4, 5, 5, 5

4. The University of La Verne prepared me mathematically for my future.
   4, 4, 5, 5, 4

5. While at ULV, I learned how to use technology (such as calculators and computers) appropriately in solving problems and also gained an appreciation of the limitations of technology.
   5, 5, 5, 5, 4

6. I feel like the ULV mathematics program helped me learn to read and explore mathematics by myself.
   4, 4, 5, 5, 4

Summary of Open-ended Responses

(Please be as specific as possible in answering the following questions. Attach extra pages if necessary.)

7. What were your expectations of the mathematics program when you first enrolled?
   A. I expected to have an open and helpful learning environment. I also expected to be prepared for the future after graduation.
   B. I expected to be challenged in ways I never thought possible. I needed to learn the different applications of mathematics. At the same time, I wanted to love and enjoy the classes, my fellow schoolmates, and my professors.
   C. Basic math education. I actually did not declare a major and wasn't thinking of math as a major until the end of my freshman year.
   D. Expand math knowledge.
   E. I wanted to learn advanced math topics and procedures.

8. Were these expectations met? If not, why were they not met?

A. Mostly, yes. I have gone on to a graduate program in Mathematics and had to take extra classes so I would be up to speed with other students, because the classes weren't offered at ULV.
B. Yes they were. That and much more.
C. Above and beyond. I learned from many math classes above and beyond basic calculus like number theory and abstract algebra.
D. Yes.
E. Yes, they were met.

9. What are the strengths of the ULV mathematics program?
   A. The strengths are the small class sizes and the dedication of the staff. There was always someone around I could talk to.
   B. Having small classes makes it so much easier to get along with everyone in the class. Not only that, but having that interaction forced us to help each other out. The professors were remarkable, challenged us, and were there to help us in every way possible.
   C. Variety of math courses as well as small class sizes which allow for more individualized attention.
   D. Small class size allowed access to direct questioning of professor about problems. *
   E. The strengths were in the small number of faculty members. This made the math department feel like a family.

10. What are the weaknesses of the ULV mathematics program?
    A. The ULV math program does not offer as many math courses as are needed to fully prepare a student for graduate school in math.
    B. There really isn't anything that I would consider a weakness, except that maybe more students should consider being math majors.
    C. High level courses offered only once every two years (understandable due to small class sizes and is a trade-off for going to a small college)
    D. I thought that often test questions were done as a challenge of problem solving abilities beyond what were practiced in class and on homework – this leads to poorer performance than I hoped than I hoped for – but then, maybe my limitations.
    E. Some of the professors are hard to talk to in person, so some of the students should be recommended to tutor.

11. With regard to the mathematics course load, and how many math courses you took each semester, was the program too hard, too easy, or about right?

    A. The program was about right. It could be stressful, but that was a good thing.
    B. I would not consider it to be too hard simply because I feel that with the right amount of dedication, even the hardest things could be made a little easier. However, it was very challenging.
    C. For me, just about right but could see where it might be challenging for others.
    D. For me, it was hard – but "too hard," I don't know I would do all the homework – felt ready to "ace" the tests – and then ☹
    E. I took no more than two math courses at one time which was just right for me.

12. Which courses do <u>you</u> think should be required for all math majors, and which ones should be available as electives?
    A. Required: Calculus I/II/III, Linear Algebra, Differential Equations, Proofs, Real Analysis, Complex Analysis Electives: Number Theory, Abstract Algebra, Math Modeling, Probability.
    B. I believe "Discrete Mathematics," "Linear Algebra," and "Differential Equations" should be required for all math majors. "Vector calculus," "Number Theory," and "Abstract Algebra" should be available as electives.
    C. Required: All Calculus Levels, Abstract Algebra, Vector Calculus, some Statistics, course Differential equations, more computer classes, Linear Algebra, Math Modeling, Electives: Number Theory, Probability
    D. Not qualified to answer.
    E. I think abstract algebra should be a requirement for all math students.

13. Which current classroom courses should be offered directed study, and which currently offered only by directed study should be classroom courses?
    A. Real analysis should be a classroom course.
    B. I never took a direct study course so I don't feel like I should entitle myself to choosing the classes that should not be offered.
    C. Some computer classes and number theory could be directed study. Not sure what is currently offered as directly study.
    D. Not qualified to answer.
    E. History of math should be offered as directed study so more students can take the course.

14. Overall, how do you feel about your experience with the ULV mathematics program?
    A. I feel I did have a great experience with the ULV math program. All of the staff was very kind and helpful. I learned more than I ever thought I would, and even though I was behind on course material compared to other grad students, I felt I had learned the skills that have helped me catch up to them.
    B. I really enjoyed my experience. I made good friends, and we challenged each other a lot. I was able to get a lot of help from my professors, especially you Dr. Frantz, since I did have you for the majority of my math classes. I would not have wanted a different undergraduate experience.
    C. I felt like I learned a lot and enjoyed what I studied while there. The professors made sure that they were available to students with convenient office hours.
    D. Positive, except see #1D, and senior project – poor communication and expectations led to a heck of a lot of work and then a poor grade. ☹
    E. Overall, I enjoyed my time in the ULV math department.

15. What other comments do you have about the ULV mathematics program, including (but not limited to) the questions posed above? (Please feel free to make additional specific comments on questions 1-6, as well as the other questions.)
    A. I think study sessions should be given to students who are eligible to take the department exit exam. I think it would result in a higher passing rate.
    B. In regards to the Senior Project, I think it should be mandatory for students to meet with their advisor at least a couple of times a month, or maybe once a week. This will make it possible for students to finish their senior project before the end of our last semester. If all goes well with

that idea, a future step might involve having a senior project class, so that all graduating seniors can help each other out in their final project.

C. Error in transcription; this was the duplicate of answer B above.

D. Not happy about having to take senior comprehensive exam and then the GRE to graduate – not required in other majors. Profs. Were all nice people and accessible. To students – that was the positive about ULV – The negatives for me could be all from my limitations as a Mathematician - Just happy I graduated.

E. Could you offer a class or three to help students pass the CSET exams for teaching?

Appendix L: Summary of Senior Comprehensive Exam Results 2003-2008

An analysis of the results from the departmental comprehensive exam indicates the following pieces of information:

1. 62% of the students had taken MATH 328 Abstract Algebra (referred to as group A students), while 32% had not (referred to as group B students. This is a key piece of information, since 10 of 60 questions on the exam cover material from that course.
2. On average, 59% of the A students and 58% of the B students answered Precalculus questions correctly.
3. On average, 49% of the A students and 51% of the B students answered Calculus I questions correctly.
4. On average, 44% of the A students and 36% of the B students answered Calculus II questions correctly.
5. On average, 45% of the A students and 42% of the B students answered Calculus III questions correctly.
6. On average, 32% of the A students and 39% of the B students answered Linear Algebra questions correctly.
7. On average, 20% of the A students and 43% of the B students answered Abstract Algebra questions correctly.

The analysis also was conducted individually on four time periods: from 1987-1992, 1993-1998, 1999-2004, and 2005-2009. The overall percentages correct for both types of students in the six categories of questions show the following trends:

Category	1987-1992	1993-1998	1999-2004	2005-2009
Precalculus	55%	62%	54%	56%
Calculus I	47%	53%	54%	54%
Calculus II	35%	47%	35%	39%
Calculus III	44%	44%	42%	41%
Linear Algebra	36%	41%	33%	33%
Abstract Algebra	40%	33%	31%	32%

Several points are worth noting:

1. After four years of college mathematics courses, students were still missing between 3 and 4 questions out of 6 on precalculus, which is considered prerequisite to the first course which even applies toward a mathematics major (Calculus I). Although students may not have formally taken a precalculus class the entire time they attended ULV, the fundamental ideas of algebra and trigonometry show up in virtually every single course associated with the major, and it is unclear why students should perform so poorly, or what should be done about it.

2. In the three core courses of Calculus I, II, and III, students rarely scored higher than 50% on the 34 questions covering that material. Again, this is far lower than

one might expect for a person graduating with four years of college level mathematics courses, and some effort should be undertaken to try to raise this in the future.

3. Students performed appreciably worse on questions related to the more advanced material from the Abstract Algebra and Linear Algebra courses, ranging from 20% to 43% correct.

4. Students who had passed Abstract Algebra (not required for the B.A.) performed better on the Linear Algebra questions (39% correct to 32% correct).

5. Student performance has remained fairly steady over the past 22 years, with some fluctuation, and a particular good five year period from 1993-1998, but no consistent downward trend to raise any alarms. A graph of the adjusted scores (one point per correct answer, -1/4 point per incorrect answer) appears in Figure 2. It should be noted that an adjusted score of 20 is the minimum passing score for graduation. Each histogram bar represents one student score, but some students may have scores for two or three tests.

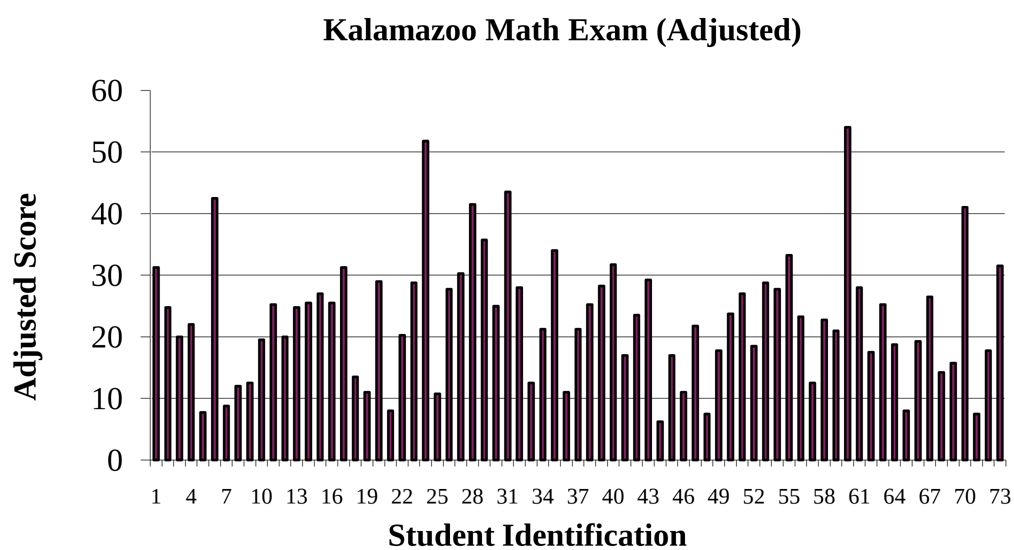

Fig. 2: Internal departmental exam scores 1987-2009 (adjusted for incorrect answers)

Figure 3 shows the same data but in terms of percentiles, as compared to several hundred students that took this exam across the nation for a number of years when it was first developed at Kalamazoo College. Although as already noted there are no marked upward or downward trends in the data over the past 22 years, there does seem to be a greater proportion of students in recent years that failed the test and had to repeat it. In the 1987-1992 period, 3 of 13 (23%) failed their first attempt; in 1993-1998, 5 of 15 (33%) failed their first attempt; in 1999-2004, 3 of 8 (38%) failed their first attempt; and in 2005-2009, 7 of 16 (44%) failed their first attempt. This does indicate a steady increase in the percentage of students failing to pass the departmental exam on the first attempt.

It should be noted that current percentiles are computed by comparison with data from the initial period 1987-1995, since the exam stopped being given on a national basis at that time and annual data stopped being available. A passing adjusted score of 20 corresponds to a national percentile rate of about 68%. Figure 4 indicates the percentile ranking recorded for each attempt at the exam.

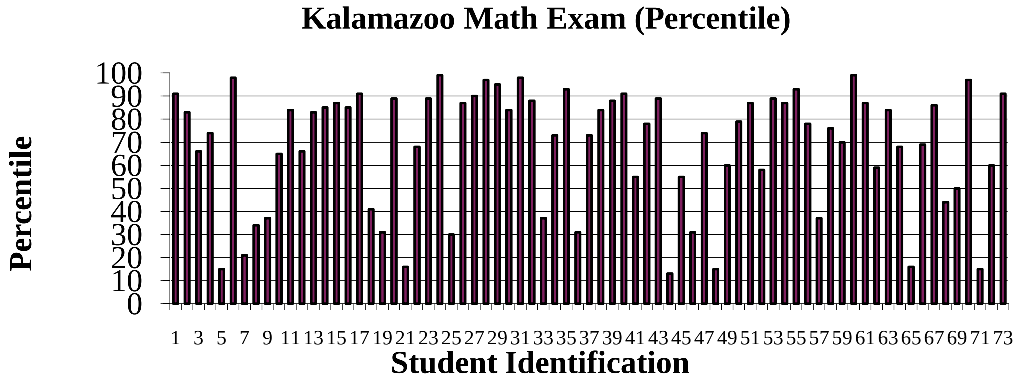

Fig. 3: Internal departmental exam scores 1987-2009 (percentile ranking)

Finally, Figure 4 displays the percentile ranking of all students taking the GRE Advanced Subject Mathematics Exam since 1965. Although there is no passing minimum score, the exam does serve the purpose of allowing a comparison of deeper mathematical understanding in students across a wide range of time in the department. Clearly the singular high-scoring spikes are occurring less and less frequently, while the proportion of students scoring below the 5th percentile is increasing rather dramatically. It is not clear whether this reflects a true decline in student understanding, or simply a decrease in the amount of time students are now willing to dedicate study time to when they know there is no minimum score required. The high cost of the exam ($140) and the questionable usefulness of the results suggest that it might be appropriate to initiate a policy of only having students on a graduate school path take the exam.

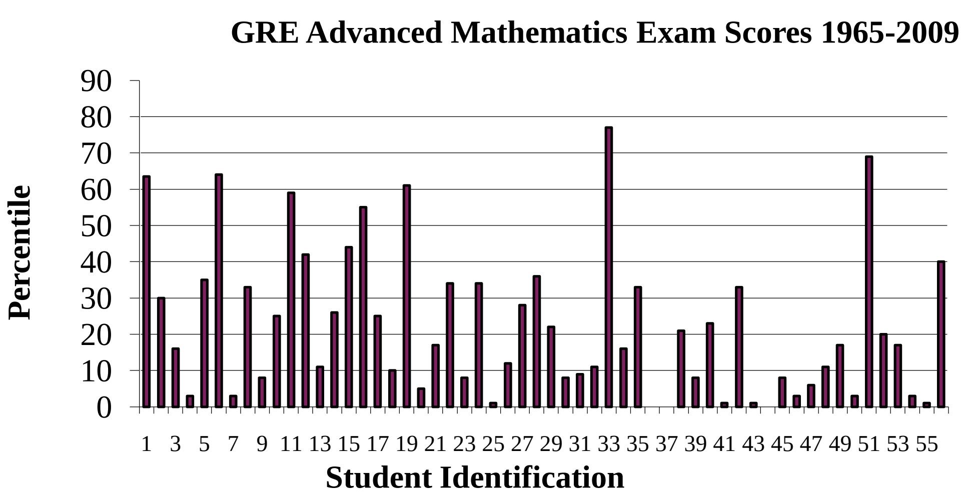

Fig. 4: GRE Advanced Mathematics Exam Scores (1965-2009)

Appendix M: Item Analysis of Departmental Senior Comprehensive Exam

Table 1. Participants who have taken Math 328

Item	Yes	No
Have you taken Math 328?	62%	38%

Table 2. Percentage of Items Correct for All Participants, those who have not taken Math 328, and those who have taken Math 328

Item	% Correct		
	All Participants (n = 69)	Have Not taken Math 328 (n= 26)	Have Taken Math 328 (n= 43)
1. Precalculus			
Question 1	91	92	91
Question 2	64	62	65
Question 3	46	62	37
Question 4	59	58	61
Question 5	45	35	51
Question 6	36	46	30
2. Calculus I			
Question 7	86	89	67
Question 8	68	69	91
Question 10	87	81	51
Question 13	52	54	51
Question 14	49	46	51
Question 15	54	47	58
Question 16	58	62	56
Question 17	49	46	51
Question 19	32	35	30
Question 20	20	12	26
Question 21	23	12	30
Question 24	61	58	63
Question 26	39	31	44
3. Calculus II			
Question 9	87	92	84
Question 12	62	46	72
Question 22	23	12	30
Question 23	62	69	58
Question 25	49	43	53
Question 27	28	19	33
Question 31	58	54	61
Question 33	32	31	33
Question 35	20	23	19
Question 36	16	82	1
Question 37	15	23	9
Question 39	16	42	3
Question 40	41	42	40

4. Calculus III			
Question 11	57	58	56
Question 18	35	35	35
Question 28	51	54	49
Question 29	48	62	40
Question 30	58	58	58
Question 32	45	39	49
Question 34	38	50	30
Question 38	12	0	19
5. Linear Algebra			
Question 41	86	85	86
Question 42	46	39	51
Question 43	39	39	40
Question 44	55	46	61
Question 45	29	27	30
Question 46	19	15	21
Question 47	32	27	35
Question 48	20	19	21
Question 49	15	8	19
Question 50	22	15	26
6. Abstract Algebra			
Question 51	67	42	81
Question 52	68	42	84
Question 53	33	23	40
Question 54	29	15	37
Question 55	52	27	67
Question 56	38	15	51
Question 57	32	15	42
Question 58	13	12	14
Question 59	6	0	9
Question 60	6	4	7

Table 3. Percentage of items correct for the four different time periods for all participants

Item	% Correct			
	1987 – 1992 (n = 17)	1993-1998 (n = 21)	1999-2004 (n = 9)	2005-2009 (n = 22)
1. Precalculus				
Question 1	82	91	100	96
Question 2	53	67	78	64
Question 3	59	48	33	41
Question 4	53	81	44	50
Question 5	47	38	44	50
Question 6	35	48	22	32
2. Calculus I				
Question 7	82	81	89	91
Question 8	59	86	44	68
Question 10	77	86	100	91
Question 13	59	48	44	54
Question 14	53	43	67	45
Question 15	59	43	50	63
Question 16	47	62	56	63
Question 17	35	57	67	45
Question 19	24	24	44	41
Question 20	12	24	22	23
Question 21	6	24	22	36
Question 24	59	57	67	63
Question 26	41	57	33	23
3. Calculus II				
Question 9	88	95	89	77
Question 12	47	62	89	63
Question 22	6	24	22	36
Question 23	59	76	33	63
Question 25	41	62	22	54
Question 27	35	29	11	27
Question 31	47	67	55	59
Question 33	41	43	33	14
Question 35	18	29	11	18
Question 36	6	24	33	9
Question 37	18	5	11	23
Question 39	12	19	11	18
Question 40	41	33	33	50

4. Calculus III

Question 11	53	62	44	59
Question 18	29	38	33	36
Question 28	35	57	44	59
Question 29	71	38	56	36
Question 30	35	71	56	63
Question 32	53	33	67	41
Question 34	65	38	11	27
Question 38	12	14	22	4

5. Linear Algebra

Question 41	94	81	78	86
Question 42	35	52	55	45
Question 43	41	52	33	27
Question 44	41	67	44	59
Question 45	35	29	56	14
Question 46	12	28	11	18
Question 47	53	33	22	18
Question 48	24	33	11	9
Question 49	0	19	0	27
Question 50	24	19	22	22

6. Abstract Algebra

Question 51	82	62	67	59
Question 52	82	62	78	59
Question 53	47	33	22	27
Question 54	35	24	22	32
Question 55	59	43	67	50
Question 56	35	33	44	41
Question 57	35	38	0	36
Question 58	18	19	0	9
Question 59	0	14	11	0
Question 60	6	5	0	9

Table 4. Percentage of items correct for the four different time periods for those who have not taken MATH 328

Item	% Correct			
	1987 – 1992 (n = 13)	1993-1998 (n = 7)	1999-2004 (n = 2)	2005-2009 (n = 4)
1. Precalculus				
Question 1	85	100	100	100
Question 2	54	71	50	75
Question 3	62	57	50	75
Question 4	46	86	50	50
Question 5	39	43	0	25
Question 6	39	57	50	50
2. Calculus I				
Question 7	85	100	50	100
Question 8	54	100	50	75
Question 10	69	85	100	100
Question 13	62	28	50	75
Question 14	46	29	50	75
Question 15	46	43	50	50
Question 16	39	85	100	75
Question 17	39	43	100	50
Question 19	23	29	0	100
Question 20	8	0	50	25
Question 21	0	29	0	25
Question 24	54	57	50	75
Question 26	31	29	50	25
3. Calculus II				
Question 9	92	100	100	75
Question 12	38	57	50	50
Question 22	0	29	0	25
Question 23	62	86	0	100
Question 25	31	57	0	75
Question 27	23	0	0	50
Question 31	38	71	100	50
Question 33	31	29	100	0
Question 35	15	14	50	50
Question 36	0	14	50	100
Question 37	15	0	50	75
Question 39	0	14	0	0
Question 40	38	14	50	100

4. Calculus III

Question 11	46	85	50	50
Question 18	23	29	50	75
Question 28	31	71	50	100
Question 29	76	43	50	50
Question 30	31	71	100	100
Question 32	38	29	100	25
Question 34	61	43	0	50
Question 38	0	0	0	0

5. Linear Algebra

Question 41	92	71	50	100
Question 42	31	43	50	50
Question 43	38	57	0	25
Question 44	31	71	0	75
Question 45	23	43	0	25
Question 46	7	43	0	0
Question 47	38	29	0	0
Question 48	31	14	0	0
Question 49	0	14	0	25
Question 50	15	29	0	0

6. Abstract Algebra

Question 51	84	0	0	0
Question 52	84	0	0	0
Question 53	46	0	0	0
Question 54	31	0	0	0
Question 55	53	0	0	0
Question 56	31	0	0	0
Question 57	31	0	0	0
Question 58	23	0	0	0
Question 59	0	0	0	0
Question 60	7	0	0	0

Table 5. Percentage of items correct for the four different time periods for those who have taken MATH 328

Item	% Correct			
	1987 – 1992 (n = 4)	1993-1998 (n = 14)	1999-2004 (n = 7)	2005-2009 (n = 18)
1. Precalculus				
Question 1	75	86	100	94
Question 2	50	64	85	61
Question 3	50	43	28	33
Question 4	75	78	42	50
Question 5	75	36	57	55
Question 6	25	43	14	28
2. Calculus I				
Question 7	75	71	100	88
Question 8	75	78	43	66
Question 10	100	85	100	88
Question 13	50	57	43	50
Question 14	75	50	71	38
Question 15	100	43	43	66
Question 16	75	50	43	61
Question 17	25	64	57	44
Question 19	25	21	57	27
Question 20	25	35	14	22
Question 21	25	21	28	38
Question 24	75	57	71	61
Question 26	75	71	28	22
3. Calculus II				
Question 9	75	93	85	77
Question 12	75	64	100	66
Question 22	25	21	28	38
Question 23	50	71	42	55
Question 25	25	64	28	50
Question 27	75	43	14	22
Question 31	75	64	42	61
Question 33	75	50	14	16
Question 35	25	36	0	11
Question 36	25	28	28	11
Question 37	25	7	0	11
Question 39	50	21	14	22
Question 40	50	43	28	38

4. Calculus III				
Question 11	75	50	42	61
Question 18	50	42	28	27
Question 28	50	50	42	50
Question 29	50	36	57	33
Question 30	50	71	43	55
Question 32	100	36	57	44
Question 34	75	35	14	22
Question 38	50	21	28	5
5. Linear Algebra				
Question 41	100	86	86	83
Question 42	50	57	57	44
Question 43	50	50	43	27
Question 44	75	64	57	55
Question 45	75	21	71	11
Question 46	25	21	14	22
Question 47	100	35	28	22
Question 48	0	42	14	11
Question 49	0	21	0	27
Question 50	50	14	28	27
6. Abstract Algebra				
Question 51	75	93	86	72
Question 52	75	93	100	72
Question 53	50	50	28	33
Question 54	50	35	28	38
Question 55	75	64	85	61
Question 56	50	50	57	50
Question 57	50	57	0	44
Question 58	0	29	0	11
Question 59	0	21	14	0
Question 60	0	7	0	11

Table 6. Means and Standard deviations for all participants, those who have not taken MATH 328, and those who have taken MATH 328.

Item	Correct					
	All Participants (n = 69)		Not taken Math 328 (n= 26)		Taken Math 328 (n= 43)	
	M	SD	M	SD	M	SD
1. Precalculus	3.42	1.53	3.53	1.53	3.34	1.55
2. Calculus I	6.83	2.77	6.52	2.56	7.02	2.89
3. Calculus II	5.08	2.20	4.65	1.91	5.34	2.33
4. Calculus III	3.42	2.10	3.53	1.55	3.34	2.38
5. Linear Algebra	3.62	2.31	3.19	2.26	3.88	2.33
6. Abstract Algebra	3.43	2.82	1.96	2.56	4.32	2.61

Appendix N: Titles and Abstracts of Recent Senior Projects

1. ***Detecting Art Forgery: The Case of Han van Meegeren's "Vermeers"*** (Carolyn Monell; December, 2009)
   This is a study of detecting art forgeries using Lead-210 dating which is using the application of differential equations. In this project, I chose to use the Carnegie Mellon method of Lead-210 dating.

2. ***The effects of wind and altitude in the 400-m sprint*** (Vanessa Alday; August, 2008)
   The purpose of this project is to investigate the effects that wind and altitude have in the 400-m sprint by applying ordinary differential equations to actual data from the 1999 World Athletics Championships. The model used is based on Newton's Law for the energy balance of a runner. The ordinary differential equations were used in the program Maple to produce data that was relatively close to the actual time. Thorough research identified the affects that both altitude and wind have in the performance of a runner in the 400-m sprint. Although the model is a good model, it fails to include other factors that might affect the performance of a runner, such as psychological factors and a runner's strategy, among other things. The model used relates to the standard IAAF track and further applications of this model have been modified to produce model data for an equal quadrant track. A comparison between the two tracks provides information as to the effects on running performances executed on different standard tracks. Differences were found between the running lanes which may indicate disadvantages of running in certain lanes on a standard running track.

3. ***Real Analysis*** (Michael Moretti; August, 2009)
   This was a directed study course designed to prepare the student for a graduate program in mathematics, and as such had much written work and a formal presentation and oral examination, but no formal written paper.

4. ***An Introduction to Elliptic Curve Cryptography*** (Krystle Burt; August, 2009)
   The purpose of this paper is to give a brief history of what cryptography is and how it is used. It will also give an overview of the differences between public and private key cryptography and how cryptography in general, has evolved throughout the years. More importantly, this paper was written to introduce a newer field of cryptography, elliptic curves. Both the mathematical applications and the public key cryptosystem are described. Through the advances in technology and society's knowledge of mathematics it has become very important that a system, that is almost impossible to solve, was designed.

5. ***Real Analysis*** (Heather Mattie; August, 2008)
   This was a directed study course designed to prepare the student for a graduate program in mathematics, and as such had much written work and a formal presentation and oral examination, but no formal written paper.

6. ***Applications of Fractals and Dynamical Systems in Algorithmic Music Composition*** (Edgar Manzo; July, 2008)
   Algorithmic music composition, or the composition of music through the use of processes, is a relatively new concept that allows a user with limited musical knowledge to compose musical pieces with the aid of a computer. This paper is written to introduce and describe the methods used to create algorithmic music utilizing fractals and dynamical systems. The research done by Richard Voss and John Clark in the mid 1970's sparked an interest in fractals and chaotic systems as means to create music. It is the self-similarity in fractals and nonlinear dynamical systems that has attracted the nonscientific community to venture into these alternative musical composition methods. This paper explores these methods and the results from them.

7. ***Predator-Prey Theory and an Application*** (Giovanna Chavez; July, 2007)
   The purpose of this project is to research and understand the evolution of predator-prey theory and to apply the models to actual data of biological systems and analyze the results. The classic Lotka-Volterra model is a less realistic model as it leaves out many important factors and theories of prey-competition discussed in this paper. Through the evolution of predator-prey theory, it has been found that ratio-dependent models are more realistic in their predictions of predator-prey systems than prey-dependent models, as they solve the paradoxes of enrichment and biological control. By applying the models to realistic data of a lion, zebra, and wildebeest predator-prey system, we will show that the Lotka-Volterra model can be improved significantly by application of these enhanced theories. The simpler two-species models will be extended to a more complex three-species system of lions, wildebeest, and zebras.

8. ***Earthquake Modeling on Multi-story Buildings*** (Hiedi Wymer-Jones; October, 2006)
   No abstract available.

9. ***Fuzzy Logic: An Overview*** (Jaimie Oberbeck; June, 2006)
   No abstract available.

10. ***Learning Mathematics – Teaching Mathematics; Bézier Curves, Surfaces, and B-Splines*** (Sherry Houston-Brown; July, 2006)
    No abstract available.

11. ***A Simple Cipher: A Quick Overview of Cryptography*** (Wanda Groppi; June 2005)
    No abstract available.

Appendix O: Senior Project Presentation Evaluation Form

Senior Project Rubric/Rating Scale

Name:____________________ Semester________________ Major____________________

Rating Scale
1 = Excellent (Demonstrates skill or property to a very high degree)
2 = Good (Demonstrates skill or property to a high degree with minor or occasional shortcomings)
3 = Fair (Demonstrates skill or property at a minimally acceptable level with some serious shortcomings)
4 = Poor (Demonstrates skill or property at less than acceptable level with serious shortcomings)

A. Integration and Inference

1	2	3	4	1. Has clear and well-defined thesis
1	2	3	4	2. Recognizes the complexity of the factors involved
1	2	3	4	3. Uses scholarly sources and appropriate research methodology
1	2	3	4	4. Thoroughly analyzes, evaluates and integrates information
1	2	3	4	5. Concludes and infers appropriately

B. Mathematical Content

1	2	3	4	6. Overall level of mathematics used is sufficiently high
1	2	3	4	7. Mathematical techniques employed are appropriate
1	2	3	4	8. Mathematical computations and analysis are without error
1	2	3	4	9. Mathematical notation is used as appropriate
1	2	3	4	10. Clear evidence is provided of independent mathematical learning of topics outside of the standard undergraduate mathematics major curriculum

C. Organization

1	2	3	4	11. Is well-organized (good headings/paragraph breaks)
1	2	3	4	12. Main ideas are clear and vivid
1	2	3	4	13. Sequencing is smooth and effective
1	2	3	4	14. Project overall is clean and presentable

D. Language Use

1	2	3	4	15. Displays consistent facility with language
1	2	3	4	16. Uses variety of sentence structures from simple to complex
1	2	3	4	17. Word choices are sophisticated, precise, and original
1	2	3	4	18. Writing style is appropriate for mathematical papers
1	2	3	4	19. There are no detectable grammatical or mechanical errors

E. Reference List

1	2	3	4	20. Majority of sources are current (within 5 years)
1	2	3	4	21. Sources are from refereed journals, scholarly books, or verified web sites
1	2	3	4	22. Formatting is consistent
1	2	3	4	23. Total number of references is appropriate
1	2	3	4	24. Reference list matches with citations errors

E. Academic Integrity

1	2	3	4	25. Citations/footnotes are placed appropriately
1	2	3	4	26. Quotation marks are placed where necessary
1	2	3	4	27. Paraphrasing is well done and cited
1	2	3	4	28. No glaring shift of style/vocabulary indicating plagiarism

Appendix P: Senior Project Presentation Evaluation Form

Mathematics Senior Project Presentations

Rating Scale

Exemplary: Highest possible level of competence demonstrated by the student.
Satisfactory: Acceptable level of competence demonstrated by the student with some room for improvement.
Adequate: Minimally acceptable level of competence with much room for improvement.
Inadequate: Unacceptable level of competence demonstrated by the student.

Name____ Date__________________

Competency	**Rating Scale**			
	Exemplary	Satisfactory	Adequate	Inadequate
Effectiveness of presentation				
1. Spoke in a clear and confident voice, with appropriate vocabulary	4	3	2	1
2. Made individually directed eye contact with the audience	4	3	2	1
3. Utilized audio-visual materials (including graphics, illustrations, and other visual aids) which were appropriate, well-designed, and effectively used	4	3	2	1
4. Communicated and explained ideas effectively	4	3	2	1
5. Paced presentation to the allotted time	4	3	2	1
6. Used well organized notes appropriately, or spoke effectively without notes	4	3	2	1
7. Responded to questions professionally, completely, and to the point	4	3	2	1

Comments ____

Content of Presentation				
8. Mathematical content was at the appropriate level	4	3	2	1
9. Specific mathematical methodologies were appropriate for the project	4	3	2	1
10. Understanding of mathematical content was at a sufficient depth	4	3	2	1
11. Mathematical notation was utilized and displayed appropriately	4	3	2	1
12. Findings were adequately supported by and/or referenced to appropriate literature	4	3	2	1
13. Limitations of the work and areas for future exploration were noted	4	3	2	1

Comments ____

Appendix Q: Program Curriculum Comparison with Peer Institutions

A group of ten schools was determined to be comparable in nature to the University of La Verne in their undergraduate programs: Azusa Pacific University, University of Redlands, California Lutheran University, Pepperdine University, Whittier College, Chapman University, Loyola Marymount University, University of San Diego, Manchester College, and Elizabethtown College . The course offerings and requirements for mathematics majors are listed below. The findings may be summarized into several categories.

There were many similarities between the La Verne mathematics curriculum and that of the other schools, particularly in the approximate number of units required and in the core required courses, in the sense that La Verne's core courses were a subset of those of other schools. Physics and computer programming were also found to be common supportive course requirements. However, the most significant difference was the fact that almost all the other schools required courses in *both* abstract algebra and real analysis. Also, whereas La Verne offers two types of degrees, the B.A. and the B.S., and provides little to no information as to why a student might select one or the other, a number of other schools provided various tracks or concentrations, including teaching, general, graduate school preparatory, math education, secondary math education, applied, engineering (including 2/2 and 3/2 programs), computer science, and actuarial.

Finally, there was a wide selection of courses across the ten schools that are not offered at La Verne, and which perhaps ought to be considered for their appropriateness for our curriculum. These included offerings such as Mathematical Writing, Reading, and Presentation; Mathematical Physics; Operations Research; Point Set Topology; Numerical Analysis; combined Probability/Statistics courses, one and two semesters; Mathematical Contributions by Women; Cryptography Throughout the Ages; a second course in Real Analysis; Mathematics and Gender Issues; Analysis of Algorithms; Mathematical Logic; Mathematical Problem Solving Seminar; and Introduction to Orbit Determination. It should also be noted that without further research beyond catalog scanning, it was impossible to determine the frequency with which some of these courses were offered, which could range from rarely, to whenever demand arises, to every two years, to every year. For many of them, it is rather unlikely that they are offered more than biannually, or in a few cases, perhaps annually.

Summary: La Verne should give serious consideration to making one semester courses in both abstract algebra and real analysis core requirements for all mathematics majors. Currently, students may opt out of abstract algebra if they complete a B.A. degree, and usually only take real analysis (and on a directed study basis) if they are applying to graduate school.

Consideration should also be given to establishing tracks if this could be done with no or very few new courses being introduced, perhaps three tracks in the areas of secondary math education, applied mathematics, and graduate school preparation.

Currently, courses like Statistical Theory, Geometry, Real Analysis, Complex Analysis, Topics in Applied Mathematics, and Advanced Engineering Mathematics are offered only on a directed study basis. Efforts should be made to identify which of these are important enough to offer as classroom courses, and strategies developed to make that possible.

Finally, the entire list of courses taught at La Verne or at other schools needs to be examined carefully to see if there are any courses which have become outdated, or other courses which we are negligent in not offering at La Verne. In addition, some courses need to be considered for deletion from the catalog, such as Pascal, Fortran, and Introduction to Computer Utilization, while Topics in Applied Mathematics has never been taught at all.

1. Azusa Pacific University

Department of Mathematics and Physics

	Core Requirements	43 units
CS 220	Introduction to Computer Science	4
MATH 161	Calculus I (formerly MATH 251)	5
MATH 162	Calculus II (formerly MATH 252)	4
MATH 263	Multivariate Calculus (formerly MATH 253)	4
MATH 270	Differential Equations (formerly MATH 350)	4
MATH 280	Discrete Mathematics	3
MATH 290	Linear Algebra (formerly MATH 300)	3
MATH 400	Abstract Algebra	3
MATH 450	Introduction to Real Analysis	3
PHYC 161	Physics for Science and Engineering I*	5
PHYC 162	Physics for Science and Engineering II	5

1. Applied Math

All mathematics majors must complete the core requirements as well as the upper-division mathematics electives. Each track can guide students in their selection of electives when completing the mathematics major.

	Applied Math Track	15 units*
MATH 360	Probability and Statistics	3
MATH 430	Mathematical Physics	3
MATH 455	Numerical Analysis	3
MATH 470	Complex Variables	3
MATH 480	Mathematical Reading, Writing, and Presentation***	3

2. General Math

	General Math Track	9 units
MATH 340	Geometry	3
MATH 360	Probability and Statistics	3
MATH 390	History of Mathematics and Number Theory (formerly MATH 460)	3
MATH 430	Mathematical Physics	3
MATH 455	Numerical Analysis	3
MATH 470	Complex Variables	3
MATH 480	Mathematical Reading, Writing, and Presentation***	3
MATH 499	Thesis/Project	1-4

3. Graduate School Prep

	Graduate School Prep Track	15 units^^^
MATH 340	Geometry	3
MATH 360	Probability and Statistics	3
MATH 390	History of Mathematics and Number Theory (formerly MATH 460)	3
MATH 470	Complex Variables	3
MATH 480	Mathematical Reading, Writing, and Presentation***	3

4. Secondary Math Education

	Secondary Math Education Track	19 units***
EDLS 300	Introduction to Teaching as a Profession, K-12	4
MATH 301	Mathematics for Secondary Teachers	3
MATH 340	Geometry	3
MATH 360	Probability and Statistics	3
MATH 390	History of Mathematics and Number Theory (formerly MATH 460)	3
MATH 480	Mathematical Reading, Writing, and Presentation***	3

**Meets a General Studies Core (or elective) requirement.*

****Meets the Upper-Division Writing Intensive requirement.*

^Deficiencies in mathematics units must be made up as electives.

^^***Note:*** *To meet the requirements of the Single-Subject Waiver Program for a teaching credential in mathematics, all 19 units within the Secondary Math Education Track must be completed.*

^^^It is recommended that the entire 15 units be completed for the track, although the major requires only 9 units.

Math/Physics Major (B.A.)

	Math/Physics Major (B.A.)	50 units
	Computer programming language course	3
CHEM 151	General Chemistry*	4
MATH 161	Calculus I (formerly MATH 251)	5
MATH 162	Calculus II (formerly MATH 252)	4
PHYC 161	Physics for Science and Engineering I*	5
PHYC 162	Physics for Science and Engineering II	5
PHYC 401	Thermodynamics	3

Upper-division courses in math or physics
(including MATH 263; minimum of six units in physics)

Pre-Engineering Program

	Requirements for the 2/2 Program	66 units
CHEM 151	General Chemistry*	4
COMM 111	Public Communication†	3
CS 220	Introduction to Computer Science	4
CSA 101	Beginnings: Personal Development and the College Experience†	1

ENGL 110	Freshman Writing Seminar†	3
MATH 161	Calculus I (formerly MATH 251)	5
MATH 162	Calculus II (formerly MATH 252)	4
MATH 263	Multivariate Calculus (formerly MATH 253)	4
MATH 270	Differential Equations (formerly MATH 350)	4
MATH 290	Linear Algebra (formerly MATH 300)	3
PE 1XX	Fitness for Life (or varsity sport)†	1
PE 240	Health Education (F, S)	2
PHYC 101	Introduction to Engineering	2
PHYC 161	Physics for Science and Engineering I	5
PHYC 162	Physics for Science and Engineering II	5
PHYC 281	Statics (formerly PHYC 301)	3
PHYC 282	Dynamics (formerly PHYC 302)	3
PHYC 283	Electric Circuits (formerly PHYC 362)	4
POLI 150	American Government	3
Select one of the following:		
UBBL 100	Introduction to Biblical Literature: Exodus/Deuteronomy*	3
UBBL 230	Luke/Acts*	3

29 units

Additional Requirements for the 3/2 Program

All the courses required for the 2/2 Program and:

BIOL 496	Senior Seminar: Ethics and the Sciences*	3
CMIN 108	Christian Life, Faith, and Ministry*	3
ENGL 111	Introduction to Literature*	3
HIST 151	United States History to 1865*	3
PHYC 284	Materials (formerly PHYC 235)	3
PHYC 401	Thermodynamics	3
PSYC 110	General Psychology*	3
Foreign Language Requirement or General Electives^		8

2. University of Redlands

Department of Mathematics and Computer Science

Candidates for the B.S. degree must complete:

• MATH 122, 201 or 204, 221, 241, 321, 341, and 459;

• Depth requirement in analysis, topology, or algebra: at least one from MATH 325; 355; 360 or 460 (with departmental approval);

• Applied mathematics requirement: at least one from MATH 233; 235; 311; 312; 331; 260, 360, or 460 (with departmental approval);

• Two additional courses: one numbered 233 or above, excluding 301, and one numbered 201 or above (at the most, only one of 231, 301, ECON 300, and ECON 301 may be counted toward the major);

• At least 16 credits in courses outside mathematics that involve quantitative or logical reasoning, or a minor or second major in any field. These courses must include CS 110, Introduction to

Programming Using C++; or a course in another programming language; or the student must demonstrate proficiency in a structured programming language.

Candidates for the B.S. degree leading to the teaching credential must complete:
• MATH 122, 201 or 204, 221, 241, 245, 251, 311, 312, 321, 341, 459;
• CS 110.
• At least 12 credits in courses outside mathematics that involve quantitative or logical reasoning, or a minor or second major in any field.

100 Mathematics for the Liberal Arts. **(4)**
101 Finite Mathematics. **(4)**
102 Explorations in Mathematics for Prospective Educators. **(4)**
111 Elementary Statistics and Probability with Applications. **(4)**
115 Mathematics through Its History. **(3)**
118-119 Integrated Calculus I / Integrated Calculus II. **(4)**
121 Calculus I. **(4)**
122 Calculus II. **(4)**
150 Techniques in Problem Solving. **(1)**
160 Introductory Topics in Mathematics. **(3)**
201 Discrete Mathematical Structures. **(4)**
204 Conjecture and Proof in Discrete Mathematics. **(3)**
221 Calculus III. **(4)**
231 Introduction to Modeling. **(4)**
233 Introduction to Operations Research. **(4)**
235 Differential Equations. **(4)**
241 Linear Algebra. **(4)**
245 Number Theory/History **(4)**
251 College Geometry. **(4)**
260, 360, 460 Topics in Mathematics. **(3)**
301 Mathematical Consulting. **(2-4)**
311 Probability. **(4)**
312 Mathematical Statistics.
321 Real Analysis. **(4)**
325 Complex Analysis. **(4)**
331 Numerical Analysis. **(4)**
335 Advanced Modeling Techniques. **(4)**
341 Abstract Algebra. **(4)**
355 Point Set Topology. **(4)**
459 Senior Research Seminar. **(4)**

3. California Lutheran University
Department of Mathematics

MATH 110 Intermediate Algebra 4 credits
MATH 115 Finite Mathematics 4 credits
MATH 151 Precalculus 4 credits
MATH 231 Biostatistics 4 credits
MATH 241 Discrete Mathematics 4 credits
MATH 250 Business Calculus 4 credits
MATH 251 Calculus I 4 credits
MATH 252 Calculus II 4 credits
MATH 261 Calculus III 4 credits
MATH 265 Differential Equations 4 credits
MATH 282 Special Topics 1 credit
MATH 343 Linear Algebra 4 credits
MATH 352 Probability and Statistics I 0 credits
MATH 381 Geometry 4 credits
MATH 382 Number Theory 4 credits
MATH 420 Real Analysis 4 credits
MATH 425 Abstract Algebra 4 credits
MATH 435 Combinatorics 4 credits
MATH 440 Mathematical Methods of Physics 4 credits
MATH 450 Complex Analysis 4 credits
MATH 452 Probability and Statistics II 4 credits
MATH 471 Mathematical Modeling 4 credits
MATH 475 Capstone 2 credits
MATH 482 Selected Topics 1 credit
MATH 485 Seminar 2-4 credits
MATH 490 Independent Study 1 credit
MATH 492 Cooperative Education 1 credit

Undergraduate Major Requirements
Only Mathematics courses numbered 200 or above earn credit towards a major in Mathematics. Either Mathematics 250 or Mathematics 251 (preferred) may be counted towards the major, but not both. Course descriptions can be found here.
Students entering CLU before Fall 2001 have the option of completing their degree under the old curriculum requirements or the new requirements listed below.

B.S. Degree in Mathematics
38 credits minimum, 22 credits Upper Division; Mathematics 250 or 251 (preferred); Mathematics 252 and 261; five 4-credit upper division Mathematics classes; Math 475 (Capstone).

Required Supporting Courses
13 credits, to include Physics 211 and 212 (with labs) and one upper division Mathematics-Intensive Science course (must be approved by major advisor).

Recommended Supporting Courses
Chemistry 151 and 152 (with labs), and a course in computer programming.

B.A. Degree in Mathematics
38 credits minimum, 22 credits Upper Division; Mathematics 250 or 251 (preferred); Mathematics 252 and 261; Mathematics 381 or 382; four additional 4-credit upper division Mathematics classes; Math 475 (Capstone).

Required Supporting Courses
13 credits, to include Physics 211 and 212 (with labs) and one Mathematical Perspectives course (must be approved by major advisor).

Recommended Supporting Courses
Chemistry 151 and 152 (with labs), and a course in computer programming.

4. Pepperdine University

Department of Mathematics

Requirements for a Bachelor of Science in Mathematics
For the Bachelor of Science degree in Mathematics, a student must pass the following:

Lower-division Courses (26 units)
Offered once or twice a year
MATH 110 Colloquium in Mathematics 1 unit
Math 210 Calculus I 4 units
Math 211 Calculus II 4 units
Math 212 Calculus III 4 units
COSC 105 Introduction to Programming 3 units
PHYS 210 Physics I 5 units
PHYS 211 Physics II 5 units

Sophomore upper-division courses (8 units)
Offered once a year
MATH 360 Transition to Abstract Math 4 units
MATH 330 Linear Algebra 4 units

Junior/Senior upper-division courses (12 units)
Offered once every 2 years
Math 430 Algebraic Structures I 4 units
Math 431 Algebraic Structures II 4 units
Math 530 Real Analysis 4 units

Select two additional upper-division courses (7-8)
Offered once every 2 years
Others may be available occasionally
Math 531 Complex Analysis 4 units
Math 510 Probability 4 units

Math 511 Statistics 4 units
Math 340 Differential Equations (offered every fall) 3 units
Math 540 Applied Mathematics 4 units
Math 420 Foundations of Mathematics 4 units

Common substitutions:
Students wishing to obtain a computer science major or minor typically substitute CoSc 220 and 221 for CoSc 105.

Requirements for a Bachelor of Arts in Mathematics Education

For the Bachelor of Arts degree in Mathematics Education, a student must pass the following:

Lower-division Courses (13 units)
Offered once or twice a year
MATH 110 Colloquium in Mathematics (spring) 1 unit
Math 210 Calculus I 4 units
Math 211 Calculus II 4 units
Math 212 Calculus III 4 units

Choose one of the following (5-7 units):
PHYS 210 Physics I 5 units
or CHEM 120 General Chemistry I 3 units
CHEM 120L General Chemistry I Lab 1 unit
CHEM 121 General Chemistry II 3 units

Sophomore upper-division courses (8 units)
Offered once a year
MATH 360 Transition to Abstract Math 4 units
MATH 330 Linear Algebra 4 units

Junior/Senior upper-division courses (4 units)
Offered once every 2 years
Math 530 Real Analysis 4 units

Select three additional upper-division courses (10-12 units)
Offered once every 2 years
Others may be available occasionally
Math 316 Biostatistics 3 units
Math 340 Differential Equations (offered every fall) 3 units
Math 420 Foundations of Mathematics 4 units
Math 430 Algebraic Structures I 4 units
Math 431 Algebraic Structures II 4 units
Math 510 Probability 4 units
Math 511 Statistics 4 units

Required Teacher Education classes (20 units)
EDUC 351 Child Development 4 units

EDUC 561 The Teaching-Learning Process 4 units
EDUC 562 The School and Society 4 units
EDUC 564S Reading and Language Arts in Content Areas--Single Subject 4 units
EDUC 570 Methods of Content Area Instruction in English for Cross-Cultural Settings 4 units

In order to earn a California teaching credential, students will be required to pass the CSET Single-Subject Mathematics Exam and complete their student teaching requirement (EDUC 566, EDUC 581, EDUC 582, and EDUC 583). Students should refer to the Teacher Education Professional Sequence Requirements listed in the Humanities and Teacher Education Division for more information.

Bachelor of Science in Computer Science/Mathematics
The Standard Sequence
The courses are divided into a first year core, a second year core, and an upper division curriculum. Following is a list of the courses that are taken in the normal sequence.

First Year
MATH 220 Formal Methods (3)
COSC 220 Computer Science I (3)
MATH 210 Calculus I (4)
MATH 221 Discrete Structures (3)
COSC 221 Computer Science II (3)

Second Year
MATH 211 Calculus II (4)
COSC 320 Data Structures (4)
PHYS 210 Physics I (5)
MATH 212 Calculus III (4)
COSC 330 Computer Systems (3)

Third Year
MATH 460 Automata Theory (3)
COSC 450 Programming Paradigms (4)
MATH 330 Linear Algebra (4)
COSC 535 Operating Systems, elective * (3)

Fourth Year
MATH 510 Probability and Statistics I (4)
COSC 475 Computer Networks (4)
COSC 490 Senior Capstone (4)
COSC 525 Computer Organization, elective * (3)

*Note: Only one elective required

5. Whittier College
Department of Mathematics

Core courses for the major (With or without emphasis)

Calculus and Analytic Geometry I, MATH 141A or Integrated Precalculus/Calculus, 139A,B, 4 (7 credits)
Calculus and Analytic Geometry II, MATH 141B (4 credits)
Calculus and Analytic Geometry III, MATH 241 (4 credits)
Abstract Thinking, MATH 280 (3 credits)
Linear Algebra, MATH 380 (3 credits)
Senior Seminar, MATH 491A, B (4 credits)

I. Major in Mathematics (no emphasis)
In addition to the core courses, this option requires seven additional mathematics courses, five of which must be at the 300 level or higher. These seven courses must include at least one course from each of groups A, B, and C below.
Group A. Analysis and Geometry Courses (at least one):
Advanced Geometry, MATH 320 (3 credits)
Complex Variables, MATH 344 (3 credits)
Differential Equations I, MATH 345A (3 credits)
Differential Equations II, MATH 345B (3 credits)
Point Set Topology, MATH 360 (3 credits)
Introduction to Analysis I, MATH 440A (3 credits)
Introduction to Analysis II, MATH 440B (3 credits)

Group B. Algebra and Discrete Mathematics Courses (at least one):
Discrete Mathematics, MATH 220 (3 credits)
Number Theory, MATH 305 (3 credits)
Modern Algebra I, MATH 480A (3 credits)
Modern Algebra II, MATH 480B (3 credits)

Group C. Applied Mathematics Courses (at least one):
Probability and Statistics, MATH 315 (3 credits)
Numerical Analysis, MATH 350 (3 credits)
Mathematical Modeling, MATH 354 (3 credits)
Quantum Mechanics, PHYS 350 (3 credits)
or another upper-division mathematics course or an upper- division course in another department. This course must be for at least 3 credits, involve an application of mathematics to another field, and be approved by the mathematics department faculty.

In addition, at least two of these seven courses beyond the Core Courses must be on the following list of Abstract Courses:

Abstract Courses
Advanced Geometry, MATH 320 (3 credits)
Point Set Topology, MATH 360 (3 credits)
Introduction to Analysis I, MATH 440A (3 credits)
Introduction to Analysis II, MATH 440B (3 credits)
Modern Algebra I, MATH 480A (3 credits)
Modern Algebra II, MATH 480B (3 credits)

II. Major in Mathematics with Teaching Credential Emphasis
In addition to the core courses, this option requires the following eight courses:
Programming I, COSC 120 (3 credits)
Discrete Mathematics, MATH 220 (3 credits)
Number Theory, MATH 305 (3 credits)
Probability and Statistics, MATH 315 (3 credits)
Advanced Geometry, MATH 320 (3 credits)
History of Mathematics, MATH 400 (3 credits)
Introduction to Analysis I, MATH 440A (3 credits)
Modern Algebra I, MATH 480A (3 credits)

6. Chapman University

Department of Mathematics and Computer Science

BACHELOR OF SCIENCE IN MATHEMATICS

requirements (32 credits)

MATH 110	Single Variable Calculus I	3
MATH 111	Single Variable Calculus II	3
MATH 210	Multivariable Calculus	3
MATH 211	Linear Algebra	3
CPSC 230	Computer Science I	4
CPSC 231	Computer Science II	4
MATH 250	Discrete Mathematics I	3
MATH 350	Differential Equations	3
MATH 380	Introduction to Abstract Algebra	3
MATH 450	Real Analysis	3

general science requirement (8 credits)

a two–semester sequence of laboratory natural science courses	8

One of these courses may be used to satisfy the natural science inquiry general education requirement.

electives (21 credits)

Students, in consultation with and approval from the mathematics department advising committee, will design individual elective programs to suit their academic goals. Mathematics electives may be satisfied by any of the following courses:

MATH 208	Foundations of Geometry	3
MATH 251	Discrete Mathematics II	3
MATH 260	Number Theory	3
MATH 270	Computational Mathematics Tools	3
	Any upper–division mathematics course.	
	Any upper–division computer science course.	

For students interested in pure mathematics, especially those interested in pursuing a graduate degree, the department strongly recommends the following courses: MATH 260, MATH 440, MATH 451 and MATH 460.

For students interested in careers or further study in applied mathematics, the department strongly recommends the following courses: MATH 251, MATH 451 and MATH 454.

For students preparing to become mathematics teachers, the department strongly recommends the following courses: MATH 206, MATH 208 and MATH 260.

total credits **61**

CHAPMAN UNIVERSITY/UNIVERSITY OF CALIFORNIA, IRVINE JOINT DEGREE PROGRAM IN ENGINEERING

Students will complete their first three years of study in the personalized academic environment at Chapman, and their last two years at UCI's Henry Samueli School of Engineering with the facilities and distinguished faculty of that renowned engineering program. While at Chapman students will major in mathematics. The mathematics majors will complete UCI's civil engineering program.

Students will receive two degrees: BS in Mathematics and BS in Civil Engineering

Chapman students need to complete the first three years of the appropriate program of study with an overall GPA of 2.750 or higher to participate in the Joint degree program for admission to UCI.

Some courses need to be completed during summer session at Chapman, UCI or through UCI's University Extension (UNEX) program (see course requirements). Chapman students must meet UC residence requirements to be classified as a resident for fee tuition purposes.

major requirements (Chapman)

PHYS 101	General Physics I	5
PHYS 102	General Physics II	5
MATH 110	Single Variable Calculus I	3
MATH 111	Single Variable Calculus II	3
CHEM 140/140L	General Chemistry I	4
CHEM 150/150L	General Chemistry II (recommended)	4
ECON 200	Principles of Microeconomics	3
MATH 210	Multivariable Calculus	3

MATH 211	Linear Algebra	3
CPSC 230	Computer Science I	4
CPSC 231	Computer Science II	4
MATH 250	Discrete Mathematics I	3
MATH 270	Computational Mathematics Tools	3
MATH 350	Differential Equations	3
MATH 360	Probability Theory	3
Math/ Computer Science electives (8)		24
	taken during summer session at UCI (10 credits)	
ENGR CEE 30	Statics	4
ENGR CEE 80	Dynamics	4
ENGR CEE 81A	CAD	3

See University of California, Irvine catalog for the 4th and 5th year classes in engineering.

7. Loyola Marymount University

Department of Mathematics

Below is a template of an 8-semester plan for a math major who wishes to graduate with the **Bachelor of Arts** degree.

Freshman Year

Fall Semester
MATH 131: Calculus I (4)
MATH 190: Workshop I (1)
ENGL 110: College Writing (3)
HIST 100: University Core (3)
PSYCH 100 [1] : University Core (3)

Spring Semester
MATH 132: Calculus II (4)
MATH 191: Workshop II (1)
PHYS 101: Science Req (4)
PHIL 160:University Core (3)
ENGL 160: University Core (3)

Core Requirement (3)
TOTAL: 17 units

TOTAL: 15 units

Sophomore Year

Fall Semester
MATH 234: Calculus III (4)
MATH 248: Intro to Methods of Proof(3)
COMM 100: University Core (3)
Critical Art: University Core (3)
Creative Art: University Core (3)
TOTAL: 16 units

Spring Semester
MATH 245: Differential Equations (3)
MATH 250: Linear Algebra (3)
MATH 282: Elem. Numerical Methods (3)
EDUC 414: Education Req (3)
EDUC 400 [2] : University Core (3)
HIST 162*: University Core (3)
MATH 293**: Field Experience (0)
TOTAL: 18 units

Junior Year

Fall Semester
MATH 321: Real Variables I (3)
MATH 360: Intro to Prob & Stat (3)
EDUC 425: Education req (or 2nd sci)(3/4)
THEO 1XX: University Core (3)
PHIL 3XX: University Core(3)
Core or Elective (3)
TOTAL: 15/16 units

Spring Semester
MATH 331: Elements of Group The (3)
MATH 490: History of Math (3)
MATH 3XX: Math elective (3)
EDUC 440: Elective (3)
THEO 3XX: University Core (3)
EDUC 401 [1] : University Core
TOTAL: 18 units

Senior Year

Fall Semester
MATH 357: Complex Var (3)
MATH 493 or 497: Sem for Educators/Thesis (3)
MATH 550: Geometry (3)
EDUC 488: Elective(3)
TOTAL: 15 units

Spring Semester
EDUC 428: Elective (3)
EDUC 412***: Elective, Student Teaching (9)
TOTAL: 12 units

1. EDUC 401 can be substituted for an upper division psych class.

2. EDUC 400 can be substituted for AMCS 100 to be paired with PSYCH 100 to satisfy the 6 units of social science requirement.

* HIST 162 satisfies both the U.S. Constitution requirement for the preliminary teaching credential and 3 units of the history core requirement. POLS 135 satisfies both the U.S. Constitution requirement for preliminary teaching credential and 3 units of the social science core requirement.

** This course is required for the student who wishes to get a secondary teaching credential.

*** For the student who is working on the teaching credential, these units can be used for the student teaching.

Below is a template of an 8-semester plan for a math major who wishes to graduate with the **Bachelor of Science** degree.

Freshman Year

Fall Semester
MATH 131: Calculus I (4)
MATH 190: Workshop I (1)
ENGL 110: College Writing (3)
Core Requirement (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 17 units

Spring Semester
MATH 132: Calculus II (4)
MATH 191: Workshop II (1)
Science Requirement (3/4)
Core Requirement (3)
Core Requirement (3)
TOTAL: 15 units

Sophomore Year

Fall Semester
MATH 234: Calculus III (4)
MATH 248: Intro to Methods of Proof(3)
Science or Core Requirement (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 17 units

Spring Semester
MATH 245: Differential Equations (3)
MATH 250: Linear Algebra (3)
MATH 282: Elem. Numerical Methods (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 15 units

Junior Year

Fall Semester
MATH 321: Real Variables I (3)
Math Requirement (3)
Math or Major Requirement (3)
Core Requirement (3)
Core or Elective (3)
TOTAL: 15 units

Spring Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core Requirement (3)
Core or Elective (3)
TOTAL: 15 units

Senior Year

Fall Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core or Elective (3)
Core or Elective (3)
TOTAL: 15 units

Spring Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core or Elective (3)
Core or Elective (3)
TOTAL: 15 units

Below is a template of an 8-semester plan for a **Bachelor of Science in Applied Mathematics** degree.

Freshman Year

Fall Semester
MATH 131: Calculus I (4)
MATH 190: Workshop I (1)
ENGL 110: College Writing (3)
Core Requirement (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 17 units

Spring Semester
MATH 132: Calculus II (4)
MATH 191: Workshop II (1)
Science Requirement (3/4)
Core Requirement (3)
Core Requirement (3)
TOTAL: 15 units

Sophomore Year

Fall Semester
MATH 234: Calculus III (4)
MATH 248: Intro to Methods of Proof(3)
Science or Core Requirement (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 17 units

Spring Semester
MATH 245: Differential Equations (3)
MATH 250: Linear Algebra (3)
MATH 282: Elem. Numerical Methods (3)
Core Requirement (3)
Core Requirement (3)
TOTAL: 15 units

Junior Year

Fall Semester
MATH 321: Real Variables I (3)
Math Requirement (3)
Math or Major Requirement (3)
Core Requirement (3)
Core or Elective (3)
TOTAL: 15 units

Spring Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core Requirement (3)
Core or Elective (3)
TOTAL: 15 units

Senior Year

Fall Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core or Elective (3)
Core or Elective (3)
TOTAL: 15 units

Spring Semester
Math Requirement (3)
Math Requirement (3)
Math or Major Requirement (3)
Core or Elective (3)
Core or Elective (3)
TOTAL: 15 units

Master of Arts in Teaching Mathematics

The Master of Arts in Teaching Mathematics program provides an opportunity for secondary school teachers to broaden their background in mathematical science and to correlate this knowledge with current education practice.

Program Requirements

During the first semester of attendance, the student should prepare a program of study with a faculty advisor. A degree candidate is required to complete, with an average grade of at least 3.0 ("B"), a program of study that may include additional prerequisite undergraduate-level coursework, and that must include thirty or more semester hours of graduate-level

coursework, as deemed appropriate by the advisor in consultation with the department. Of the graduate level coursework, at least fifteen semester hours are to be in Mathematics and the remainder in Education. Available courses in Mathematics include topics courses in Real Variables, Complex Variables, Algebraic Structures, Geometry, Topology, Numerical Analysis, Probability and Statistics, Mathematical Modeling, Operations Research, and History of Mathematics. All coursework in Education is to be 600-level courses. In addition, all candidates for the Master of Arts in Teaching Mathematics are required to register for and complete an approved project in mathematics education.

Lower Division Courses 100 - 299
MATH 101: ALGEBRA (3 Semester Hours)
MATH 102: QUANTITATIVE SKILLS FOR THE MODERN WORLD (3 Semester Hours)
MATH 103: Quantitative Skills for the Modern World Lab (0 Semester Hours)
MATH 104: ELEMENTARY STATISTICS (3 Semester Hours)
MATH 106: MATHEMATICS FOR ELEMENTARY TEACHERS I (3 Semester Hours)
MATH 107: MATHEMATICS FOR ELEMENTARY TEACHERS II (3 Semester Hours)
MATH 111: MATHEMATICAL ANALYSIS FOR BUSINESS I (3 Semester Hours)
MATH 112: MATHEMATICAL ANALYSIS FOR BUSINESS II (3 Semester Hours)
MATH 120: PRECALCULUS MATHEMATICS (3 Semester Hours)
MATH 122: CALCULUS FOR THE LIFE SCIENCES I (3 Semester Hours)
MATH 123: CALCULUS FOR THE LIFE SCIENCES II (3 Semester Hours)
MATH 131: CALCULUS I (4 Semester Hours)
MATH 132: CALCULUS II (4 Semester Hours)
MATH 190: WORKSHOP IN MATHEMATICS I (2 Semester Hours)
MATH 191: WORKSHOP IN MATHEMATICS II (2 Semester Hours)
MATH 198: SPECIAL STUDIES (0-4 Semester Hours)
MATH 199: INDEPENDENT STUDIES (1-4 Semester Hours)
MATH 234: CALCULUS III (4 Semester Hours)
MATH 245: ORDINARY DIFFERENTIAL EQUATIONS (3 Semester Hours)
MATH 248: INTRODUCTION TO METHODS OF PROOF (3 Semester Hours)
MATH 250: LINEAR ALGEBRA (3 Semester Hours)
MATH 261: MATHEMATICS: CONTRIBUTIONS BY WOMEN (3 Semester Hours)
MATH 264: CRYPTOGRAPHY THROUGHOUT THE AGES (3 Semester Hours)
MATH 282: ELEMENTARY NUMERICAL METHODS (3 Semester Hours)
MATH 285: DISCRETE MATHEMATICS FOR ENGINEERING (3 Semester Hours)
MATH 293: FIELD EXPERIENCE FOR FUTURE TEACHERS (0 Semester Hours)
MATH 298: SPECIAL STUDIES (1-4 Semester Hours)
MATH 299: INDEPENDENT STUDIES (1-4 Semester Hours)

Upper Division Courses 300 - 499
MATH 301: MATHEMATICAL IDEAS FOR FUTURE TEACHERS I (3 Semester Hours)
MATH 302: MATHEMATICAL IDEAS FOR FUTURE TEACHERS II (3 Semester Hours)
MATH 308: MATHEMATICS FOR ELEMENTARY SCHOOL TEACHERS WORKSHOP I (1 Semester Hour)
MATH 309: MATHEMATICS FOR ELEMENTARY SCHOOL TEACHERS WORKSHOP II (1 Semester Hour)
MATH 321: REAL VARIABLES I (3 Semester Hours)

MATH 322: REAL VARIABLES II (3 Semester Hours)
MATH 331: ELEMENTS OF GROUP THEORY (3 Semester Hours)
MATH 332: ELEMENTS OF THE THEORY OF RINGS AND FIELDS (3 Semester Hours)
MATH 350: ADVANCED LINEAR ALGEBRA (3 Semester Hours)
MATH 355: METHODS OF APPLIED MATHEMATICS (3 Semester Hours)
MATH 357: COMPLEX VARIABLES (3 Semester Hours)
MATH 360: INTRODUCTION TO PROBABILITY AND STATISTICS (3 Semester Hours)
MATH 366: DISCRETE METHODS (3 Semester Hours)
MATH 393: MATHEMATICS INTERNSHIP (1-3 Semester Hours)
MATH 397: PUTNAM PREPARATION (0-1 Semester Hours)
MATH 398: SPECIAL STUDIES (1-4 Semester Hours)
MATH 399: INDEPENDENT STUDIES (1-4 Semester Hours)
MATH 471: TOPOLOGY (3 Semester Hours)
MATH 473: DIFFERENTIAL GEOMETRY (3 Semester Hours)
MATH 490: HISTORY OF MATHEMATICS (3 Semester Hours)
MATH 491: SENIOR MATHEMATICS SEMINAR (3 Semester Hours)
MATH 493: SENIOR SEMINAR FOR FUTURE MATHEMATICS EDUCATORS (3 Sem Hrs)
MATH 495: MATHEMATICAL MODELING (3 Semester Hours)
MATH 497: SENIOR THESIS (3 Semester Hours)
MATH 498: SPECIAL STUDIES (1-3 Semester Hours)
MATH 499: INDEPENDENT STUDIES (1-3 Semester Hours)

Upper Division Courses 500 - 599
MATH 511 MATHEMATICS AND GENDER ISSUES (3 Semester Hours)
MATH 550: FUNDAMENTAL CONCEPTS OF GEOMETRY (3 Semester Hours)
.MATH 560: ADVANCED TOPICS IN PROBABILITY AND STATISTICS (3 Semester Hours)
MATH 561: COMPUTATIONAL METHODS IN LINEAR ALGEBRA (3 Semester Hours)
MATH 562: NUMERICAL ANALYSIS (3 Semester Hours)
MATH 568: MATHEMATICAL METHODS OF OPERATIONS RESEARCH (3 Sem Hrs)
MATH 575: INTRODUCTION TO ORBIT DETERMINATION (3 Semester Hours)
MATH 582: ANALYSIS OF ALGORITHMS (3 Semester Hours)
MATH 590 HISTORY OF MATHEMATICS FOR SECONDARY TEACHERS (3 Sem Hrs)
MATH 598: SPECIAL STUDIES (1-3 Semester Hours)
MATH 599: INDEPENDENT STUDIES (1-3 Semester Hours)
MATH 695 MAT FINAL PROJECT

8. University of San Diego

Department of Mathematics and Computer Science

Major Requirements

In order to obtain a major in mathematics, the student must satisfy the Core Curriculum requirements as set forth in this Bulletin and complete the following courses:

COMP 150 (3)
MATH 150, 151, 160*, 250 (15)
MATH 320 (3)
MATH 350 or 361 or 380 (3)
MATH 360 (3)
MATH 375 or 385 (3)
PHYS 270, 271 (8)
Upper-division mathematics electives (12)

Recommended Program of Study for the Mathematics Major

	Semester I	**Semester II**
Freshman Year	Preceptorial (3), COMP 150 (3), MATH 150 (4), CC or Electives (6)	MATH 151 (4), MATH 160 (3), PHYS 270 (4), CC or Electives (3 or 6)
Sophomore Year	[MATH 160 (3)], MATH 250 (4), PHYS 271 (4), CC or Electives (6-9)	MATH 320 (3), CC or Electives (9)
Junior Year	Upper-division MATH (6), CC, Minor, or Electives (9)	Upper-division MATH (6), CC, Minor, or Electives (9)
Senior Year	Upper-division MATH (6), CC, Minor, or Electives (9)	Upper-division MATH (3), CC, Minor, or Electives (9)

MATH 150 Calculus I
MATH 151 Calculus II
MATH 160 Logic for Mathematics and Computer Science
MATH 250 Calculus III
MATH 310 Applied Mathematics for Science and Engineering I
MATH 311 Applied Mathematics for Science and Engineering II
MATH 315 Applied Probability and Statistics
MATH 320 Linear Algebra
MATH 330 Ordinary Differential Equations
MATH 331 Partial Differential Equations
MATH 340 Numerical Analysis
MATH 341 Numerical Analysis II
MATH 350 Probability
MATH 351 Mathematical Statistics
MATH 355 Combinatorics
MATH 360-361 Advanced Calculus
MATH 365 Complex Function Theory
MATH 370 Theory of Numbers
MATH 375 Algebraic Systems
MATH 380 Geometry
MATH 385 Topology
MATH 388 Mathematical Logic
MATH 395 Mathematical Problem Solving Seminar
MATH 405 Advanced Perspective on High School Mathematics
MATH 445 Mathematical Modeling
MATH 494 Special Topics
MATH 495W Senior Project in Applied Mathematics A
MATH 496W Senior Project in Applied Mathematics B
MATH 498 Internship
MATH 499 Independent Study

Minor Requirements

Students may obtain a minor in mathematics by completing 18 units of mathematics course work. These units must include at least 6 units of upper-division work as well as MATH 150, 151, and 250. The Single Subject Teaching Credential in Mathematics: Math 120, 370, 380, 375, 325W, and 305 are required for the credential. See the School of Education for further requirements.

9. Manchester College

Department of Mathematics and Computer Science

Baccalaureate Degree
Courses listed in parentheses are prerequisites.
Major in mathematics, 42-44 hours: MATH 121, 122, 130, 231, 240, 251, 333, 421, 499; Nine hours of approved electives, selected from: (CPTR 105) MATH 233, 245, 306, 330, 402, 380 or 480, 385 or 485; (PHYS 210, 220) PHYS 301 or (CHEM 211 and PHYS 210, 220) CHEM 341; (ECON 221) ECON 350; (CPTR 205) CPTR 310.
Majors must successfully complete the senior comp. evaluation prior to graduation

Minor in mathematics, 25 hours: MATH 121, 130; 17 hours of electives selected from: MATH 122, 231, (CPTR 105) 233, MATH 240, 245, 251, 306, 330, 333, 402, 421, 380 or 480, 385 or 485; (PHYS 210, 220) PHYS 301 or (CHEM 211 and PHYS 210, 112) CHEM 341; (CPTR 205) CPTR 310; (ECON 221) ECON 350.

Courses:
100 BASIC MATHEMATICS - 2 hours
101 MATH FOR ELEMENTARY TEACHERS I - 3 hours
102 MATH FOR ELEMENTARY TEACHERS II - 3 hours
103 SURVEY OF MATHEMATICAL THOUGHT - 3 hours
105 BASIC ALGEBRA - 2 hours
107 MATHEMATICS FOR ELEMENTARY TEACHERS - 3 hours
112 COLLEGE ALGEBRA - 3 hours
113 QUANTITATIVE REASONING - 3 hours
115 ELEMENTARY PROBABILITY AND STATISTICS - 3 hours
120 PRECALCULUS - 3 hours
121 CALCULUS I - 4 hours
122 CALCULUS II - 4 hours
130 DISCRETE MATHEMATICS - 4 hours
210 STATISTICAL ANALYSIS - 4 hours
231 MULTIVARIABLE CALCULUS - 4 hours
233 NUMERICAL ANALYSIS - 3 hours
240 MATHEMATICAL STATISTICS - 4 hours
245 ORDINARY DIFFERENTIAL EQUATIONS - 3 hours
251 LINEAR ALGEBRA I - 4 hours
303 MATH FOR ELEMENTARY TEACHERS III - 3 hours
306 GEOMETRY - 3 hours
330 OPERATIONS RESEARCH MODELS - 3 hours
333 ALGEBRAIC STRUCTURES - 4 hours
402 LINEAR ALGEBRA II - 3 hours
421 REAL ANALYSIS - 3 hours
475 INTERNSHIP IN MATHEMATICS - 1-3 hours
499 SENIOR PROJECT (W) - 1-3 hours
380 or 480 SPECIAL PROBLEMS - 1-4 hours
385 or 485 SEMINAR - 1-4 hour

10. Elizabethtown College

Department of Mathematical Sciences

Majors Offered

- Bachelor of Science in Actuarial Science
- Bachelor of Science in Mathematics

Honors Mathematics

- HMA270* HNR MA History of Mathematics
- HMA272* HNR MA Ethnomathematics
- HMA275* HNR CE Mathematics in Music

Mathematics

- MA011 Intermediate Algebra
- MA105* MA Mathematics for Liberal Studies
- MA110* MA College Algebra and Trigonometry
- MA117* MA Concepts of Calculus
- MA121* MA Calculus I
- MA122 Calculus II
- MA170 Special Topics in Mathematics
- MA201 Linear Algebra
- MA205 Fundamentals of Mathematics
- MA222 Calculus III
- MA235 Discrete Mathematics with Proofs
- MA251* MA Probability and Statistics
- MA252 Statistical Methods in Research
- MA255 Mathematics of Compound Interest
- MA256 Problem Solving in Interest Theory
- MA301 Abstract Algebra
- MA321 Differential Equations
- MA331 Operations Research
- MA341 Modern Geometry
- MA351 Theory of Probability
- MA352 Mathematical Statistics
- MA355 Problem Solving in Actuarial Science
- MA362 Numerical Analysis
- MA370 Special Topics in Math
- MA400 Senior Project
- MA421 Real Analysis
- MA425 Complex Variables
- MA441 Topology
- MA457 Actuarial Models - Financial Economics
- MA458 Actuarial Models - Life Contingencies

- MA471 Internship in Mathematics
- MA484 Independent Study in Math

Bachelor of Science in Actuarial Science
Actuarial science majors are required to take Mathematics 121, 122, 201, 222, 235, 251, 252, 255, 256, 351, 352, 355, either Mathematics 331 or 362, and either Mathematics 457 or 458; Accounting 101; Economics 101, 102 and 309; and Business Administration 325. In addition, Computer Science 121 is required and should be taken as early as possible. Also required is evidence of successful completion, prior to graduation, of the Exam P or Exam FM examination of the Society of Actuaries (SOA). The completion of additional examinations is encouraged.

Bachelor of Science in Mathematics
All mathematics majors are required to take a minimum of 43 credits in mathematics courses, including Mathematics 121, 122, 201, 222, 235, 301, 351 and 421. Acceptable mathematics electives are courses numbered 251 or above. In addition, Computer Science 121 is required and should be taken as early as possible. As part of these requirements, students may elect one of the following three concentrations:

The Applied Mathematics concentration provides a background in applied mathematics and statistics, enabling graduates to seek careers in government and industry, or to pursue graduate work in applied mathematics or statistics. The Applied Mathematics concentration requires three courses selected from Mathematics 321, 331, 352 and 362 and one course from acceptable mathematics electives; Computer Science 122; and Physics 200.

The Pure Mathematics concentration is designed to provide a foundation for successful graduate study in mathematics. The Pure Mathematics concentration requires Mathematics 425 and 441, and two courses from acceptable mathematics electives.

The Secondary Education concentration (Mathematics Education) is required for secondary education certification. Students in this concentration are given a solid foundation in geometry, algebra and statistics essential for effective teaching and analysis of the secondary school mathematics curriculum. In addition to the requirements above for the Mathematics major, the Secondary Education concentration requires Mathematics 341, either Mathematics 252 or 352, and two courses from acceptable mathematics electives; Education 106, 151, 241, 305, 470, 490, 497; Special Education 282; Physics 200; and two English courses (one writing and one literature). Education 161 or 162 also is recommended.

Appendix R: Curriculum Map

		Learning Outcomes														
		1						**2**					**3**	**4**	**5**	**6**
Crs #	**Course Title**	**a**	**b**	**c**	**D**	**e**	**f**	**a**	**b**	**c**	**d**	**e**				
201	Calculus I	X	X	X			X	X	X		X	X	X	X	X	X
202	Calculus II	X	X	X		X	X	X	X		X	X	X	X	X	X
305	Transition to Advanced Mathematics		X	X				X			X		X	X		X
311	Calculus III	X	X	X			X	X	X		X	X	X	X	X	X
315	Differential Equations	X	X		X	X	X	X	X	X		X		X	X	X
319	Vector Calculus	X	X				X	X	X	X		X		X	X	X
320	Linear Algebra		X		X		X	X	X	X	X	X	X	X	X	X
325	Number Theory		X				X	X	X	X		X	X	X	X	X
327	Discrete Mathematics		X	X				X				X			X	X
328	Abstract Algebra		X	X				X		X	X	X	X	X	X	X
330	Foundations of Geometry		X					X		X				X		X
342	Analytical Mechanics					X	X	X	X	X		X			X	X
351	Probability		X	X				X		X		X	X			X
362	Numerical Algorithms	X				X	X	X	X	X	X	X				X
367	Object Oriented Language C++ (CMPS)						X	X	X		X					X
375	Mathematical Modeling				X	X	X	X	X	X	X	X	X		X	X
410	Real Analysis	X	X	X				X		X			X	X		X
412	Complex Analysis	X	X	X				X		X				X		X
418	Advanced Engineering Math				X	X	X	X	X			X		X	X	X
482	History of Mathematics		X					X		X			X	X		X
499	Senior Project		X					X		X		X	X	X	X	X

	Learning Outcomes
1	Acquired core knowledge in:
1a	single and multivariable differential and integral calculus,
1b	standard techniques of proof and application within framework of math. logic and quantifier theory,
1c	fundamental set theory, function theory, and various concepts of abstraction in mathematics related to cardinality, sequences, basic probability and combinatorics
1d	linear algebra,
1e	differential equations,
1f	and a high level (such as C++), software package, significant experience with a CAS.
2	Developed abilities related to solving problems and conducting mathematical explorations, including:
2a	an attitude of persistence and a willingness to explore a variety of problem solution methods,

2b	appropriate use of technology while being mindful of inherent limitations,
2c	the ability to independently learn mathematics from written sources, and through ind. math. investigation,
2d	the ability to work collaboratively in a group setting,
2e	and application of theory and techniques to solve problems arising in diverse areas such as …
3	Learned to effectively communicate mathematical information both orally and in written form.
4	Developed a sense of the consistency, organization, and beauty inherent in mathematics.
5	Developed a sense of the interconnectedness of concepts in seemingly disparate fields of mathematics, as well as how techniques in one area of mathematics can be applied to solve problems in another area.
6	Prepared themselves for a position in teaching, graduate school, or industry or government.

Appendix S: Course Evaluation Analysis

Mathematics Department

Course Evaluation Analysis
Summary Report

Submitted to:
Dr. Michael Frantz, Chair
February 17, 2009

Prepared by:
Danielle Bryce and Natalie Roweiheb, M.A., Psychology Doctorate students at the University of La Verne

Supervised by:
Aghop Der-Karabetian, Ph.D.

Purpose

The purpose of the content analysis of course evaluations in the Mathematics Department is to provide faculty program-wide feedback regarding perceptions and experiences of students in the classroom as part of the departmental program review process.

Method

The course evaluations from Fall 2006 semester through Spring 2008 semester were used. Only the responses to the four open-ended questions were used. Because of the large volume of responses every fifth student's comment was randomly selected for inclusion from each question across all courses. Altogether the following six categories were used to group the responses:
1. Positive personal teacher characteristics
2. Positive course structure and presentation characteristics
3. Negative personal teacher characteristics
4. Negative course structure and presentation characteristics
5. Classroom environment and student factors
6. General unspecified positive and negative comments

Within each of the categories a variety of themes were identified which were used to capture student comments. A comment by one student could include one or more themes.
Two independent judges had to agree about the thematic response category of any one particular comment.

The statistics in the tables present the percentage of thematic responses within each category as well as percentage of grand total of all thematic responses. A grand total of 1037 thematic responses were identified, and 35 percent of the grand total of thematic responses were negative and 65 percent were positive; a similar breakdown of responses has been observed in other such content analyses.

Findings

- Table 1 shows that nearly 2 out of every 3 of all responses reflected positive themes regarding the mathematics courses.
- Table 2 illustrates the percentage of positive themes related to the teacher's characteristics in the classroom. Approximately 1 out of every 3 positive themes related to personal teacher characteristics was due to the perception that he or she was "caring, positive, nurturing, approachable, and helpful".
- Table 3 demonstrates the percentage of positive themes related to course structure and presentation. In this category, responses indicating that assignments and class activities were helpful occurred in 3 out of 10 responses, as did responses indicating that students learned course content.
- Table 4 illustrates the percentage of negative themes related to personal teacher characteristics. Over half of the responses indicated that the professor had a "limited variety of teaching techniques".
- Table 5 presents the percentage of negative themes related to course structure and presentation. At least 1 in 3 responses reflected that the course work was overly rigorous, grading was harsh, there was too much material and the class was too fast-paced.

- Table 6 reflects classroom environmental factors or students' influences that negatively impacted the course. Half of the responses indicated that other students in the course negatively impacted it.
- Table 7 reflects the percentage of the unspecified positive and negative themes of the responses provided by the students. Approximately 3 out of every 4 responses were positive.

Summary

The most frequently identified positive characteristic of the professors was that they were "caring, positive, nurturing, approachable, and helpful", while the most frequent negative characteristics was that they had a "limited variety of teaching techniques". The most frequent positive themes related to course structure and presentation were that the courses entailed helpful assignments and activities and that students learned the course content, and the most frequent negative theme regarded course work that was overly rigorous, grading that was harsh, there was too much material, and that the class was too fast-paced. Environmental and student factors that negatively impacted the course were "other students".

Table 1

Percentage of grand total of **positive** and **negative** themes in the evaluation of courses in the Mathematics Department at the University of La Verne

	All Thematic Responses	
Themes	n	%
Negative	367	35
Positive	670	65
Grand Total	1037	100

Note. The majority of the overall comments taken from course evaluations were positive.

Table 2

Percentage of **positive** themes related to **personal teacher characteristics** in the Evaluations of courses taught by the faculty in the Mathematics Department at the University of La Verne.

	This Category		% of Grand Total
Themes	n	%	
1. Caring, positive, Nurturing, approachable, Helpful	116	35	11
2. Enthusiastic and motivating	37	11	4
3. Knowledgeable, professional, prepared, high standards	70	21	7
4. Good communication skills Effective teaching techniques	80	25	8
5. Good personalized attention	25	8	2
Total	328	100	32

Note. The most reported positive theme related to the personal characteristics of professors was that they were “caring, positive, nurturing, approachable, and helpful”.

Table 3

Percentage of **positive** themes related to course structure and presentation in the evaluations of courses taught by the faculty in the Mathematics Department at the University of La Verne.

	This Category		% of Grand Total
Themes	n	%	
1. Helpful assignments/ Activities	36	30	3.5
2. Well organized	8	6	1
3. Interesting subject matter	3	2	.03
4. Student and class involvement	10	7	1
5. Effective resources	7	5	.07
6. Relevant or applied material	10	7	1
7. Productive-learned content	36	30	3.5
8. Productive-learned skills	14	10	1.5
9. Relaxed atmosphere	5	3	.05
Total	129	100	13

Note. The most reported positive themes pertaining to course structure and presentation were that assignments and class activities were helpful and that the student learned course content.

Table 4

Percentage of **negative** themes related to personal teacher characteristics in the evaluations of courses taught by the faculty in the Mathematics Department at the University of La Verne.

	This Category		% of Grand Total
Themes	n	%	
1. Uncaring, critical, unapproachable, biased	23	17	2
2. Lack of enthusiasm	8	6	.08
3. Lack of knowledge and/or preparation	8	6	.08
4. Poor communication skills (monotone, unclear speaking or Unintelligible writing)	23	17	2
5. Unprofessional	5	3	.04
6. Limited variety of Teaching techniques	70	51	7
Total	137	100	13

Note. The most reported negative theme related to the personal characteristics of professors was that they had a “limited variety of teaching techniques”.

Table 5

Percentage of **negative** themes related to course structure and presentation in the evaluations of courses taught by the faculty in the Mathematics Department at the University of La Verne.

	This Category		% of Grand Total
Themes	n	%	
1. Inappropriate or unhelpful Assignments	15	10	1.5
2. Poor organized, Time management	15	10	1.5
3. Subject matter is not Interesting	7	4	.06
4. Lack of student involvement	16	11	1.5
5. Poor resources (dull or inappropriate audio/ Visuals, speakers)	9	6	.09
5. Overly rigorous course work Or harsh grading, too much Material, too fast paced	54	35	5
6. Limited presentation, wish for Additional topics or for topics to Be covered in more depth	26	17	3
7. Poor scheduling and timing	6	4	.06
8. Irrelevant course material	4	3	.04
Total	152	100	15

Note. The most reported negative theme pertaining to course structure and presentation was that the course work was overly rigorous, the grading was harsh, there was too much material, and/or the course was too fast paced.

Table 6

Percentage of **negative** themes related to classroom environment and student factors in the evaluations of courses taught by the faculty in the Mathematics Department at the University of La Verne.

	This Category		% of Grand Total
Themes	n	%	
1. Poor Facilities	1	6	.10
2. Other Students	8	50	.80
3. Time slot too short	3	19	.30
4.Lack of readiness for the course	4	25	.40
Total	16	100	1.6

Note. The most reported negative theme pertaining to environmental or student factors affecting the courses were “other students”.

Table 7

Percentage of unspecified general **positive** and **negative** themes in the evaluations of courses in the Mathematics Department at the University of La Verne

	This Category		% of Grand Total
Themes	n	%	
1. Negative	62	23	6
2. Positive	213	77	20
Total	275	100	26

Note. The majority of reported unspecified themes were positive.

Appendix T: Recent Faculty and Student Papers and Presentations; Grants

Vanessa Alday (graduate, 2008)

The Effects of Wind and Altitude in the 400-m Sprint, paper presentation at the Southern California Conference on Undergraduate Research, California Polytechnical University, Pomona, November 22, 2008.

The Effects of Wind and Altitude in the 400-m Sprint with Various IAAF Track Geometries (joint work with Michael Frantz), Mathematics and Sports, Chapter 21, Mathematical Association of America, Dolciani Mathematical Expositions #43, 2010.

Yousef Daneshbod

Papers

Y. Daneshbod, J. D. Sterling and A. Nadim, *Moment Analysis of Near Equilibrium Binding Interactions during Electrophoresis,* Physical Review E 76, 051922 (2007) (Selected for inclusion in the December 1, 2007 issue of Virtual Journal of Biological Physics Research).

Y. Daneshbod and J. Latulippe, *The geometry of undamped harmonic oscillators* , The Mathematical Scientist, In Press (to appear summer 2010).

Y. Daneshbod, J. D. Sterling and A. Nadim, *Modification of Young-Lippmann's Equation in Electrowetting Phenomenon* (in preparation).

Y. Daneshbod, J. D. Sterling and A. Nadim, *Mathematical Model for the Lysis of Cells and Spores,* (In preparation).

Y. Daneshbod and J. Latulippe, *A Look at Harmonic Oscillators Through the Phase Plane ,* submitted to the Mathematics Magazine.

Y. Daneshbod and J. Latulippe, *Similar Curves and Homogeneous First Order Differential Equations,* Submitted to the Mathematics Magazine.

Conference and Seminar Presentations

"Manipulation of sessile drops by electrowetting", R. Miraghaie, A.I. Hickerson, Y. Daneshbod, J.D. Sterling, and A. Nadim, 15th U.S. National Congress of Theoretical and Applied Mechanics, Boulder, Colorado (June 2006).

"The Fascinating World of Microfluidics", Mathematics Department Colloquium at California State Polytechnic University, Pomona, California (November 2007).

"Shape Analysis of Droplets on Patterned Surfaces", AMS, MAA Joint Mathematics Meetings, San Diego, California (January 2008).

Speaker at the Annual Damien High School Career Day, Title of Talk: "What is Mathematics all About?", San Dimas, CA (November 2008).

"A Mathematical Model for Reducing Noise in a Cell-Lyser", Graduate Student Modeling Mini-Camp, Claremont, California (July 2009).
"Designing Channels in a Microfluidic Biochip Device", Claremont Math-in-Industry Workshop, Claremont, California (July 2009).

"Analysis of Electrostatic Forces on Sessile Drops During Electrowetting-on-Dielectric", Y. Daneshbod, J. D. Sterling and A. Nadim 16th US National Congress on Theoretical and Applied Mechanics (USNCTAM), State College, Pennsylvania (July 2010).

Michael Frantz

Papers

The Effects of Wind and Altitude in the 400-m Sprint with Various IAAF Track Geometries (joint work with Michael Frantz), Mathematics and Sports, Chapter 21, Mathematical Association of America, Dolciani Mathematical Expositions #43, 2010.

The Frustrated Mathematician: A Call to Artists, Proceedings, 12th International Bridges Conference on Mathematics, Science, Art, and Music, Banff, Canada, July 26-30, 2009.

A Perspective on Infinity: Anamorphism and Stereographic Projection, Proceedings, 8th International Bridges Conference on Mathematics, Science, Art, and Music, Banff, Canada, Aug. 1-4, 2005.

Presentations

"The Frustrated Mathematician: A Call to Artists", presentation at the 12th International Bridges Conference on Mathematics, Science, Art, and Music, Banff, Canada, July 26-30, 2009.

"The Effects of Wind and Altitude in the 400-m Sprint with Various IAAF Track Geometries" (joint work with Vanessa Alday), presentation at the AMS-MAA Joint Mathematics Meetings in Washington, DC, January 6, 2009.

Xiaoyan Liu

Papers

Univariate and Bivariate Orthornormal Splines and Cardinal Splines on the Compact Supports, Journal of Computational and Applied Mathematics, 195 (2006) 93-105.

Construction of Univariate and Bivariate exponential Splines, to be published in the book Harmonic, wavelet, p-adic analysis, ed. by Nguyen Minh Chuong et. al., World Scientific Pub. Co. Inc.（2007）.

Univariate and Bivariate Cardinal trigonometric Splines, to be published.

Interpolation by Cardinal Exponential Splines, The Journal of Information and Computational Science Vol. 4, No 1 (2007) 179-194.

Interpolation by Cardinal Trigonometric Splines, International Journal of Pure and Applied Mathematics, Vol. 40 , No. 1 (2007) 115-122.

Bivariate Trigonometric and Exponential Splines on Hexagonal Lattices, Seventh International Conference on Mathematical Problems in Engineering, Aerospace and Sciences, Editor: Seenith Sivasundaram, Cambridge Scientific Publishers Ltd, (2009) 288-297.

Presentations

Presentation at the Mathematical Problems in Engineering, Aerospace and Sciences (Genoa, Italy, July, 2008)

Presentation at Seventh International Conference on Mathematical Problems in Engineering, Aerospace and Sciences, (Plovdiv, Bulgaria, July, 2007)

Presentation at the International Symposium on Information and Computational Science (Dalian, Liaoning, China, August , 2006.

Presentation at the International conference on Mathematics (Ulaanbaatar, Mongolia, July, 2006).

Presentation at the International Conference on Hot Topics in Current Applied and Industrial Mathematics (Guiyang, Guizhou, China, July 2005).

Presentation at the 1st International Symposium on Computing and Information (Zhuhai, China, August 2004).

Presentation at the 5th International Congress on Industrial & Applied Mathematics 2003, (Sydney, Australia, July 2003).

Grants

2009-2014, National Science Foundation: Robert Noyce Teacher Scholarship Program, Recruiting, Preparing and Retaining Diverse Science and Mathematics Teachers: The La Verne Noyce Teacher Scholars Program $900K, (C. Broussard, P.I; Y. Daneshbod, V. Preisler, M. Madhuri, D. Nasmyth and H. Good, co-PI).

NSF-CSEMS grant for $400,000 to fund scholarships for students in mathematics and computer science, 2004-2008 (extended to 2008-09, and again to 2009-10); Xiaoyan Liu, P.I.; Michael Frantz, Seta Whitby, co-P.I.'s.

Appendix U: Update on 2004-2009 Mathematics Program Goals and Spring 2003 External Program Review Recommendations

The following is a cumulative list of the goals proposed for the mathematics program for the five year period 2004-2009, ranked by general priority, followed by specific recommendations from an external review team that visited the mathematics program in spring of 2003. Goals over the five year period are assigned on a on a cyclic basis, meaning that if a goal is not accomplished in one year, it cycles forward to the next year, until it gets done. Items are ranked into high-intermediate-low priority listings, and while the high priority items are also ranked in more or less prioritized order, the items rated intermediate or low are not prioritized in this fashion. A rough estimate of resources is given in (parentheses) after each item. In most cases, the primary resource needed is simply time for the faculty members to be able to carry out these tasks, time which could be made available through release time and even simply through increased salaries which would reduce the need for overload courses to be taught. This is an update on all these goals as of August 27, 2008, with current responses indicated by the ► symbol.

Mathematics Program Goals 2004-2009

High Priority (in prioritized order)

1. An additional full time mathematics faculty member is needed. Currently, the mathematics program employs five part-time instructors to teach approximately 28 classes per year, and it is always a major task to staff those positions with high quality instructors. This position should ideally be advertised in late fall, 2004, and hired for the 2005-06 academic year. ($50,000?)

► After submitting requests for a new faculty position for five years running, a new full time faculty member (Dr. Yousef Daneshbod) was hired in spring 2008 to begin teaching in September, 2008. The hiring was the culmination of a five month national search involving over 330 applications and five finalists interviewing on campus. Status: **COMPLETED**

2. A final decision needs to be made within a few months about whether or not the mathematics program will submit a document to the state to apply for subject matter approval in mathematics, and if affirmative, the document needs to be written and submitted by March 1, 2005. (One course paid release time - $2500)

► The decision of the department was that the number of students who benefited from the subject matter program in the past 12 years (2) did not warrant the expenditure of time and resources necessary to submit and get state approval for a new subject matter proposal in mathematics. The decision was made to counsel students to study for and pass the CSET exams instead, and that this was a perfectly good alternative that many other ULV mathematics graduates have adopted successfully. The College of Education would really like the program to reconsider this decision and put a subject matter program in place for mathematics. The mathematics faculty are not excited by the perceived potential return on investment. Status: **COMPLETED**, but **PENDING REVIEW**.

3. A new introductory statistics course which would meet the mathematics general education graduation requirement should be developed, and other possible courses possibly involving art, music, computer graphics, or any of a myriad of other topics should also be considered. (Time)

► A new course, MATH 150 Elementary Statistics, was developed by Michael Frantz and approved to meet the Quantitative Reasoning requirement of the new G.E. (G.E. I), although it appears that its debut on the teaching schedule for fall 2008 will be postponed due to very low initial enrollment. Status: **COMPLETED**

4. The compensation for part-time mathematics instructors needs to be increased to around $3500 to be competitive with other schools that draw from the same hiring pool. (Considerable $ annually!)

► As of Fall 2006, the base salary rate for all undergraduate categories had increased by $145 per four unit course, and in 2008, further annual increases of $500 for each of the subsequent three years were proposed to the administration by the Faculty Salary Committee, until the pay rate is comparable to the average rate for local competing institutions. Status: **STALLED / EXTERNAL**

5. Strategies for maximizing the benefit from the current NSF CSEMS grant money in terms of increasing the number of mathematics majors need to be explored. (Time and unknown $ for support)

► Two separate approvals for extensions were granted by the NSF for ULV to extend the dispersal of a large amount of residual CSEMS funds to the 2008-09 and 2009-10 academic years, two years beyond the scheduled end of the CSEMS program. The PI and CoPIs will continue to meet to discuss strategies for ensuring that as much money as possible is awarded to qualified students. It is unlikely that the NSF would grant a third extension if money remains at the end of this period. Status: **COMPLETED**

6. A handbook for mathematics majors needs to be developed, along the lines of the handbook for biology majors. This should include a set of guidelines for senior projects. (Time and $1000 in printing costs)

► This is still an idea that all want to be done, it is just a question of the chair either writing the handbook, or assigning other faculty members to help him write it and just get it done. Time is the biggest impediment. Some work has been completed on it by the chair. Status: **IN PROGRESS / NEEDS WORK**

7. A Mathematics Club existed at one time, and its revival should be considered now to generate more interest in mathematics. (Time and unknown $ for support of activities)

► A student indicated that she would be interested in and willing to help start a new Mathematics Club, and Dr. Daneshbod has been working on organizing the start-up of such a club, meeting with students several times in the fall of 2009. Care, attention, and support need to be lavished on this venture by the program so as to insure its success, which is not completely assured at this point. Having some key students around for a few years to get it going and stabilized is crucial, and we probably need to increase our core number of majors to come up with such a critical mass. Status: **IN PROGRESS**

8. All mathematics faculty need to maintain web pages with current and relevant information about themselves and the courses they teach. In addition, web pages should be set up within the department pages to provide information on suggested course schedules for majors and minors, as well as senior comprehensive and senior project information, and current events and news in the mathematics program. A web "problem of the week" (or month) type of page would also be nice. (Time)

► With the introduction of a new university-wide content management system for web pages, it has become much easier to maintain web pages on the department site. The chair is the person authorized and trained to make changes to departmental web pages. All full time faculty utilize pre-set course shells in Blackboard for disseminating information and email to their students, automatically set-up through the course registration process. Most if not all part time faculty make use of various aspects of Blackboard as well for disseminating course information and communication with students. Links have been established to major and minor requirements, but further links are needed to suggested course schedules for majors and the two year cycle of courses that mathematics major's courses are offered on. There is also still a need to develop components of the department pages addressing senior comprehensive exam and senior project information, and current events and news in the mathematics program, and a web "problem of the week" (or month) type of page. (Time) Status: **IN PROGRESS / NEEDS WORK**

Intermediate Priority (not in priority order)

1. The mathematics major should be examined in light of recent recommendations by the MAA and revisions in state requirements for subject matter programs, with an eye toward possibly reducing the number of upper division courses offered, reducing the number of directed studies taken by students, and building consistent enrollments in the remaining courses. Every directed study course should count for as some type of overload for faculty, in contrast with the current policy, which mandates up to 10 directed studies per year as a normal part of the load. The questions of whether or not a distinction between the B.A. and B.S. degrees should be maintained, and whether or not different tracks (teaching, industry, graduate school) should be developed for majors, should also be examined. (Time)

► All directed studies are now compensated at the rate of $75 per semester unit, or $300 for a typical 4-unit course. The number of upper division courses has been reduced in the sense that Computer Science has now assumed responsibility for the MATH 327 Discrete Mathematics course, and courses like differential equations, vector calculus, and number theory are only offered if enrollments permit it, even though they are already cut to an every other year offering scheme. A recent change making differential equations a required supportive course for the physics major should assist with low enrollments in that course. The questions of retaining two degrees, the B.A. and B.S., and whether or not to institute various tracks within the major, still need to be addressed. Status: **COMPLETED / IN PROGRESS**

2. A Senior Project course needs to be developed which all graduating seniors can enroll in during the spring semester, to provide a context in which to develop and work on the senior project. (Time)

► No serious work has been done on this yet, mostly because of the large variation in the class size of such a course, but alternate forms of this type of course could be explored. The need still exists for at least a system of regular meetings (if only an hour a week) to keep students on track, as there has been a small uptick in the number of students who have participated in commencement but only lack completing their senior projects and senior comprehensive exams to receive their diplomas. Status: **NO PROGRESS / NEEDS WORK**

3. The College Algebra course should be revised to integrate more real world modeling and problem solving into it, and web-based tutoring for College Algebra and Intermediate Algebra should be investigated to assist students with skills development and concept mastery. With less class time needed for fundamentals, more emphasis could be placed on the higher-order thinking skills the revised course would demand. (Time and unknown $ for online tutoring software licenses)

► A new textbook was selected (Young) that it is hoped will enable the students to perform and pass at higher levels, but the content has not yet shifted in any serious way as described above. The web-based tutoring systems looked at are oriented toward the individual student. A system that would be installed and available for all students in a class has not yet been found, but further investigation is required, as the offerings in this segment of the software world change rapidly. Status: **COMPLETED / IN PROGRESS**

4. Each faculty member in the department should visit the classroom of at least one other faculty member in the department for a collegial review sometime during the year. The division chair has even provided an incentive in the form of a free lunch afterward to discuss the classroom visit. (Time and minor $ incentives)

► This has not happened. The chair needs to get behind this and lead by example and strongly encourage others to make it happen. Status: **NO PROGRESS / NEEDS WORK**

5. The student area for math, physics and chemistry students needs to be expanded to at least twice the present size (currently the front half of MA54), to accommodate more majors wishing to utilize the space, more computers (from the current 4 up to 8), and bookshelves for display of relevant journals and books. (Unknown $)

► No progress has been made on this in terms of space, because there simply is not any more space. It is unlikely that this goal can be achieved until a new science building is built. Status: **NO PROGRESS / NEEDS WORK**

6. ***All*** classrooms in which math courses are taught need to be smart classrooms so that a laptop or other portable computer could be plugged in and used with a projection device and the internet. (Budget from ITC)

► All of the classrooms in which mathematics classes are taught are now smart classrooms. Status: **COMPLETED**

7. The math placement system needs to be thoroughly investigated to see why each semester there still seem to be students that are admitted to math classes without the appropriate prerequisites of math placement scores. An obstacle to being fully aware of the depth of the problem is the difficulty in getting data as to which students have what placement scores or grades in previous classes. (Time and $ for Banner query coding)

► Investigation revealed that there are faculty and professional advisors across campus who at times put in prerequisite registration overrides for students to get into math courses for which they have not qualified. This practice has been brought to the attention of the registrar's office and Academic Advising, and steps have apparently been by those offices taken to reduce this considerably from the prior rate of occurrence. There is still no convenient way for all faculty to retrieve student math placement scores from the MyULV online system; only the chair can get such information from the old Banner production system, and only one student at a time. Status: **ONE COMPLETED / ONE NO PROGRESS / NEEDS WORK.**

8. A system of web-based or online mathematics placement testing should be investigated. (Time and possibly a considerable amount of $)

► The Mathematics Faculty and the LEC worked together to transition in the Fall of 2008 to a new online placement testing system delivered via Maple on the LEC lab computers, funded by the A&S Dean's office, and using widely used standard tests vetted by the Mathematical Association of America. Each year the mathematics faculty will analyze placement test score data and final grades earned in subsequent courses to try to correlate the two in order to tweak the placement cut-off scores for these new tests. The process of setting the optimal cut-off scores is one which will most likely take a few years of this tweaking. Status: **COMPLETED**

9. Although class sizes in MATH 170 Mathematics in Society are improving, work still needs to continue to educate advisors as to the appropriateness of that course meeting the math G.E. requirements for most students, and to increase enrollments in the MATH 170 course. (Time)

► Enrollments actually have dropped considerably, to the point where the three sections that used to be offered each year had been reduced down to one. A new round of advertising via flyer to all advisors resulted in an increase in the past year to where three sections were once again offered, with 24, 8, and 9 students enrolled. Status: **COMPLETED *but continuous monitoring needed***

10. (New goal for August 2008) Strategies need to be developed to either boost enrollments in MATH 150 Elementary Statistics, or else develop a completely different type of Quantitative Reasoning Course that would have greater appeal than statistics.

► The offering of the new MATH 150 Elementary Statics course in Fall 2008 revealed a fact that perhaps in hindsight should have been anticipated by the mathematics faculty: students who desire or need to take statistics prefer to take it from any department other than a mathematics department. The creation of the course did lead to standards whereby the other statistics courses on campus could be adjusted in content and prerequisite to be approved by the mathematics faculty for meeting the CSQR G.E. requirement, a very positive benefit for the university, and a result long sought by other departments. It is probable that this course will not be offered in the classroom for the foreseeable future. Status: **COMPLETED**

11. An in-house database of mathematics graduates should be developed, and letters and a survey instrument should be sent out on an annual basis, in order to create an initial database of graduate feedback. (Time and unknown $)

► The chair has a fairly accurate database of graduates that is being kept up to date moving forward. It probably is not optimal to send out surveys to every alumnus on an annual basis, but rather every five years when a program review is done. An alumni survey instrument has been developed (see Appendix J). Status: **COMPLETED**

12. The senior comprehensive exams need to be looked at by the mathematics faculty for possible revision or alternate exam selection. (Time and unknown $ if another standardized is adopted for in-house use)

► The department still needs to consider this and make a decision on it. The chair examined a mathematics field test from ETS in 2005 and invited the other faculty members to look at it, but they declined. It was the opinion of the chair that that exam was not appropriate for the program of courses that we offer. The two primary questions are whether or not the in-house exam (with a minimum passing score) is appropriate or needs revision, and whether or not we want to continue requiring the GRE Advanced Subject Exam in mathematics (no minimum passing score). Status: **NO PROGRESS / NEEDS WORK**

13. The calculus curriculum should be looked at and possibly revised to try to get it more in synch with three and five hour programs at other schools. (Time)

► The faculty have briefly looked at the sequencing, and although there did not seem to be a feeling that drastic changes were immediately needed, further consideration should be given to the matter. Status: **IN PROGRESS**

Low Priority (not in priority order)

1. Consideration needs to be given to deciding which math courses are suited to and can benefit from adaptation to web versions. (Time; unknown $ for actual conversions)

► At present, no mathematics courses are being offered on the web. There may be a market for online statistics or college algebra or intermediate algebra courses, but the mathematics faculty have little to no time for web course development, and little confidence in the ability of ULV students to be able to pass online courses when they have so much difficulty in passing them in face to face classes. Status: **COMPLETED**, ***but subject to later review***

Summary of and Responses to the 2003 External Review Recommendations

1. Pay part-time faculty members at least $3000 per course, perhaps with a requirement of a minimal number of office hours. They might be contracted for $2500 per course plus $500 for a specified number of office hours.

► See High Priority item 4 above. Status: **STALLED**

2. Consider hiring a full-time instructor or lecturer to teach 8 sections of lower level courses per year with a certain number of office hours and possible committee expectations. (Ideally, hire another tenure track member, and even more ideally, both.)

► See High Priority item 1 above regarding the hiring of a new tenure-track faculty member. Since there are still enough courses taught each year by part-time faculty to fill two full-time positions, it is very desirable to still hire a full-time instructor or lecturer with a full-time salary and benefits to replace half-a dozen part-time faculty, but given the current economic status of the university and the fact that a new faculty member in mathematic was just hired, the probability of such a hiring is bleak at best. Status: **ONE COMPLETED / ONE NO PROGRESS**

3. The chair should reduce the number of class preparations per faculty member to reduce loads.

► The chair has implemented this policy whenever possible within scheduling constraints, and whenever desired by the faculty, and will continue to do so. It is also a high priority with the scheduling of the part time faculty. Status: **COMPLETED**

4. Faculty should stop taking on overloads, especially those that require extra preparation.

► This is a personal choice of faculty, up to a point. A new university policy effective September, 2006 now limits the number of overload classes to a maximum of two per semester, to be reduced gradually to two per year. No mathematics faculty member has ever taught more than two overloads in one semester, so there is no issue with the new policy, but it is difficult at times for faculty to avoid teaching any overloads at all simply because of the lower salaries at ULV than at other schools we compare ourselves to. The addition of a fourth full time faculty member has made it possible for faculty to only teach overloads if they wish to, not because they must because of staffing issues. Status: **ADDRESSED**

5. The university should increase faculty pay and program staffing so that faculty do not feel obligated to teach overloads.

► No significant progress has been made on increasing faculty pay sufficiently to address this, it is out of the hands of the department, beyond simply making requests, which is already being done. The staffing change of a fourth faculty member has made it possible, however, to reduce the number of overloads that need to be taught by full-time faculty. Status: **NO PROGRESS / EXTERNAL**

6. Directed studies should be counted in faculty teaching loads. Two directed studies should count as one course, but, perhaps, as a starting point, six directed studies could count as one course (or one overload).

► See Intermediate Priority #1 above. Status: **COMPLETED** (as much as it will be)

7. The administration should provide (and mathematics program faculty members take advantage of) course releases for curriculum development. Participation in curriculum development should be regarded favorably for promotion. In order to give all faculty the opportunity to engage in scholarly activity, the university should take steps to reduce teaching loads in programs with very heavy teaching loads, including mathematics.

► The university has now made it possible to apply to obtain a course release in return for a commitment to doing a major piece of research, and money is available for certain kinds of January Interterm course development, although not release time. Status: **NEEDS WORK**

8. The university should continue to expand and improve classroom technology by making more classrooms "smart" and by providing adequate computer laboratories. The university should set up one classroom computer laboratory in which mathematics courses could meet regularly.

► This has been done, and FH 206 and FH 207 are two computer laboratories "owned" by the C.S. program, which can be scheduled by math professors as necessary, subject to C.S. teaching schedules. There is still a need for a classroom dedicated to mathematics classrooms, since the two C.S. labs are utilized through much of the day and evening hours. See Intermediate Priority #6 above. Status: **COMPLETED / NEEDS WORK**

9. Encourage the faculty to design and offer a "thinking" statistics course featuring collection and interpretation of real-world data sets. This course should be marketed to biology majors as well as to business and social science majors, with the eventual goal of having these programs require the course for their majors.

► See High Priority #3 above. Status: **COMPLETED**

10. If MATH 170 ends up being supplanted by the new statistics course, the business course, the mathematics and the arts courses, and/or an applications-based College Algebra course (see below), then so be it. In order to encourage students to take Mathematics in Society, mathematics program faculty might bar students who have placed solidly into Precalculus or Calculus I (or higher) from College Algebra but not from Mathematics in Society.

► See Intermediate Priority #9 above. Status: **COMPLETED*****, but continuous monitoring needed***

11. We recommend following national curriculum recommendations for College Algebra [9] by integrating real world modeling and problem solving into the course. (Also see [13].) We very much like Professor Frantz's suggestion of an approach drawing on environmental problems and modeling. This should appeal to many students, fits in with wider university curricular themes, and may be supported by recent textbook development.

► See Intermediate Priority #3 above. Status: **IN PROGRESS / NEEDS WORK**

12. We recommend that mathematics faculty investigate ALEKS [1] or another web-based mathematics tutorial system. Such a system may be very helpful in assisting students with skills

development and concept mastery in elementary courses such as College Algebra. With less class time needed for fundamentals, more emphasis could be placed on the higher-order thinking skills the revised course would demand. We caution, however, that such tutorial systems are not magic; some students may also need human tutors.

► See Intermediate Priority #3 above. Status: **ADDRESSED / NEEDS WORK**

13. Current resources can support only a very focused program. By deciding which courses are most important and focusing on them, the mathematics program should be able to offer fewer upper division courses overall, but offer more upper division courses as classes rather than as directed studies. Since most mathematics majors plan to become high school mathematics teachers, the core of the major should be those courses within the credential program. These courses should be required or at least highly recommended for all majors, not just those intending to teach high school mathematics. The new standards for the single subject credential in mathematics issued by the California Commission on Teacher Credentialing, together with the Commission's requirement that all colleges and universities re-submit credential program applications within the next two years, give the ULV mathematics faculty an ideal opportunity to redesign major requirements and upper division course offerings around credential program goals. It also is important that regular course offerings include at least one course that each full-time faculty member would be really and truly excited about teaching, e.g. courses in biological or environmental modeling or in numerical methods. The net result of centering the mathematics major around courses required for the teaching credential should be that the same number of courses are offered as regular courses (we don't see how to reduce this number), but that fewer courses are offered as directed studies. We acknowledge that reducing the number of courses offered does have some disadvantages. It reduces student choices, and the soon-to-be-released recommendations of the Mathematical Association of America advocate wider variety in courses with closer attention to individual student interests. But, again, we believe current faculty and student resources at ULV can support only a very focused program.

► See Intermediate Priority #1 above. Although the idea of each faculty member having their favorite course to teach would make for a passionate experience in that course for the students, this is only practical in a small program such as ours if no other faculty member desires to teach that course. The chair has tried to established which courses are personal favorites of faculty and which faculty do well with which courses, and accommodate all when possible, while allowing a faculty member to teach a "favorite course" at least twice before handing it off to someone else, since most courses above Calculus III would only meet twice in four years. Status: **ADDRESSED**

14. The primary resource allocation goal should be to make sure there almost always are four or more students in each upper division course, and that each student in the course is prepared to take the course. Nevertheless, the administration should support the occasional course with only two or three students in it, recognizing that the mathematics faculty has done everything possible to streamline course offerings while keeping the program attractive to potential majors.

► As the numbers of mathematics majors increases, the sizes of core upper division courses have increased to seven or eight in some cases, and this trend is expected to continue. One problem arises with the split between the B.A. and B.S. and subsequent reduction in enrollments for courses required by one but not the other. As one can readily see from Appendix G, out of 33 upper division courses for the major offered from 2003-2008, only five fell below enrollments of four, to two or three. Status: **ADDRESSED**

15. Directed study courses should be reserved only for students intending to pursue graduate study in the mathematical sciences. Depending on their intended programs, these students would need from two to six additional courses.

► Scheduling has changed so that directed studies are used much less frequently now, in the cases cited above, or when a student fails a class and needs to repeat it before it is offered again. Status: **ADDRESSED**

16. The Senior Project should be offered as a yearly spring course, perhaps jointly with physics and/or other programs. It might instead be offered during fall semester or, less ideally, January term if that would help increase the number of students in it and other courses. Another option would be a 1- or 2-unit seminar taken throughout the senior year. Career information could be included in the Senior Project course.

► See Intermediate Priority #2 above. The program has instituted a new policy whereby students need to register for the MATH 499 Senior Project course in the fall of their senior year, in order to give them time to complete the project by commencement in the following May, and to provide the opportunity for students to have progressed sufficiently to give a poster presentation at the annual regional spring MAA meeting. Status: **NO PROGRESS / NEEDS WORK**

17. In redesigning the mathematics curriculum, it may be possible to retain a few choices for majors and to distinguish between the B.A. and the B.S. However, it may not be necessary to offer these two degrees. Redlands offers only the B.S. and Occidental offers only the B.A. We note also that the two main features of the highly successful mathematics program at SUNY-Potsdam are its close faculty attention to individual students and its single-track mathematics degree [5].

► See Intermediate Priority #1 above.

18. While we appreciate the mathematics faculty's support of the computer science and physics programs through course requirements in these areas for mathematics majors, as well as its message to mathematics majors that being able to apply their skills in other areas is important, the mathematics faculty may wish to allow students to choose between the two or to design their own "emphasis" or application of mathematics. Perhaps all mathematics majors would complete a computer programming course but only students earning the B.S. degree would complete the physics courses.

► The department does not see this as a make-or-break factor for students deciding whether or not to enter into or remain in a mathematics major, and at present intends to keep the full year of calculus-based physics supportive requirement. It will give further consideration to the matter during meetings in 2009-2010, and in conjunction with any possible revision of the B.A. / B.S. structure. Status: **ADDRESSED / IN PROGRESS**

19. We recommend dropping the GRE as one of the two exit examinations, as we suspect it is demoralizing for weak to average mathematics majors. Other "outside" exams available include those taken by prospective mathematics teachers (currently, the SSAT or Praxis exams) and a more general mathematics assessment exam offered by ETS. (Note: One of the reviewers is an ETS consultant.)

► See Intermediate Priority #12 above. Status: **NO PROGRESS / NEEDS WORK**

20. Opportunities for tutoring and peer mentoring in mathematics [12] should be expanded for qualified students.

► The CSEMS program has implemented requirements for tutoring and mentoring for its participants. More money has been made available for hiring tutors in the Learning Enhancement Center. The larger issue in increasing the number of tutors and peer mentors regards the limited amount of time that most mathematics students feel they have for such activities. Status: **COMPLETED**

21. Faculty and students must be realistic about prerequisites. For example, students will have a much greater chance of success in the probability and statistics sequence if they take Calculus III first.

► This notion will has yet to be examined, but will be in an upcoming math faculty meeting. Status: **NO PROGRESS / NEEDS WORK**

22. In our focus group with students, they expressed a desire for more help with homework. Help in class was preferred, but an outside-of-class homework session with a little more structure than office hours (much like a recitation section at a larger university) also was attractive to them. They also expressed a desire to be able to re-do homework assignments, a request which seems worth accommodating when possible. As for student complaints that mathematics courses are challenging and time-consuming and that taking more than one of them per semester is unrealistic, the faculty should continue to encourage and help students---and to help them plan schedules containing no more than two mathematics courses per semester! Again, students are unanimous in praising the availability of the mathematics faculty for help and guidance.

► Many if not most faculty provide opportunities for students to receive help in class while working in small groups on assigned problems. The department has instituted mandatory one hour lab sections (MATH 172L) for all MATH 172 classes, instructed by other students and/or LEC staff, and these seem to have proven effective, so much so that the math faculty would like to institute required lab sections for other classes such as (possibly) MATH 001, 102, 104, 105, and 170. The idea of T.A.-like "help sessions" for students in upper division courses should also be promoted and encouraged. Teaching tips like re-doing of homework are shared at multiple opportunities throughout the year, at department meetings and the annual part time faculty workshop. Students normally are not advised to take more than two mathematics courses in a semester, unless they are exceptional students and in the joint estimation of the faculty member and student, can handle it. Status: **COMPLETED / NEEDS WORK**

23. Students were also unanimous in expressing appreciation for their study space in MA 54. Maintaining and improving this space should be of highest priority. Seating might also be provided outside faculty offices so students can wait for faculty there.

► See Intermediate Priority #5 above. The issue of seating for waiting students is more or less resolved by the nearness of two student study areas (MA 157, MA 54) to faculty offices. Status: **ADDRESSED / NO PROGRESS *(on more space)***

24. Students' already strong sense of community might be further improved by a Math Club and activities, and by additional program-related employment opportunities for students as tutors, peer-led workshop leaders, graders, or even office assistants. Program alumni should be invited to share career information with current students, by visiting campus or via e-mail

► See High Priority #7 above. The new interim dean has provided a major increase in the budget for student workers in mathematics and physics, meaning it should be much easier to provide more jobs for students in these areas indicated. Also, the program has sponsored a visit to JPL with a private tour led by a ULV Mathematics alumna, who also paid a visit to the campus the next semester for a seminar on employment at JPL, what they do there, and how a math student can best prepare for the workforce. We plan to invite this alumna to present a science seminar to all the science students in Fall 2010, and to maintain a program of at least annual contact with our mathematics, physics, and computer science students. It would also be valuable to institute something like a "career night" once a year when alumni could return to campus and speak to our students about various career paths and employment tips. Status: **COMPLETED / NEEDS WORK**

25. In addition to the improvements already made in the advising of mathematics majors as a result of better college records, mathematics faculty members might use a little class time each registration period for general advising about upcoming courses and to encourage students to meet with them for further advising, and/or hold general meetings for intended mathematics majors (with food as well as advice as incentive) to dispense information. One-page checklists of mathematics major requirements and recommended course sequencing should be distributed to prospective mathematics majors whenever and wherever possible, including in class. Ideally, ULV students would declare their majors by the end of their sophomore year to help ensure better advising and degree completion.

► Much of this is already done informally with students and more formally with the annual fall departmental "picnic".

26. The mathematics faculty should pay even more attention to the calculus sequence, especially Calculus I, as the primary place where they will recruit mathematics majors and minors. Calculus courses must be stimulating and rewarding. The faculty might encourage or even require students who place solidly into Precalculus or Calculus I to take that course rather than College Algebra to fulfill general education requirements. Unless articulation really has become a big problem, we encourage the mathematics faculty to continue to design its calculus curriculum based on the needs of various ULV programs rather than on external norms.

► See Intermediate Priority #13. Status: **IN PROGRESS**

27. The faculty also should identify other courses, such as Discrete Mathematics or Bridges Between Art and Mathematics, from which to recruit mathematics majors and minors. Every physics major should have a mathematics minor, if not a second major in mathematics. A mathematics minor should be encouraged for economics and computer science majors.

► The CORE 320 class, The Mysterious Dance of Art, Mathematics, and Music, is not appropriate to recruit math majors from, as it is for juniors and seniors only. Care must be exercised in recruiting form other classes such as Discrete Mathematics, which mostly enroll computer science majors, to not be seen as poaching from within our own department. The notions of required minors in other disciplines will be discussed in a future department meeting. Status: **ADDRESSED / NEEDS WORK**

28. In addition to encouraging the Admissions Office to recruit strong students, capable of and interested in majoring in mathematics, ask Admissions to identify the best incoming students, regardless of intended major. Encourage these students to take Calculus I early in order to keep open their science and mathematics major and career opportunities.

► Although the Admissions Office is reluctant to provide information about simply ":strong students", they have been very good about providing lists to the chair of potential new incoming students who show an interest in mathematics, and asking faculty to call these students. Status: **ADDRESSED**

29. Carrying out the curricular changes we recommend will require an even higher level of coordination and mutual inspiration than already exists. We note that the mathematics program is planning a faculty retreat for Summer 2003 to discuss our recommendations. We wish to encourage this kind of activity, which strengthens the faculty's sense of community while also addressing program goals.

► The retreat never took place. A retreat should take place for perhaps the department as a whole (to achieve a critical mass) sometime during the 2009-10 or 2010-11 years. Status: **NO PROGRESS / NEEDS WORK**

30. Consider having adjacent offices. This can improve collegiality within the program, though reducing interaction with other science faculty might be a concern.

► At the present time, the space configuration will probably remain as it is, due to the desires of the various faculty members. However, with computer science faculty moving into the Mainiero Building in late summer 2006 facilitated much more interaction among all the department and division faculty, and with the addition of the fourth faculty member, three of the four mathematics faculty are at least on the same floor now. Status: **ADDRESSED**

31. Select one to three goals on which to focus for a given year, using importance and feasibility as criteria. After further discussion, have each faculty member in the program commit to specific tasks needed to achieve these goals. Then meet on a regular basis for the sole purpose of making progress towards these goals, excluding discussions of other program or institutional business from those meetings.

► As an annual practice, this has not taken place. It should be a priority at the end of May or August to select several goals to concentrate on for the coming year. Status: **NO PROGRESS / NEEDS WORK**

32. Take a look at some of the recent literature on organizational change ([6],[7],[8] in the references for the report) and faculty learning communities ([3],[4]); consider the applicability of this work to your situation.

► This has not been done. The chair can try to make some of these materials available to the department faculty in 2009-10 and 2010-11 for discussion.
Status: **NO PROGRESS / NEEDS WORK**

Appendix V: Adjunct Faculty Survey Instrument and Analysis

(conducted at the Part-Time Faculty Workshop, 11/15/08)

Demographics:

Of the four adjunct professors that completed the survey, the following demographic information was collected from self reports: 2 men, and 1 woman; 2 Caucasian and 1 Pacific Islander; 3 are adjunct faculty and 1 is a senior adjunct professor; all teach in the mathematics department; their time teaching at ULV ranges from 1 year to 13 years; all teach on the main campus; and 3 state that they use online resources for teaching and 1 does not.

All comments:

1. What do you like about teaching for La Verne?
   - Smallness, hiddenness, friendliness, campus atmosphere, fairness among faculty
   - Small school, warm, and friendly
   - Small campus, great administrators
   - Small classes, interaction with department chair
   - Interested students

2. What do you dislike about teaching for La Verne?
   - No health benefits
   - No problems
   - Not enough parking at times, air conditioning is not well in some parts of the building

3. How would you describe the support you receive from faculty colleagues, including chairs?
   - Very good, including syllabi, old exams, resources, supplies, coverage of class, practicing exams
   - Excellent, quick, and helpful
   - Timely and always responsive
   - Very good, very helpful, chair easily accessible

4. How would you describe the support you receive from administration?
   - Slow to fix copier, quick to fix computer
   - Same as #3
   - Excellent, quick responses, friendly
   - Frequent/good communication, training for part time faculty

5. What aspects of the support you personally receive are you…

a. Most happy with?
   - Communication from chair, sharing with colleagues, friendliness of colleagues
   - Quick and friendly
   - Always responsive to my requests
   - Attention, quick response

b. Least happy with?

- Maybe better response if lower levels had more authority
- Computers in some buildings have log-ins that have changed and unable to get access on these computers, and some don’t work with some printers

6. What kind of support would you like to receive that you do not receive now?

- Online resources for math 102 class
- Receive enough support
- Administrative: set system so computers print directly to copier

7. Would you like to be involved when your program conducts program reviews or self-studies? If so, how?

- Yes, consult on all aspects, allow to review and add comments to final reports
- Sure, not sure
- No
- Sure, however, I am needed and asked

8. How would you describe the campus climate of the University of La Verne?

- Small campus, pleasant environment
- Very good small campus atmosphere
- Friendly and charming
- Friendly and helpful

10. What do you think you can do to help students attain higher levels of learning outcomes?

- More training and discussion before term
- More collaborative work
- Assign projects and more group work in the classroom
- Encourage more collaboration
- Do more group work, more oral/written expression

11. What do you think students can do to attain high levels of learning outcomes?

- Ask more question, think about reasonableness of answer, applications to life
- Improve discipline, persistence, learn from mistakes
- Read the book, work together outside the classroom, maybe tutor in the subject
- Study more, work together outside of class, and use LEC and library resources

9. In your opinion to what extent do students in your classes develop the following attributes and/or abilities?

Table 1

Item	N	% Somewhat	% Adequate	% High Degree	% N/A
a. Work Collaboratively	4	50	25	25	0

b. Consistency, organization	4	50	50	0	0
c. Beauty, Aesthetics	4	75	25	0	0
d. Interconnectedness	4	50	25	25	0
e. Persistence	4	50	50	0	0
f. Explore var. solution methods	4	25	75	0	0
g. Appropriate technology use	4	0	75	0	25
h. Communicate mathematics	4	50	50	0	0
i. Problem-solving/ applications	4	25	75	0	0

University of La Verne
Mathematics Program
Adjunct Faculty Survey

The purpose of this survey is to obtain your impressions and opinions about how well the department is supporting you and how well the students are attaining the program learning outcomes. The survey is a work in progress, with most of it coming from an assessment group at ULV, and probably needs considerable tweaking from this first draft. Even if some of the questions may seem odd, we hope that you can get a feel for what information it is we are trying to extract out of you, and answer as helpfully and frankly as possible. You may skip questions you don't wish to answer, or choose not respond to the survey at all.

Demographic Questions:

1. Gender: Female Male
2. Ethnic background: ___________________________
3. Current adjunct faculty status/title: _______________________________
4. Program or Department you teach in at this time: _____________________________
5. Including this year, how many years have you been teaching for La Verne: ________
6. Primary teaching responsibility is on: Main Campus Regional Campus Both
7. Do you use on-line resources for your teaching? Yes No

Issues and Perceptions (Please use the back, if need be)

1. What do you like about teaching for La Verne?
2. What do you dislike about teaching for La Verne?
3. How would you describe the support you receive from faculty colleagues, including chairs?
4. How would you describe the support you receive from administration?
5. What aspects of the support you personally receive are you
   a. Most happy with?
   b. Least happy with?
6. What kind of support would you like to receive that you do not receive now?
7. Would you like to be involved when your program conducts program reviews or self-studies? If so, how?
8. How would you describe the campus climate of the University of La Verne?
9. In your opinion to what extent do students in your classes develop the following attributes and/or abilities? (circle one response per line)

a. Work collaboratively	Not at all	Somewhat	Adequate	High Degree	N/A
b. Consistency, organization	Not at all	Somewhat	Adequate	High Degree	N/A
c. Beauty, aesthetics	Not at all	Somewhat	Adequate	High Degree	N/A
d. Interconnectedness	Not at all	Somewhat	Adequate	High Degree	N/A
e. Persistence	Not at all	Somewhat	Adequate	High Degree	N/A
f. Explore var. solution mthds	Not at all	Somewhat	Adequate	High Degree	N/A
g. Appropriate technology use	Not at all	Somewhat	Adequate	High Degree	N/A
h. Communicate mathematics	Not at all	Somewhat	Adequate	High Degree	N/A
i. Problem-solving / applics.	Not at all	Somewhat	Adequate	High Degree	N/A

10. What do you think you can do to help students attain higher levels of learning outcomes?
11. What do you think students can do to attain higher levels of learning outcomes?

Appendix W: Syllabi and/or Course Outlines

Spring 2010
Dr. Joan J. Marge

Math 001 Math Workshop – Syllabus

Course Designation
Math 001 – Math Workshop. An undergraduate math workshop mandated for all students who do not pass the mathematics entry examination before they are able to take Math 102. (2 semester hours).

Course Description and Prerequisites
This course will provide students with a review of basic arithmetic skills, and then concentrate on learning elementary algebra. The overall goal is to prepare students for success in Intermediate Algebra.

Learning Outcomes

A. Students will review the concept of whole numbers, including rounding and inequalities. They will also review and practice the basic four processes with whole numbers, namely, addition, subtraction, multiplication and division. They will review exponents and powers of 10. They will practice order of operations and perform the average, mean, median and mode on whole numbers. Students will draw and interpret graphs.

B. Students will review primes and multiples. They will go over the divisibility tests involving divisibility by 2, 3, 5, and 10. They will study multiples, divisors and factors. They will learn primes and composites, and be expected to know the prime numbers up to 50. They will practice prime factorization and getting the least common multiple.

C. Students will learn fractions and mixed numbers. They will study the differences between proper, improper and mixed numbers. They will learn how to simplify fractions. They will multiply and divide fractions and mixed numbers. Then they will learn how to add and subtract fractions and mixed numbers. They will work on order of operations and averaging of fractions and mixed numbers.

D. Students will study working with decimals, including adding, subtracting, multiplying and dividing fractions. They will practice changing decimals to fractions. Students will learn performing the averages on decimals, as well as finding the mean, median and mode of decimals. They will learn how to perform the order of operations when working with decimals.

E. Students will study ration and proportion by investigating ratio and rate. They will learn how to solve proportion and see the application of proportions.

F. Students will study percent, including the meaning of percent. They will learn how to change decimals to percents and percents to decimals. They will also learn how to change fractions to percents and percents to fractions. They will practice solving percent problems and see the applications of percents in such things as sales tax, discounts and commissions.

Assignments and Tests
Homework will be assigned at the end of each class meeting, according to the sections

that have been covered that day. By working in this fashion, it assures that we do not move on to the next topic until all students feel comfortable with the material covered. You may work on homework assignments with a fellow classmate, but it is assumed and expected that you do not merely copy another's work! If you must be absent, you should obtain the homework information either from a fellow classmate, or by emailing or phoning me and requesting it. Homework will not be collected each meeting, but will be randomly spot-checked – so – **do it**!

Evaluation
This course is offered on a Credit/No Credit basis only. In order to receive credit, students must receive a composite score of at *least 70%* for the semester. However, since it is assumed that you will be working diligently throughout the semester, I will give each of you a personal 'report card' with your final actual grade. Grading will be calculated as follows:

Quizzes		50 %
Attendance/participation		5
Labs		10
Project[s]		5
Midterm exam		15
Final exam		15
	Total:	100 %

Quizzes will be given at the end of each chapter in our text. They will be similar in nature to the chapter test at the end of each chapter, so you can review that in order to be ready for each quiz.

Text and Computer Resources
The text required for this course is Fundamentals of Mathematics, Van Dyke, Rogers & Adams, 9th Edition [2007]

Academic Honesty
Each student is responsible for performing all academic tasks in such a way that honesty is not in question. Unless an instructor defines an exception, students are expected to maintain the following standards of integrity:

1. All tests, term papers, oral and written assignments and recitations are to be the work of the student presenting the material.
2. Any use of wording, ideas, or findings of other persons, writers, or researchers required the explicit citation of the source, and, use of the exact wording required a "quotation" format.
3. Deliberately supplying material to a student for purposes of plagiarism is also deemed a culpable offense.

A faculty member who has proof that academic honesty has been violated may take appropriate disciplinary action, including the refusal of course credit. If a faculty member has reason to suspect academic dishonesty but is unable to prove it, s/he may require additional and/or revised work from the student. A faculty member shall bring to the attention of the appropriate dean all violations of academic honesty. The dean may place on probation, suspend, or expel any student who violates the academic honesty policy.

Office Hours

You may email me at my personal email: jmarge@aol.com (indicate *Math 001* in the subject box please – or else I will not open it for fear of viruses). My mailbox is located in Mainiero - Room 152. I will be happy to meet with you after class or before a class by prior arrangement. You may also reach me at my home phone number: 909/624-5099.

Math 001 Workshop Topics

Text: Fundamentals of Mathematics, Van Dyke, Rogers & Adams, 9^{th} Edition [2007]
While this text reviews basic arithmetic facts, it also incorporates basic elementary algebra as each arithmetic topic is reviewed.

A. Whole Numbers
- Writing, rounding and inequalities
- Adding and subtracting whole numbers
- Multiplying and dividing whole numbers
- Exponents and powers of 10
- Order of operations
- Average, mean, median and mode
- Drawing and interpreting graphs

B. Primes and Multiples
- Divisibility tests
- Multiples
- Divisors and factors
- Primes and composites
- Prime factorization
- Least common multiple

C. Fractions and Mixed Numbers
- Proper and improper fractions, mixed numbers
- Simplifying fractions
- Multiplying and dividing fractions
- Multiplying and dividing mixed numbers
- Adding and subtracting fractions
- Adding and dividing mixed numbers
- Order of operations and averaging with fractions

D. Decimals
- Reading, writing and rounding decimals
- Changing decimals to fractions
- Listing decimals in order
- Adding and subtracting decimals
- Multiplying and dividing decimals
- Average, mean, median and mode with decimals
- Changing fractions to decimals
- Order of operations and averaging with decimals

E. Ratio and Proportion

- Ratio and rate
- Solving proportions
- Applications of proportions

Math 102 Intermediate Algebra **SYLLABUS** Fall, 2010

Instructor: Dr. Rick Simon

Office: MB 56A

Phone: 593-3511 *x*4611

email: rsimon02@gmail.com

Office Hours: T 2-3:30 pm, W 9-10 am

Other times available by arrangement

Text: Aufmann/Lockwood, Intermediate Algebra: An Applied Approach, 8th Edition. (Brooks/Cole Cengage, 2011.)

- **Prerequisites**: One year of high school algebra, plus passing score on the placement test.

Course Description and Goals: This course covers essential algebra skills needed for College Algebra, Mathematics in Society, and various courses in other departments. Students in this course will develop facility in working with variables, polynomials and exponents. We will stress solving linear equations and applying them to solve problems.

Portfolio: I will assign homework in class each day. Assignments will include working exercises from the textbook and special portfolio assignments. You will keep your assignments in your portfolio, according to the General Portfolio Instructions handout, and I will collect your portfolio for grading every two or three weeks. **If you do not turn your portfolio in on time, you will lose 10% of the points for each (calendar) day it is late**. The portfolio will count toward 20% of your course grade. Half of your portfolio grade will be based on me grading your portfolio and the other half will be based on you grading your own efforts. Success in mathematics classes usually requires a lot of time beyond coming to class. You should expect to spend 6-12 hours per week on this course outside of class.

Performance Opportunities: There will be 4 midterm tests. (See schedule below for tentative dates.) There will be no makeup tests; if you miss a test, your score for that test is zero. Only your best 3 scores will count towards the course grade. Test and quiz problems are often like homework problems.

Ultimate Performance Opportunity: Everyone will take a 3-hour comprehensive Final Exam, 1-4 p.m., on Monday, December 13**.**

Grades: This course is offered on a credit/no credit basis only. The cutoff for passing will probably be between 70 and 75 percent of the total points. Your portfolio is 20% of your grade, tests are 60%, and the exam is 20%:

Score = .2(P%) + .6(T%) +. 2(E%) An overall score of 75% guarantees you will pass this course.

Attendance: You are expected to attend regularly, to be on time, and to be prepared to ask questions in class. While I do not *require* you to attend, there will be no way to make up any quizzes or other activities you may miss. Also, I will assume you are aware of anything I announced in class, even if you were not there. It is your responsibility to find out *from the other students* what information you miss when you are not in class.

Academic Honesty: You are strongly encouraged to work together and support each other; however, note there is a difference between "working together" and "copying". You should write your work up on your own. If I detect copying, I will assign zero points for a first offense (to everyone involved). There will be stiffer penalties for repeat offenses. See "Academic Honesty" in the ULV Catalog.

Calculators and Cellphones: You are welcome to use a calculator in this class, but you will need to show your work to get credit for your answers. A basic scientific calculator which can do exponents is fine for this class. A calculator which can do logarithms and statistics might be helpful for later classes. Cell phones should not be used in class—this includes texting! ←←←←
You will not be able to use your phone as a calculator during tests or quizzes.

Approximate Schedule

Week	Chapter	Topics
1-2	1	Real Numbers: properties and operations
3-4	2	Linear Equations and Inequalities: solving equations, inequalities and problems
	Performance Opportunity #1	
5-6	3	Cartesian Coordinates, Lines and Inequalities
6-7	4	Systems of Equations and Inequalities
	Performance Opportunity #2	
8-9	5	Polynomials: operations, factoring, solving equations
10-12	6	Rational Expressions: operations, complex fractions, equations
	Performance Opportunity #3	
12-13	7	Exponents and Radicals
	Performance Opportunity #4	
14	8	Quadratic Equations
15		Review

<u>Tentative</u> test dates: Friday 9/24, Wednesday 10/20, Friday 11/12, Friday 12/3

Due	Pages	Assignment or Section	Exercises
W 9/1	--	*Questionnaire*	
W 9/1	--	*Syllabus Assignment*	
F 9/3	13-16	1.1	1,57,63,79,89,97,103
W 9/8	**25-8**	**1.2**	**25,49,85,107,113,117,119**
F 9/10	33-6	1.3	49,53,91
	41-2	1.4	13,19,21,27,35
	54-55	Chapter 1 Test (for practice)	
	64-67	2.1	1,25,49,79,89,91,111
	72-73	2.2	3,11,19,23
	80-83	2.3	3,13,23,33,37
	90-95	2.4	23,39,51,67,79,91,101,111
	117-18	Chapter 2 Test (for practice): 1-13 odd,18,20-25	

Due	Pages	Section	Exercises
	128-31	3.1	15,19,29,33
	138-43	3.2	37,39,45,49,73,97,99
	151-55	3.3	7,13,25,39,47
	162-66	3.4	23,29,31,35,37,47,61
	171-75	3.5	17,31,51,55,83
	180-81	3.6	13,21,23,31
	--	3.7	--
		Chapter 3 Test (for practice): 1-13 odd, 17,20	
	210-13	4.1	47,49,61,65,69
	222-25	4.2	9,17,25,33,41
	--	4.3	--
	238-41	4.4	3,5,13,17,23
		Chapter 4 Test (for practice): 5,9,18,19,20	
	268-71	5.1	17,33,51,77,83,89,93,103,113,119
	278-79	5.2	1,23,35,37
	286-89	5.3	25,43,55,57,71,83,107
	297-300	5.4	19,31,43,57,63,81A
	309-12	5.5	19,51,95,101,105
	319-22	5.6	21,23,31,37,81,95,107
	325-26	5.7	15,25,29,45
		Chapter 5 Test (for practice): 1,3,5,7,11,13,15,17,21	
	348-51	6.1	19,29,57,69,83
	356-59	6.2	13,35,47,55,69,79
	--	6.3	--
	--	6.4	--
	374-77	6.5	3,27,35,45,55
	404-07	7.1	5,49,61,103,125,135
	414-17	7.2	27,43,59,63,67,95
	422-23	7.3	1,13
	450-53	8.1	21,35,43,53,83,107
	--	8.2	--
	464-65	8.3	9,13,25

Final Exam, 1-4 p.m., on Monday, December 13

Course Outline:
MATH 104 College Algebra

1. **Course Designation**
   MATH 104, College Algebra (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 102 minimum grade of CRD or appropriate score on ULV Math Placement Test
   Revised December 23, 2008

2. **Course Description**
   This course provides a basic understanding of the fundamental mathematical concepts necessary to achieve the breadth and depth of a complete liberal arts education; covers knowledge of basic algebraic operations; emphasizes their utilization in problem-solving in the physical and social sciences; discusses a wide variety of practical applications of elementary algebra; develops the reasoning processes relevant to setting up and solving problems.

3. **Learning Outcomes**
   A. Students will become competent at the symbolic manipulation and simplification of algebraic expressions pertaining to the mathematics needed for solving a wide range of general mathematical problems.
   B. Students will learn techniques of solution for linear and quadratic equations and systems of linear equations.
   C. Students will become familiar with elementary functions and their uses in modeling real world situations, including polynomial, rational, algebraic, exponential, and logarithmic functions.
   D. Students will develop skills in graphing relevant to basic analytic geometry, with respect to lines, circles, parabolas, as well as the ability to interpret and analyze data presented in various forms.
   E. Students will become familiar with the use of theory and technology in working with graphs of more complex functions and obtain skills in using computer software to assist in the formulation, analysis, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   F. Students will become familiar with a wide variety of practical applications of elementary college mathematics in diverse fields of undergraduate study.
   G. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   H. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations.
   I. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of applied real world problems.

4. Course Contents

Major areas to be covered by this course include the following:

A. Algebra Review
- (i) real numbers
- (ii) exponents and radicals
- (iii) basic polynomial operations
- (iv) polynomial factorization
- (v) rational expressions
- (vi) equations

B. Equations and Inequalities
- (i) linear equations and applications
- (ii) quadratic equations and applications
- (iii) radical equations and equations in quadratic form
- (iv) linear inequalities
- (v) polynomial and rational inequalities
- (vi) absolute value in equations and inequalities

C. Graphs
- (i) basic tools: Cartesian plane, distance, and midpoint formulae
- (ii) graphing equations: point plotting and symmetry
- (iii) straight lines
- (iv) circles

D. Functions and their Graphs
- (i) functions
- (ii) graphs of functions: common functions and piecewise-defined functions
- (iii) graphing techniques: transformations
- (iv) operations on functions and composition of functions
- (v) one-to-one functions and inverse functions

E. Polynomial and Rational Functions
- (i) quadratic functions
- (ii) polynomial functions of higher degree
- (iii) dividing polynomials: long division and synthetic division
- (iv) properties and tests of zeros of polynomial functions
- (v) rational functions

F. Exponential and Logarithm Functions
- (i) exponential functions and their graphs
- (ii) exponential functions with base e
- (iii) logarithmic functions and their graphs
- (iv) properties of logarithms
- (v) exponential and logarithm equations

G. Systems of Equations and Inequalities
   (i) systems of linear equations in two variables
   (ii) systems of multivariable linear equations
   (iii) systems of nonlinear equations

H. Matrices
   (i) matrices and systems of linear equations
   (ii) systems of linear equations: augmented matrices
   (iii) systems of linear equations: determinants

I. Conics
   (i) conic basics
   (ii) parabolas
   (iii) ellipses
   (iv) hyperbolas

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) biology, physics, economics, business, architecture, engineering, and design

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. Text, Materials and Resources

The primary resources for this course will be College Algebra, first edition, by Cynthia Y. Young (2005) (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) Derive and WinPlot.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.

B. This course will not be permitted to meet any direct requirements for a major or minor in mathematics. It is, however, considered as a formal prerequisite for many majors in business and economics, and is recommended for students in certain majors intending to go on to graduate work, psychology in particular. It is often used as a buffer course between Intermediate Algebra and Precalculus.

C. With respect to the ULV Mission Statement, this course
   - (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
   - (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
   - (iii) will stress the universality of the mathematical techniques learned,
   - (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
   - (v) will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description:

Emphasizes problem-solving skills and applications. Includes linear and quadratic equations, inequalities, systems and matrices, polynomials, functions, exponentials, logarithms, and graphing.

Prereq: Undergraduate level MATH 102 minimum grade of CRD or Maple Math Placement Test A 16

Course Outline:
MATH 105 Precalculus

1. **Course Designation**
   MATH 105, Precalculus (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 104 minimum grade of C- or appropriate score on ULV Math Placement Test
   Revised December 23, 2008

2. **Course Description**
   This course reviews basic algebra and linear and quadratic equations and inequalities, systems of equations, and polynomials; it concentrates on functions, graphing, complex numbers, the theory of equations, exponential and logarithm functions, and trigonometric theory and concepts in preparation for calculus or science courses.

3. **Learning Outcomes**
   A. Students will become competent at the symbolic manipulation and simplification of algebraic expressions pertaining to the mathematics needed for solving a wide range of general mathematical problems.
   B. Students will learn techniques of solution for linear and quadratic equations and systems of linear equations.
   C. Students will become familiar with elementary functions and their uses in modeling real world situations, including polynomial, rational, algebraic, exponential, and logarithmic functions.
   D. Students will develop skills in graphing relevant to basic analytic geometry, with respect to lines, circles, parabolas, as well as the ability to interpret and analyze data presented in various forms.
   E. Students will become familiar with the use of theory and technology in working with graphs of more complex functions and obtain skills in using computer software to assist in the formulation, analysis, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   F. Students will become familiar with a wide variety of practical applications of elementary college mathematics in diverse fields of undergraduate study.
   G. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   H. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations.
   I. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of applied real world problems.
   J. Students will become familiar with the definitions and graphs of the standard trigonometric and inverse trigonometric functions, as well as related trigonometric

identities and formulas, methods of solution of trigonometric equations, and applications of trigonometric functions model and solve a variety of real world problems.

4. Course Contents

Major areas to be covered by this course include the following:

A. Algebra Review
- (i) Real Numbers and their Properties
- (ii) Exponents and Radicals
- (iii) Polynomials and Factoring
- (iv) Rational Expressions
- (v) Solution of Equations
- (vi) Linear Inequalities

B. Functions and their Graphs
- (i) Rectangular Coordinates
- (ii) Graphs of Equations
- (iii) Linear Equations in Two Variables
- (iv) Functions
- (v) Analyzing Graphs of Functions
- (vi) Various types of Functions
- (vii) Transformations of Functions
- (viii) Combinations of Functions: Composite Functions
- (ix) Inverse Functions
- (x) Mathematical Modeling and Variation

C. Polynomial and Rational Functions
- (i) Quadratic Functions and Models
- (ii) Polynomial Functions of Higher Degree
- (iii) Polynomial and Synthetic Division
- (iv) Complex Numbers
- (v) Zeros of Polynomial Functions
- (vi) Rational Functions
- (vii) Nonlinear Inequalities

D. Exponential and Logarithm Functions
- (i) Exponential Functions and their Graphs
- (ii) Logarithmic Functions and their Graphs
- (iii) Properties of Logarithms
- (iv) Exponential and Logarithm Equations
- (v) Exponential and Logarithm Models

E. Trigonometry
- (i) Radian and Degree Measure
- (ii) Trigonometric Functions: The Unit Circle
- (iii) Right Angle Trigonometry

(iv) Trigonometric Functions of Any Angle
(v) Graphs of Sine and Cosine Functions
(vi) Graphs of Other Trigonometric Functions
(vii) Inverse Trigonometric Functions
(viii) Applications and Models

F. Analytic Trigonometry
(i) Using Fundamental Identities
(ii) Verifying Trigonometric Identities
(iii) Solving Trigonometric Equations
(iv) Sum and Difference Formulas
(v) Multiple-Angle and Product-to-Sum Formulas
(vi) Law of Sines
(vii) Law of Cosines

G. Conic Sections
(i) parabolas
(ii) ellipses
(iii) hyperbolas

H. Systems of Equations and Inequalities
(i) systems of linear equations in two variables
(ii) systems of nonlinear equations

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) biology, physics, economics, business, architecture, engineering, and design

7. **Assessment Plan**
   The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. **Text, Materials and Resources**
   The primary resources for this course will be <u>Precalculus: A Concise Edition</u>, first edition, by Larson and Hostetler (2007) (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) Derive and WinPlot.

9. **Program Relationship**
   A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.
   B. This course will not be permitted to meet any direct requirements for a major or minor in mathematics. It is, however, considered as a formal prerequisite Math 201 Calculus I.
   C. With respect to the ULV Mission Statement, this course
      (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
      (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
      (iii) will stress the universality of the mathematical techniques learned,
      (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
      (v) will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description:
Reviews equations and inequalities, systems and polynomials; concentrates on functions, graphing, complex numbers, theory of equations, and trigonometry in preparation for calculus or science courses.
Prereq: Undergraduate level MATH 104 minimum grade of C- or Math Placement Test A 20 or Math Placement Test B 10

Course Outline Proposal:
MATH 150 Elementary Statistics

1. **Course Designation**
   MATH 150, Elementary Statistics (4 semester hours) (Undergraduate credit only)
   Prereq: Undergraduate level MATH 102 minimum grade of CRD or Math Placement Test A 16; Revised October 21, 2007

2. **Course Description**
   An introduction to concepts and procedures in elementary statistics, with a focus on analysis of data from applications drawn from the behavioral, health, social science, economics, biological science, and physical science areas. Major topics include basic probability theory and common probability distributions, data acquisition, graphical exploration and presentation of data, descriptive statistical analyses, measures of central tendency and dispersion, hypothesis testing, statistical inference, appropriate modeling methodologies, correlation and regression, chi-square tests, analysis of variance, and basic nonparametric statistics. Students will also learn to analyze data using statistical software.

3. **Goals**
   A. Students will learn that statistics is the science of collecting, organizing, displaying, analyzing, and drawing conclusions or inferences from data.
   B. Students will gain an understanding of various ways to appropriately collect data in an unbiased fashion, and gain experience in doing so.
   C. Students will be able to organize data to produce and interpret descriptive statistics, both graphically and numerically, and be able to interpret the data and draw conclusions based on the graphical displays and numerical summaries.
   D. Students will be able explain the fundamental issues of sampling and experiment design.
   E. Students will be able to compute and interpret probabilities in various situations.
   F. Students will be able to explain the concepts of random variable and distribution, become familiar with the binomial and normal distributions, and develop proficiency in applying these distributions to solve common statistical problems.
   G. Students will understand the concept of confidence intervals and be able to compute them.
   H. Students will understand the concept of hypothesis testing (null and alternative hypotheses), and perform various tests for statistical significance of hypotheses regarding means, variances, or standard deviations.
   I. Students will be able to perform tests to identify differences between means, variances, and proportions.
   J. Students will learn how to perform linear regression on one and more variables, and estimate the accuracy of the regression line.
   K. Students will be able to perform tests of goodness-of-fit and utilize contingency tables to test frequency distributions, independence of variables, and homogeneity of proportions.
   L. Students will be able to perform tests to identify differences between means, variances, and proportions.

M. Students will be able to perform both a one-way and two-way ANOVA and understand the interpretation of the results.
N. Students will be able to perform nonparametric statistical tests, and understand when it is appropriate to use such tests.
O. Students will learn the many different limitations of statistics and statistical processes, in addition to the multitude of ways in which statistical results may be used to mislead or misinform, thereby enabling them to be better informed citizens in today's world, drowning in statistics.
P. Time permitting, students will learn more sophisticated sampling techniques, designs for questionnaires, and techniques of simulation.

4. Course Contents

Major areas to be covered by this course include the following:

A. The Nature of Probability and Statistics
- (i) descriptive and inferential statistics; data types
- (ii) data collection and sampling techniques
- (iii) observational and experimental studies
- (iv) uses and misuses of statistics

B. Frequency Distributions and Graphs
- (i) organization of data
- (ii) histograms, frequency polygons, ogives
- (iii) other graph types: pareto charts, time series graphs, pie charts, steam and leaf plots
- (iv) misleading graphs

C. Data Description
- (i) measures of central tendency: mean, median, mode, midrange, weighted mean
- (ii) measures of variation: range, variance and standard deviation for populations, sampling, and grouped data; Chebyshev's Theorem
- (iii) measures of position: standard scores, percentiles, quartiles, deciles, outliers
- (iv) exploratory data analysis: five number summary, box plots

D. Probability and Counting Rules
- (i) basic theory of sample spaces and probability; law of large numbers
- (ii) probability rules: addition, multiplication, conditional probability
- (iii) counting rules, factorials, permutations, combinations

E. Discrete Probability Distributions
- (i) mean, variance, standard deviation, expectation
- (ii) binomial distribution
- (iii) other (optional) distributions (multinomial, Poisson, hypergeometric?)

F. Normal Distribution
   (i) standard normal distribution and properties
   (ii) applications of the normal distribution
   (iii) Central Limit Theorem
   (iv) normal approximation to the binomial distribution

G. Confidence Intervals and Sample Size
   (i) confidence intervals for the mean for known S.D. or large sample size; sample size
   (ii) confidence intervals for the mean for unknown S.D. and small sample size (Student's t)
   (iii) confidence intervals and sample size for proportions
   (iv) confidence intervals for variances and standard deviations

H. Hypothesis Testing
   (i) z and t tests for the mean
   (ii) z test for a proportion
   (iii) chi-square test for a variance or standard deviation

I. Testing Differences between Two Means, Variances, or Proportions
   (i) testing the difference between two means (large sample)
   (ii) testing the difference between two variances
   (iii) testing the difference between two means (small independent sample)
   (iv) testing the difference between two means (small dependent sample)
   (v) testing the difference between two proportions

J. Correlation and Regression
   (i) scatterplots
   (ii) correlation coefficients
   (iii) regression lines
   (iv) coefficient of determination and standard error of the estimate
   (v) multiple regression

K. Other Chi-Square Tests
   (i) goodness of fit
   (ii) contingency tables

L. Analysis of Variance
   (i) one-way ANOVA
   (ii) Scheffe and Tukey tests
   (iii) two-way ANOVA

M. Nonparametric Statistics
   (i) introduction; advantages and disadvantages
   (ii) single-sample and paired-sample sign tests
   (iii) Wilcoxon rank sum and signed-rank tests

(iv) Kruskal-Wallis test
(v) Spearman rank correlation coefficient; Runs test

N. Sampling and Simulation (optional, if time permits)
(i) common sampling techniques: random, systematic, stratified, cluster
(ii) surveys and questionnaire design
(iii) simulation techniques
(iv) Monte Carlo methods

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Collect real data for sample analyses in class.
F. Participate (within a small group) in the design and execution of a valid, appropriate statistical survey, using the concepts and methods learned in class, as well as perform appropriate analysis of the data, and present the findings in both oral and written form.
G. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments.

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis, including a major survey project conducted within the context of a small group
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) behavioral, health, social science, economics, biological science, and physical science areas.

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of objective evaluations of activities such as: homework assignments submitted for grading (problems done by hand and by computer), presentations at the board of collaborative problem solutions, written and oral presentation of small group survey project, participation in class discussions and exercises, midterm exams, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the individual professor, but might typically run in the range of: homework (15%), class participation and presentations (5%), group project (10%), midterms (50%), final exam (20%).

8. Text, Materials and Resources

The primary resources for this course will be Elementary Statistics, sixth edition, by Allan G. Bluman (or a reasonably similar alternative), Excel with its statistical tools package, MegaStat (free package accompanying the text), an Excel statistics manual keyed to the text, WinStats (a free program), and (subject to available funding) possibly Minitab,.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the quantitative reasoning component of the general education requirements for graduation.

B. This course will not meet any direct requirements for a major or minor in mathematics. However, the mathematics faculty strongly recommend that this course or Mathematics in Society (MATH 170) should be utilized by all students (not needing Precalculus or Calculus I for their majors) to meet their Quantitative Reasoning general education requirement.

C. With respect to the ULV Mission Statement, this course
   - (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
   - (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
   - (iii) will stress the universality of the mathematical techniques learned,
   - (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
   - (v) will stress the service value of these solution methods with respect to both human and environmental problems.

Catalog course description:

An introduction to concepts and procedures in elementary statistics, with a focus on analysis of data from applications drawn from the behavioral, health, social science, economics, biological science, and physical science areas. Major topics include basic probability theory and common probability distributions, data acquisition, graphical exploration and presentation of data, descriptive statistical analyses, measures of central tendency and dispersion, hypothesis testing, statistical inference, appropriate modeling methodologies, correlation and regression, chi-square tests, analysis of variance, and basic nonparametric statistics. Students will also learn to analyze data using statistical software.

Prereq: Undergraduate level MATH 102 minimum grade of CRD or Math Placement Test A 16

Course Outline:
MATH 170 Mathematics in Society

1. **Course Designation**
   MATH 170, Mathematics in Society (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 102 minimum grade of CRD or Math Placement Test A 16 or Math Placement Test B 5
   Revised August 16, 2007

2. **Course Description**
   This course provides an introduction to various mathematical sciences. Current mathematical concepts and problem-solving techniques will be covered from the areas of statistics, social choice, management science, and size, shape and growth. Real world applications will be presented and various solution algorithms discussed in detail.

3. **Goals**
   A. Students will develop problem solving skills using mathematical algorithms not often exposed at introductory levels, in many different areas of applied mathematics, including statistics, probability, management science, task scheduling, linear programming optimization, social choice methods, voting methods, geometric similarity, pattern classification, coding theory, fractal geometry, sustainable growth theory, and dynamical systems.
   B. Students will learn the importance of a working knowledge of mathematics in today's society, and will be encouraged to discover on their own the many applications of mathematical concepts in their personal and professional lives, and become better prepared for the challenges they face or will face in the professional world.
   C. Students will learn how to collect data, organize it, display it, analyze it, and draw inferences from it, when presented in many different forms.
   D. Students will become familiar with the use of theory and technology in working with graphs of more complex functions and obtain skills in using computer software to assist in the formulation, analysis, and solution of real problems, and to.
   E. Students will be exposed to a comprehensive overview of the practical applications of mathematics that is both informative and entertaining.
   F. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   G. Students will expand their mathematical reasoning skills as they apply complex algorithms, and enhance their judgment of the reasonableness of results obtained via mathematics, while also learning to recognize that mathematical and statistical methods have limitations.
   H. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of applied real world problems.

4. Course Contents

Major areas to be covered by this course include the following:

A. Statistics and Probability

(i) Displaying Distributions: Histograms
(ii) Interpreting Histograms
(iii) Displaying Distributions: Stemplots
(iv) Describing Center: Mean and Median
(v) Describing Spread: The Quartiles
(vi) The Five-Number Summary and Boxplots
(vii) Describing Spread: The Standard Deviation
(viii) Normal Distributions
(ix) The 68-95-99.7 Rule
(x) Displaying Relationships: Scatterplots
(xi) Regression Lines
(xii) Correlation
(xiii) Least-Squares Regression
(xiv) Interpreting Correlation and Regression
(xv) Sampling
(xvi) Bad Sampling Methods
(xvii) Simple Random Samples
(xviii) Cautions About Sample Surveys
(xix) Thinking About Experiments
(xx) Inference: From Sample to Population
(xxi) Confidence Intervals
(xxii) Probability Models and Rule
(xxiii) Discrete Probability Models
(xxiv) Equally Likely Outcomes
(xxv) Continuous Probability Models
(xxvi) The Mean and Standard Deviation of a Probability Model
(xxvii) The Central Limit Theorem

B. Management Science

(i) Euler Circuits
(ii) Finding Euler Circuits
(iii) Beyond Euler Circuits
(iv) Urban Graph Traversal Problems
(v) Hamiltonian Circuits
(vi) Traveling Salesman Problem
(vii) Helping Traveling Salesmen
(viii) Critical Path Analysis
(ix) Scheduling Tasks
(x) Critical-Path Schedules
(xi) Independent Tasks
(xii) Bin Packing
(xiii) Resolving Conflicts via Coloring

(xiv) Mixture Problems: Combining Resources to Maximize Profit
(xv) Finding the Optimal Production Policy
(xvi) Why the Corner-Point Principle Works
(xvii) Linear Programming: Life Is Complicated
(xviii) A Transportation Problem: Delivering Perishables
(xix) Improving on the Current Solution

C. Voting and Social Choice
(i) Majority Rule and Condorcet's Method
(ii) Other Voting Systems for Three or More Candidates
(iii) Insurmountable Difficulties: Arrow's Impossibility Theorem
(iv) A Better Approach? Approval Voting
(v) Manipulation of Majority Rule and Condorcet's Method
(vi) Manipulation of Other Voting Systems for Three or More Candidates
(vii) Impossibility
(viii) The Chair's Paradox
(ix) The Banzhaf Power Index
(x) Comparing Voting Systems
(xi) Elections with Only Two Alternatives
(xii) Elections with Three or More Alternatives: Procedures and Problems
(xiii) Insurmountable Difficulties: From Paradox to Impossibility
(xiv) A Better Approach? Approval Voting
(xv) The Adjusted Winner Procedure
(xvi) The Knaster Inheritance Procedure
(xvii) Taking Turns
(xviii) Divide-and-Choose
(xix) Cake-Division Procedures: Proportionality
(xx) Cake-Division Procedures: The Problem of Envy
(xxi) The Apportionment Problem
(xxii) The Hamilton Method
(xxiii) Divisor Methods
(xxiv) Which Divisor Method is Best?

C. Managing Information
(i) Check Digits
(ii) The ZIP Code
(iii) Bar Codes
(iv) Encoding Personal Data
(v) Binary Codes
(vi) Encoding with Parity-Check Sums
(vii) Cryptography
(viii) Mathematical Logic and Web Searches

D. On Size and Growth
(i) Geometric Similarity
(ii) The Language of Growth, Enlargement, and Decrease

(iii) Measuring Length, Area, Volume, and Weight
(iv) Scaling Real Objects
(v) Solving the Problem of Scale
(vi) Similarity and Growth
(vii) Fibonacci Numbers and the Golden Ratio
(viii) Symmetries Preserve the Pattern
(ix) Rosette, Strip, and Wallpaper Patterns
(x) Classifying Patterns
(xi) Symmetry Groups
(xii) Fractals and Patterns
(xiii) Regular Polygons
(xiv) Irregular Polygons
(xv) Using Translation
(xvi) Using Translations and Half-Turns
(xvii) Non-Periodic Tilings
(xviii) The Penrose Tiles and Quasicrystals
(xix) Growth Models for Biological Populations
(xx) How Long Can a Nonrenewable Resource Last?
(xxi) Sustaining Renewable Resources
(xxii) The Economics of Harvesting Resources
(xxiii) Dynamical Systems and Chaos

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) biology, physics, economics, business, architecture, engineering, and design

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. Text, Materials and Resources

The primary resources for this course will be <u>For All Practical Purposes</u>, 7th edition (2006), published by COMAP (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) Derive, WinPlot, and linear programming software.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.

B. This course will not be permitted to meet any direct requirements for a major or minor in mathematics. It is, however, recommended by the Mathematics faculty as the most appropriate general education mathematics course for any major not requiring College Algebra, Precalculus, Mathematical Methods for Business and Economics, or Calculus I.

C. With respect to the ULV Mission Statement, this course

- (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
- (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
- (iii) will stress the universality of the mathematical techniques learned,
- (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
- (v) will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description:

Introduces contemporary mathematical sciences to the non-specialist through real-world applications. Includes concepts from management science, statistics and probability, and social decision theory, and selected topics from geometry, scale and growth, and coding theory.
Prereq: Undergraduate level MATH 102 minimum grade of CRD or Math Placement Test A 16 or Math Placement Test B 5

Course Outline:
MATH 172 Mathematical Methods for Business and Economics

1. **Course Designation**
   MATH 172, Mathematical Methods for Business and Economics (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 102 minimum grade of CRD or undergraduate level MATH 104 minimum grade of C- or undergraduate level MATH 105 minimum grade of C- or appropriate score on ULV Math Placement Test
   Coreq: MATH 172L
   Revised December 23, 2008

2. **Course Description**
   This course provides treatments of selected topics in finite mathematics, algebra, analytic geometry and calculus; develops applied mathematical analysis and modeling techniques in finance and economics as well as general overviews of management-related applications of quantitative methods; familiarizes students with both basic and advanced mathematical and computerized tools for the modeling, analysis and solution of real problems and data sets; gives students the opportunity to work together as a team to solve problems and present solutions.

3. **Learning Outcomes**
   A. Students will become competent at symbolic manipulation of relevant equations and expressions pertaining to the mathematics of business applications
   B. Students will obtain skills in using computer software to assist in the formulation, analysis of, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   C. Students will be introduced to the fundamental ideas of the differential calculus, as well as applications from business and economics amenable to treatments based on these concepts.
   D. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   E. Students will learn mathematical techniques and their application to business problems through modeling real-world situations, in the process recognizing the interdisciplinary and pervasive nature of mathematics in diverse fields of human endeavor.
   F. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations.
   G. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of the business context.

4. Course Contents

Major areas to be covered by this course include the following:

A. Analytic Geometry and Algebra Review
   - (i) equations of lines; characteristics; applications
   - (ii) systems of linear equations; solution methods; applications
   - (iii) review of various algebraic concepts: exponents, elementary radicals, etc.

B. Functions
   (i) properties; operations on functions;
   (ii) graphical, verbal, numerical, and symbolic representation of functions
   (iii) linear and quadratic functions; finding zeros
   (iv) polynomial and rational functions; finding zeros; numerical/graphical techniques
   (v) exponential and logarithm functions

C. Matrix Algebra
   (i) operations on matrices
   (ii) applications

D. Differentiation
   (i) limits
   (ii) continuity
   (iii) rates of change
   (iv) definition of and rules for differentiation
   (v) higher order derivatives
   (vi) applications, including marginal functions in economics

E. Optimization
   (i) extrema
   (ii) curve sketching
   (iii) revenue, cost and profit
   (v) other applications of optimization of univariate functions
   (vi) least squares linear regression; correlation

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis

C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in the arena of business, finance and economics

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. Text, Materials and Resources

The primary resources for this course will be Applied Mathematics for the Managerial, Life, and Social Sciences, 4th edition (2007), by Tan (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) DERIVE, Mathematica, MATLAB, Linear Programming, PEAMATH, MPP, and MDEP.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.
B. This course will not be permitted to meet any direct requirements for a major or minor in either mathematics of business and economics. It is, however, considered as a formal prerequisite for most majors in business and economics.
C. With respect to the ULV Mission Statement, this course
   (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
   (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
   (iii) will stress the universality of the mathematical techniques learned,
   (iv) will attempt to model and give value to the idea of life-long learning through the completion of a team project,
   (v) and will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description: Explores selected topics in analytic geometry and calculus. Develops applied mathematics as employed in business for the modeling, analysis, and solution of real problems and data sets. Lab included.
Prereq: Undergraduate level MATH 102 minimum grade of CRD or undergraduate level MATH 104 minimum grade of C- or undergraduate level MATH 105 minimum grade of C- or Math Placement Test A 20 or Math Placement Test B 12
Coreq: MATH 172L

Course Outline:
MATH 172L Mathematical Methods for Business and Economics Lab

1. **Course Designation, Authorship, and Date**

   MATH 172L, Mathematical Methods for Business and Economics Lab (0 semester hours)
   For undergraduate credit only
   Coreq: MATH 172 Mathematical Methods for Business and Economics
   Prepared by Michael Frantz, April 22, 2007

2. **Course Description**

   Provides instructional support for the students enrolled in MATH 172. Several sections of MATH 172L will be made available each semester, generally speaking at least one more section than the number of MATH 172 sections offered, in order to both allow students to find an available time slot compatible with their schedules, and to reduce the size of the labs from 28 down to 22 or so for more effective instruction. The labs will be held in the Learning Enhancement Center (permission already granted by Bailey Smith), and will be taught by students enrolled in business majors who have already passed the MATH 172 course at a high level and who are recommended by the mathematics or business faculty. Lab sessions will be similar to a typical T.A. session in graduate schools, with the lab leader reinforcing and re-explaining more difficult or troublesome concepts from the lecture to students through small group work, software made available from publishers and others, and one-on-one tutoring.

3. **Goals (same as those for MATH 172)**

   A. Students will become competent at symbolic manipulation of relevant equations and expressions pertaining to the mathematics of business applications
   B. Students will obtain skills in using computer software to assist in the formulation, analysis of, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   C. Students will be introduced to the fundamental ideas of the differential calculus, as well as applications from business and economics amenable to treatments based on these concepts.
   D. Students will engage in substantial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group projects).
   E. Students will learn mathematical techniques and their application to business problems through modeling real-world situations.
   F. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments.

G. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of the business context.

4. Course Contents

Major areas to be addressed via problem solution techniques in this course include the following:

A. Analytic Geometry and Algebra Review
   - (I) equations of lines; characteristics; applications
   - (ii) systems of linear equations; solution methods; applications
   - (iii) review of various algebraic concepts: exponents, elementary radicals, etc.

B. Functions
   - (i) properties; operations on functions;
   - (ii) graphical, verbal, numerical, and symbolic representation of functions
   - (iii) linear and quadratic functions; finding zeros
   - (iv) polynomial and rational functions; finding zeros; numerical/graphical techniques
   - (v) exponential and logarithm functions
   - (vi) applications; modeling

C. Matrix Algebra
   - (i) basic operations on matrices
   - (ii) applications

D. Differentiation
   - (i) limits
   - (ii) continuity
   - (iii) rates of change
   - (iv) definition of and rules for differentiation
   - (v) higher order derivatives
   - (vi) applications

E. Optimization
   - (I) extrema
   - (ii) curve sketching
   - (iii) revenue, cost and profit
   - (iv) applications of optimization of univariate functions

5. Evidence of Learning Outcomes

Since this is a laboratory class with zero units of credit attached, the primary evidence of learning outcomes will be revealed through the assessment methods applied to the associated MATH 172 course.

6. Assessment Plan

This lab course will not have a separate grade attached to it, since it will be available only for zero units of credit, but attendance by students at the lab sessions will be mandatory and will be accounted for in the grading calculations for the MATH 172 course as outlined in that syllabus. The success of the laboratory course will be reflected in the classroom performance of the students on their homework and tests.

7. Text, Materials and Resources

The primary resource for this course will be the text, Applied Mathematics for the Managerial, Life, and Social Sciences, 4th edition (2007), by Tan (or a suitable alternative), and various computer programs accessible in the computer labs as necessary, including (but not limited to) DERIVE, Mathematica, MATLAB, Linear Programming, PEAMATH, MPP, and MDEP.

Catalog course description:

Hands-on problem-solving lab to reinforce mathematical techniques and methods introduced in the MATH 172 course lecture sessions.
Corequisite: MATH 172.

Course Outline:
MATH 201 Calculus I

1. **Course Designation**
   MATH 201, Calculus I (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 105 minimum grade of C- or appropriate score on ULV Math Placement Test
   Revised December 23, 2008

2. **Course Description**
   This course introduces the student to the two fundamental operations of the calculus of functions of one variable, differentiation and integration, through the study of limiting processes. Applications of differentiation and integration in the physical and social sciences are emphasized. In addition, some numerical techniques in calculus are discussed and problems solved via computer algebra system.

3. **Learning Outcomes**
   A. Students will become competent at the symbolic manipulation and simplification of algebraic expressions pertaining to the calculation of limits, derivatives, and integrals, the tools needed for solving a wide range of general mathematical problems.
   B. Students will become familiar with the definitions of limits (informal and formal), derivatives, and definite and indefinite integrals, and competent in the computation thereof, as pertains to polynomial, rational, algebraic, and trigonometric functions.
   C. Students will develop skills in the use of the first and second derivatives to graph and optimize functions.
   D. Students will become familiar with the statements and applications of classical name theorems and algorithms in calculus, such as Rolle's Theorem, the Mean Value Theorem, and Newton's Algorithm for finding zeros of functions.
   E. Students will become familiar with the use of theory and technology in working with graphs of more complex functions and obtain skills in using computer software to assist in the formulation, analysis, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   F. Students will become familiar with a wide variety of practical applications of elementary calculus mathematics in diverse fields of undergraduate study, particular with respect to problems involving rates of change and optimization.
   G. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   H. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations.
   I. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of applied real world problems.

4. Course Contents

Major areas to be covered by this course include the following:

A. Precalculus Review
- (i) the real line; notation; inequalities; absolute value
- (ii) midpoint and distance formulae; circles
- (iii) parabolas, ellipses, and hyperbolas
- (iv) trigonometry review
- (v) graphs; symmetry; models
- (vi) linear models and rates of change
- (vii) functions and their graphs
- (viii) use of Derive software

B. Limits and Continuity
- (i) finding limits graphically and numerically
- (ii) evaluating limits analytically
- (iii) continuity and one-sided limits; Intermediate Value Theorem
- (iv) infinite limits
- (v) limits at infinity
- (vi) formal limit definitions

C. Differentiation
- (i) definition of derivative; tangent lines
- (ii) basic differentiation rules; velocity, acceleration, and rates of change
- (iii) derivatives of products, quotients; higher order derivatives
- (iv) chain rule
- (v) implicit differentiation
- (vi) related rates

D. Exponential and Logarithm Functions
- (i) Exponential Functions and their Graphs
- (ii) Logarithmic Functions and their Graphs
- (iii) Properties of Logarithms
- (iv) Exponential and Logarithm Equations
- (v) Exponential and Logarithm Models

E. Applications of Derivatives
- (i) extrema on intervals; relative extrema; critical numbers
- (ii) Rolle's theorem; the Mean Value Theorem
- (iii) increasing and decreasing functions; first derivative test
- (iv) concavity; inflection points; second derivative test
- (v) summary of curve sketching techniques
- (vi) optimization problems
- (vii) Newton's method for finding zeros of functions
- (viii) differentials

F. Integration
   (i) antiderivatives and indefinite integration
   (ii) area
   (iii) Riemann sums and definite integrals
   (iv) the fundamental theorem(s) of calculus; average value of a function
   (v) integration by substitution
   (vi) numerical integration; trapezoidal rule, Simpson's rule
   (vii) area between curves

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers
B. Participate actively in topic discussions with the professor and peers
C. Submit solutions for homework problems on a regular basis
D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) biology, physics, economics, business, architecture, engineering, and design

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. Text, Materials and Resources

The primary resources for this course will be Calculus 8th edition, by Larson, Hostetler and Edwards (2006) (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) Derive and WinPlot.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.

B. This course is a core requirement for a major or minor in mathematics, and is a formal prerequisite for Math 202 Calculus II. It is also a supportive requirement for majors in physics, biology, chemistry, and computer science.
C. With respect to the ULV Mission Statement, this course
   (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
   (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
   (iii) will stress the universality of the mathematical techniques learned,
   (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
   (v) will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description: Introduces standard topics in differential and integral calculus of functions of one variable including a review of analytic geometry.
Prereq: Undergraduate level MATH 105 minimum grade of C- or Math Placement Test B 20

Course Outline:
MATH 202 Calculus II

1. **Course Designation**
   MATH 202, Calculus II (4 semester hours)
   Undergraduate credit only
   Prereq: Undergraduate level MATH 201 minimum grade of C-
   Revised December 23, 2008

2. **Course Description**
   This course is a continuation of Calculus I which deals with transcendental functions and additional techniques of differentiation and integration, as well as many applications of these methods. In addition, some numerical techniques in calculus are discussed and problems solved via computer algebra system. A brief introduction to functions of two variables and their derivatives is also included.

3. **Learning Outcomes**
   A. Students will obtain skills in various differentiation and integration techniques for the standard transcendental functions, including exponential, logarithmic, inverse trigonometric, and hyperbolic functions.
   B. Students will learn to use differential equations to model physical situations, as well as the technique of separation of variables for their solution.
   C. Students will learn important applications of integration for computing volumes by the disk, washer, shell, and cross-section methods, as well methods for computing arc length, surfaces of revolution, work, moments, centers of mass, centroids, fluid pressure and fluid force.
   D. Students will become familiar with the use of theory and technology in working with graphs and limits of functions of two variables, and obtain skills in using computer software to assist in the formulation, analysis, and solution of real problems, and to enhance their judgment of the reasonableness of results.
   E. Students will become familiar with a wide variety of practical applications of more advanced calculus mathematics in diverse fields of undergraduate study, particular with respect to problems involving applications of integration.
   F. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group project).
   G. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations.
   H. Students will acquire the ability to read, write, listen to, and speak mathematics within the framework of applied real world problems.

4. **Course Contents**
   Major areas to be covered by this course include the following:

A. Review, Exponential, Logarithm, and Inverse Trigonometric Functions, and D.E.'s
   - (i) review of integration by substitution; areas between curves
   - (ii) review of the trapezoidal Rule, Simpson's Rule
   - (iii) natural logarithm function: differentiation
   - (iv) natural logarithm function: integration
   - (v) inverse functions
   - (vi) exponential functions: differentiation and integration
   - (vii) bases other than "e", and applications
   - (viii) differential equations: growth and decay
   - (ix) differential equations: separation of variables
   - (x) inverse trigonometric functions: differentiation
   - (xi) inverse trigonometric functions: integration
   - (xii) hyperbolic functions

B. Applications of Integration
   - (i) volumes by disks, washers and cross-sections
   - (ii) volumes by the shell method
   - (iii) arc length, surfaces of revolution
   - (iv) work
   - (v) moments, centers of mass, and centroids
   - (vi) fluid pressure and fluid force

C. Techniques of Integration
   - (i) integration by parts
   - (ii) trigonometric integrals
   - (iii) integration by trigonometric substitution
   - (iv) partial fractions
   - (v) integration by tables and other miscellaneous integration techniques
   - (vi) indeterminate forms and L'Hospital's rule
   - (vii) improper integrals

D. Calculus of Two Variables
   - (i) introduction to functions of two variables
   - (ii) limits and continuity
   - (iii) partial derivatives
   - (iv) differentials
   - (v) chain rules for functions of several variables
   - (vi) introduction to vectors, dot and cross products
   - (vii) directional derivatives and gradients
   - (viii) tangent planes to surfaces

5. Activities of Participants

The students will do the following:

A. Listen to presentations of the professor and visiting lecturers

B. Participate actively in topic discussions with the professor and peers

C. Submit solutions for homework problems on a regular basis

D. Participate in regular small-group activities relating to new topics being introduced, including regular presentation of group solutions on the board
E. Spend appropriate amounts of time in the computer lab to understand software tools available for business and economics and how they function, and to complete computer assignments

6. Evidence of Learning Outcomes

By the end of the course, the student will have

A. Demonstrated, via completed class discussions, written homework problem sets, and periodic written tests, competence in the specific content areas listed under point 4, Course Contents, above
B. Taken part in the analysis and solution of real problems and orally presented the results of such analysis
C. Displayed skills in the computer lab directly to the instructor (and indirectly via computer assignments) which relate to analyzing problems in a wide variety of applied areas, including (but not limited to) biology, physics, economics, business, architecture, engineering, and design

7. Assessment Plan

The assessment of the students' performance will be based on a weighted average of their homework assignments (both computer problems and otherwise), board presentations of collaborative problem solutions, class participation, 70-minute tests, (optional) quizzes, and a comprehensive final exam. The final weighting formula is at the discretion of the professor.

8. Text, Materials and Resources

The primary resources for this course will be Calculus 8th edition, by Larson, Hostetler and Edwards (2006) (or a suitable alternative), and various computer programs accessible in the computer labs, including (but not limited to) Derive and WinPlot.

9. Program Relationship

A. Completion of this course with a grade of C- or better will satisfy the mathematics component of the general education requirements for graduation.
B. This course is a core requirement for a major or minor in mathematics, and is a formal prerequisite for Math 311 Calculus III. It is also a supportive requirement for majors in physics, chemistry, and some concentrations in computer science.
C. With respect to the ULV Mission Statement, this course
   (i) will attempt to keep an appropriate perspective on professional and societal values with respect to the real-world problems considered,
   (ii) will seek to use problems and applications relevant to a wide variety of cultural backgrounds,
   (iii) will stress the universality of the mathematical techniques learned,
   (iv) will attempt to model and give value to the idea of life-long learning through collaborative group work, and
   (v) will stress the service value of these solution methods with respect to both human and ecological problems.

Catalog course description:
Continuation of 201, with an emphasis on transcendental functions and various techniques and applications of integration. Introduces the calculus of functions of two variables.
Prereq: Undergraduate level MATH 201 minimum grade of C-

Spring, 2008
Michael Frantz

MATH 305 Transition to Advanced Mathematics

Course Designation

MATH 305 -- Transition to Advanced Mathematics: An upper division mathematics course which is required for mathematics majors and strongly recommended as a prerequisite for Linear Algebra, Abstract Algebra, Number Theory, Foundations of Geometry, and Discrete Mathematics. The pre-requisite is MATH 202 Calculus II. (4 semester hours)

Course Description and Prerequisites

This course is the first course for most students in progressing from computational mathematics to the study of the structure of mathematics and the roles of abstraction and rigorous proof in advanced mathematics. The course works to increase: the mathematical maturity of students by developing their logical reasoning ability, their skills in both reading and writing mathematics, their ability to comprehend and construct mathematical proofs, and their competence in working with complex mathematical statements including definitions, conjectures and theorems. Topics covered include principles of symbolic logic, various methods of mathematical proof, set theory, basic number theory, introductory real analysis, functions, relations, and number systems.

Goals

The goals of this course include the following: to provide a firm foundation in the major concepts needed to study abstract mathematics, to guide the student in being able to think and to express him/herself mathematically, to expose the student to a wide variety of mathematical proof techniques, to develop proficiency in constructing and writing rigorous mathematical proofs, and to introduce the student to the elementary mathematical structures and terminology found in fields such as such as number theory, abstract algebra and analysis.

Assignments and Tests

Homework and reading assignments will be made at each class meeting from both texts, including a number of exercises to be worked out by the student but not turned in, and a number of problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be due by 5pm of the day of the second class meeting after it is assigned. There will be four tests and a semi-comprehensive final exam. The fourth test will actually make up the first hour of the final exam, and the remaining two hours of the final exam will be over the first 3/4 of the course. Some or all of the tests may contain take-home components to them. Tests will be announced at least one week in advance, and approximate test dates may be inferred from the topics list provided later in this document. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on or prior to the day of the test, and prior to the testing time**.

<u>Evaluation</u>

The grade for the course will be based on the homework assignments (20%), the average of the four tests (60%), and the final exam (20%). If one of the first three test scores (including a test not taken) is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 20% or (in this latter case) 35% of the total grade. Late homework assignments (<u>if accepted at all</u>) will receive <u>at least</u> a 20% to 100% reduction in credit, determined at the discretion of the instructor, based on various factors. Final course grades will be determined by the following scale:

100- 90		A	A-
89 -80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59		F	

Note 1: If you choose the CREDIT/NO CREDIT grading option *(not available for mathematics majors)*, <u>you must earn at least a "C"- to obtain CREDIT</u>.
Note 2: This grading system is minimal in the sense that the student is guaranteed <u>at least</u> as high a grade as indicated by the above scale. A small amount of grade curving <u>may</u> make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.
Note 3: Students are individually responsible for determining what material was covered or other information distributed in any missed classes, what homework assignments were made, and when assignments are due.

<u>Textbook, Blackboard, and Other Resources</u>

The texts for this course will be <u>Proof, Logic and Conjecture</u>, 1st edition, by Robert Wolf, and <u>How to Read and Do Proofs</u>, 4th edition, by Daniel Solow. The material covered will include almost all of the Solow text, and chapters 1-7 and selected sections of chapters 8-10 in the Wolf text. Solutions and hints to selected (odd and even) exercises are given in the back of the Wolf text, and solutions to selected odd exercises only are given in the back of the Solow text. ***Log in to the ULV Blackboard system and check the course listing there frequently for homework information/solutions and other course information.***

<u>Academic Honesty and Classroom Etiquette</u>

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. Cell phones, pagers, and any other electronic beeping devices must be turned off while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to the call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of cell phones to transmit text and images, cell phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class.

Office Hours

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA 152, x4601) is available from 8am to 5pm.

Transition to Advanced Mathematics—Topics

Texts: Proof, Logic and Conjecture, 1st ed., by Wolf, and How to Read and Do Proofs, 4th ed., by Solow

Description of topic		(Approx.) number of 70 min lectures
Introduction to Course		
1.1 Knowledge and Proof; 1.2 Proofs in Mathematics	Solow: 1	1
2.1 Basics of Propositional Logic		1
2.2 Conditionals and Biconditionals		2
2.3 Propositional Consequences; Introduction to Proofs	Solow: 2	1
3.1 The Language and Grammar of Mathematics	Solow: 3	
3.2 Quantifiers		1
3.3 Working with Quantifiers	Solow: 10	2
3.4 Equality Relation; Uniqueness	Solow: 11.1, p. 114	1

TEST I		9
4.1 Different Types of Proofs		1
4.2 Use of Propositional Logic in Proofs		1
4.3 Use of Quantifiers in Proofs	Solow: 4, 5, 6, 7	2
4.4 Use of Equations in Proofs		1
4.5 Mathematical Induction	Solow: 11.2, and p. 115	2
4.6 Hints for Finding Proofs		2
Selections from How to Read and Do Proofs	Solow: 8, 9, 12	4

TEST II		13
5.1 Naïve Set Theory and Russell's Paradox		1
5.2 Basic Set Operations		1
5.3 More Advanced Set Operations		1
6.1 Ordered Pairs, Cartesian Products, and Relations		1
6.2 Equivalence Relations		2

TEST III		6

7.1 Functions and Function Notation	1
7.2 One-to-one and "Onto" Functions; Inverse Functions and Compositions	2
7.3 Proofs Involving Functions	1
7.4 Sequences and Inductive Definitions	1
7.5 Cardinality	2
7.6 Counting and Combinatorics	1

	8

TEST IV ; FINAL COMPREHENSIVE EXAM

This schedule provides material for 36 lectures (70 minutes each), leaving 5 lecture days open in a typical 41 lecture course for tests and review, and (time permitting) optional topics or applications. ***The topics and the time spent on them are subject to change.***

POSSIBLE OPTIONAL TOPICS IF TIME PERMITS

7.7 Axiom of Choice and the Continuum Hypothesis
The Ring Z and the Field Q
Introduction to Number Theory
More Examples of Rings and Fields
The Completeness Axiom
Limits of Sequences and Sums of Series
Limits of Functions and Continuity
Topology of the Real Line
Construction of the Real Numbers

Schedule of Assignments for MATH 305 – Transition to Advanced Mathematics (Spring, 2008)

Selected problems have solutions in the back of the text, and in the case of the Solow book, sometimes on a web site. Unless otherwise announced, problem sets will be due by 5pm of the <u>second</u> class meeting after they are assigned. [Bracketed] problems indicate those to be handed in, while {braced} problems can be turned in for extra credit. *Unless otherwise specified, exercises will be from the Wolf text.* There will be other problems periodically assigned for students to do on the board in class. ***The following list is subject to changes and/or additions at any time.***

TEXTS: **<u>Proof, Logic and Conjecture</u>, 1st ed., by Wolf, and <u>How to Read and Do Proofs</u>, 4th ed., by Solow**

1.1 2, 3

1.2 1, 2, 3 [4abd, 5, 6, 7, 8abc, 9abd, 10] {9c, 11a}

Solow 1: 1, 3, 4, 6, 8, 10, 11 [2, 5, 7, 12]

2.1 1b, 2, 3cd, 4abdegij, 6a, 9bd [1eh, 3abef, 4cfhk, 5, 6bcde, 8, 9ac, 10, 11]

2.2 2df, 3d, 4a7b1, 5b4, 6cf, 8cd,12 [1,2abce, 3abc, 4a3a5b3b5c2c6c8,5b1,6abdeghijk,7,8abef, 9,10,11,13,14]

2.3 1abcd,2bc,3c,4ce,5ab [1efgh, 2ade, 3ab, 4abd, 5cd, 7, 8, 9, 10] {12, 13, 14, 15, 16, 17}

Solow 2: 23 [26]

3.1 READ

3.2 1bcd, 3bcdh, 5bd, 6d, 7abcfg, 8def [1ae, 3aef, 5ac, 6abc, 7deh, 8abcghijkl]

Solow 3: 7, 9, 10, 13, 15, 17, 18, 19 [8, 11, 14]

3.3 5acef, 8bc, 9bd, 10d [5bd, 6abcdef, 8a, 9a, 10abc]

3.4 2a, 3a, 5ae, 7acd, 9, 12b [2b, 3b, 5bcd, 6abcdef, 7b, 11a, 12a]

Solow 10: READ

Solow 11: 1, 3 [4 (p. 118)]

4.1 READ

4.2 13, 16, 17 [4bcd, 10, 12, 14, 15]

4.3 READ

4.4 READ

Solow 4: 6, 7, 9, 11, 13, 14 [4, 8, 10, 12]

Solow 5: 13 [14, 15]

Solow 6: 15 [16] Note: other proof problems will also be assigned

Solow 7: 3, 7, 9, 11 [2, 4, 8, 10] during this time!

4.5 [1acd, 7, 13, 14, 17, 18, 21ac, 23]

Solow Chapter 11: 6, 10, 12, 14, 16, 25, 26 [11, 13, 15]

5.1 1bcde, 2e, 3, 4, 6a, 9c, 12 [1a, 2abcd, 5, 6bcde, 7, 8abef, 9ab]

5.2 1ci, 6c, 7cf [1abdefgh, 2fh, 3de, 6abd, 7abde, 11, 13, 14, 15ae]

5.3 1cd, 2a, 3bf, 11 [1abe, 2bce, 3acde, 11, 12, 13, 15]

6.1 1abefghij, 3ce, 4c [1cd, 2cdefghij, 3abdf, 4abde, 5, 6, 15, 16, 17a]

6.2 1bc, 3acd, 5 [1adf, 2, 3befg, 8, 17, 18]

7.1 2d, 5 [1bdghi, 2abcf, 6, 7, 8]

7.2 7, 13d [2, 3, 5, 8, 13abc, 14, 20]

7.3 19bd [12a(ii,iii,iv), 12b, 19acef, 20, 21]

7.4 2c, 6 [1, 2abd, 4abcd, 5, 7cd, 11bc]

7.5 [4, 15, 16, 17, 18, 20]

7.6 10a, 2a, 12b [1b, 2ab, 3, 5, 12acde, 13ab]

Michael Frantz

CALCULUS III -- SYLLABUS

COURSE DESIGNATION

MATH 311 - Calculus III: An upper division undergraduate math course required for all mathematics and physics majors, and recommended for biology, chemistry, and computer science/engineering majors.
(4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course is a continuation of Calculus II, dealing primarily with polar coordinates, infinite sequences and series, vectors in the plane and space, parametric functions and equations, and multiple integration. Computer algebra systems will play a role throughout the course in enhancing the understanding of difficult topics and assisting in problem-solving. The prerequisite is MATH 202 (Calculus II) with a grade of "C" or better.

GOALS

The goals of this course include the following: to develop a working knowledge of the polar coordinate system and techniques of differentiation and integration within that system; to learn the fundamentals of infinite series and the basic convergence tests, as well as representations of functions by series; to introduce two and three-dimensional vectors and fundamental mathematical operations on them; to acquire proficiency in setting up and evaluating multiple integrals in both rectangular and polar coordinate systems, as well some knowledge of cylindrical and spherical coordinate systems; and to provide a framework of computational skills on a computer algebra system (DERIVE or MATHEMATICA) to assist in the development of course concepts and to enhance problem-solving capabilities.

ASSIGNMENTS and TESTS

Daily homework assignments will be made, including a number of exercises to be worked by the student but not turned in, and a few problems which must be handed in and will be considered as part of the course grade. Each set of problems assigned to be graded will be due at the beginning of the second class meeting after it is assigned. There will also be a mandatory component of the course requiring the student to use a computer algebra system (DERIVE or MATHEMATICA) in the computer lab to solve various exercises and work through lab assignments. No programming experience is required.

There will be four one-hour tests, and a semi-comprehensive final exam. The fourth one-hour test will actually make up the first hour of the final exam, and the remaining two hours of the final exam will be over the first 3/4 of the course. Tests will be announced at least one week in advance. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be more difficult than the original test. **Note: the fee for a make-up test is $40.00**. If you will not be able to attend class on a test day, **please inform the instructor by phone on the day of the test prior to the testing time**.

EVALUATION

The grade for the course will be based on the average of the four one-hour tests (60%), the textbook homework and computer lab assignments (20%), and the final exam (20%). If any one-hour exam score (including a test not taken) is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 20% or (in this latter case) 35% of the total grade. Late homework assignments (if accepted at all) will receive at least a 20% to 50% reduction in credit, determined at the discretion of the instructor, based on various factors. Final course grades will be determined by the following scale:

100 - 90				A	A-
89 - 80	B+	B	B-		
79 - 70	C+	C	C-		
69 - 60	D+	D			
0 - 59	F				

Note 1: If you choose the CREDIT/NO CREDIT grading option, you must earn at least a "C" to obtain CREDIT.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B", or a 68.5 to be a "C", for example.

TEXT

The text for this course will be Calculus, 5th edition, by Larson, Hostetler and Edwards (D.C. Heath). The material covered will include most or all of chapters 8, 10, 11, 12 and 14, although not necessarily in that order. Student solution manuals with odd numbered problems worked out will be available in the bookstore, as well as in the library on a limited access (two hour check-out) basis.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **NOT** include the practice of copying assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the failure of that test or possible dismissal from the course as per university policy.

OFFICE HOURS

My office number is 56B, located on the bottom floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by electronic mail on the VAX computer (FRANTZM). The Natural Sciences secretary (Sharla, MA250) is also available, at ext. 4601 from 8am to 5pm.

CALCULUS III TOPICS

Text: Calculus, 5th ed., by Larson, Hostetler, Edwards (D.C. Heath, pub.)

Description of topic	Approx. number of lectures
Introduction to Calculus III	0.5
Plane curves and parametric equations	1.5
Parametric equations and calculus; slopes, arc lengths, areas of surfaces of revolution	1.5
Polar coordinates and polar graphs; tangent lines and curve sketching	2
Area and arc length in polar coordinates	2
Instruction on using DERIVE, MPP in computer lab	0.5

	8
TEST I	
Sequences of real numbers	1.5
Series and convergence; geometric series	1.5
The integral test and p-series test	1
Direct comparison and limit comparison tests	1
Alternating series	2
Ratio and root tests	1
Taylor polynomials and approximations	2
Power series	1
Representation of functions by power series	1.5
Taylor and Maclaurin series	2
General review of series techniques	0.5

	15
TEST II	
Vectors in the plane	0.5
Space coordinates and vectors in space	0.5
The dot product of two vectors	1
The cross product of two vectors in space	1
Lines and planes in space	1
Cylindrical and spherical coordinates	1
Vector-valued functions (v.v.f.'s)	1
Differentiation and integration of v.v.f.'s	1
Velocity and acceleration	1
Tangent vectors and normal vectors	1
Arc length and curvature	1

	10
TEST III	
Iterated integrals and area in the plane	1
Double integrals and volume	2
Change of variables: polar coordinates	2
Center of mass and moments of inertia	1
Surface area	1
Triple integrals and applications	2
Triple integrals in cylindrical and spherical coordinates	2

	11

TEST IV, **FINAL EXAM**

This schedule provides material for 44 lectures, leaving 8 lectures open in a typical 52 lecture course for tests, review, computer lab instruction, and optional topics.

EXERCISE SETS FOR MATH 311 -- CALCULUS III

Text: Calculus, 5th ed., by Larson, Hostetler, Edwards (D.C. Heath, pub.)

NOTE: The following list of exercises is subject to change at any time. It is highly recommended that students attempted to do as many of the "regular" exercises as possible, checking the answers in the back of the text. Note also that many odd problems have solutions completely worked out in the STUDENT STUDY AND SOLUTIONS GUIDE, a limited number of which are available in the ULV bookstore (more may be ordered if there is a need). The [boxed] exercises must be handed in a timely fashion (as per due dates announced in class) and will count for a portion of the course grade, as outlined in the syllabus. Several {extra credit} exercises, generally of a more difficult nature, have also been listed. Exercise numbers in **boldface** type will be most easily done with the assistance of DERIVE. In fact, DERIVE may be used to check the correctness of a great proportion of the total homework exercises, even though the work is done by hand to solve the problem. USE THIS SHEET AS A PROBLEM CHECKLIST!

Note: **there will also be formal lab assignments to be done with the DERIVE program**. The list below is not complete and is subject to changes/additions at any time!

SECTION REGULAR EXERCISES [EXERCISES TO BE HANDED IN] {EXTRA CREDIT}

10.1 3-11,15-19,25-35,41-45,49,59,61,67,69,73-77 [4-20,24-32,36-46,50-56,60,62,68-76] {64}
10.2 3,7,11,13,15,21,25,29,31,36,43,45,59,61,63 [8,10,12,14,20,22,26,34,37,44,46,62,64]
10.3 3,7,11-25,29,33,37,41,45-75,91 [2,8,12-26,30,34,38,46-76] {32,95}
10.4 3-19,27,29,33-41,47,49,57,58,59,60 [4-8,12,16,28-34,40,42,46,48] {61,62,63}

8.1 5,13-19,23-27,33-65,69,81-89 [38-52,56,60,62,68,78,86,88]
8.2 7,9,13,15,27,33,39,51,55,57,75,83-87 [10,14,16,26,28,34,40-46,52,56,58,65,66,70,74,78, 86,88]
8.3 5,7,13-33,41-45,51 [6,8,10,22-36,40,42,48] {52}
8.4 1-33,39-43,47,49 [2,8,12-34,40-44,48,50] {52}
8.5 1-43,49-53 [6-14,18,26,32-36,40-44,48-54]
8.6 5-55,59 [6-24,28-50,54] {58}
8.7 1,3,9-17,21,23,31-41,42 [2,4,10-18,22,24,28,32-40]
8.8 1-7,11-17,23,25,29,31,35,43,47,49 [2-8,12-18,22,26,28,32-36,42,46-50]
8.9 3,5,9,13-21,25,31,39-45 [2,6,10-26,32,40-46] {37-38,48}
8.10 1-13,17-29,41-45,51 [4-12,16,20,22,26,28,34,36,40,44,48,52-62,61] {57,59,63}

11.1 15-21,27,31,35,39,43,47,51,61-65,69,71,77-81 [26,32,38,40,42,46,50,64-70,78-82]
11.2 7,9,13,17,35,39,47,53,61 [6,10,14,18,36,38,52,62]
11.3 3,9,13,15,25,29,37,41,45,49-55 [6,8,12,18,24,30,38,42,46,52,54,56]
11.4 11,19,21,25,29-33 [12,18,22,24,30,32,34] {49}
11.5 5-17,21,25,29,33-45,49,57-73,76 [6-18,22,28-46,50,58,62-70]
11.7 3,5,9-13,17,23,25,29,31,35,39,41,49,59-69,73-81 [2,4,10,12,16,18,22,24,30,32,44,52,60,62,64,68-82]

12.1 3,5,9-15,27-33,37-49,59 [10-14,18-36,40-50,60]
12.2 7,17,21,25,29-33,37,39,43,53,54 [8,16,24,26,30-34,38-44]
12.3 5,13,17,23,31,33,35,43 [6,14,18,24,28,30,44,45,46]
12.4 1,5,13,15,23,27,29,31,39 [2,6,14,24,28,30,32,40] {38}
12.5 3,7,13,19,23,25,29,31,35,41-45,49,57 [2,8,14,22,28,30,36,42,44,48,66] {56}

14.1 7,9,13,19,21-27,33,35,41,43,49,51,57,59 [6,10,14,20-28,34,36,42-46,50,52,58,60]
14.2 5,9,11,15,23,25,27,35,37,43,47,49,53,67,71 [6,8,10,24,26,28,36,38,44,48,50,54] {69,72}
14.3 3,5,9,17,19,23,25,29 [4,6,10,18,20,24,26,30,40]
14.4 5,7,9,11,13,15 [6,8,12,14,16,20]
14.5 3,7-11,15,17,23,27,29,33 [4,8-18,24,28,30,34]
14.6 1,5,7,13,15,17,23,25,33,35 [2,4,6,14,16,18,24,26,32,34,36]
14.7 3,9,11,25,31,33,37 [4,10,12,26,28,30,32,34,38]

Spring, 2009
Michael Frantz

MATH 315 Differential Equations

Course Designation

MATH 315 - Differential Equations: A upper division undergraduate math course required for the B.S. mathematics major, and strongly recommended for the B.A. mathematics major and physics majors. Also recommended for students in chemistry. (4 semester hours)

Course Description and Prerequisites

This course serves as an introduction to the methods of solution, applications, and theory of ordinary differential equations. Various solution techniques will be examined, including extensive experience with numerical and graphical techniques implemented on computers. Modeling applications for differential equations from various areas of science and engineering will also be discussed. All students enrolling in this course should have passed a complete sequence in the calculus of functions of one variable, up through Taylor series. At the University of La Verne, this means Calculus I, II and III. See the instructor for further information.

Goals

The goals of this course include the following: to develop proficiency in various methods of solution for first order and higher order ordinary differential equations and linear systems, including exact, separable, homogeneous, linear and Bernoulli equations, utilizing the methods of variation of parameters, undetermined coefficients, power series, Laplace transforms, and numerical approximation; to acquaint the student with the modeling processes used in applying differential equations to solve real problems in the sciences, and expose the student to some of the standard (as well as non-standard) physical problems with solutions governed by differential equations; to develop an operational knowledge of the basic computational algorithms and software used to generate mathematical solutions to differential equations and systems of differential equations; to acquire a depth of understanding of complex concepts and ideas through the exploratory use of sophisticated mathematical software for computing and displaying solutions of differential equations and systems; and to provide a sound mathematical base for the goals listed above, in terms of when solutions are known to exist and whether such solutions are meaningful.

Assignments and Tests

Daily homework assignments will be made, including a number of exercises to be worked by the student but not turned in, and several problems which must be handed in and graded. Each problem set to be graded will be due by 5pm one week after it is assigned, unless otherwise specified.

Note: a key component of this course will be the use of software to assist the student in exploring complex mathematical concepts and models through the interactive graphical display and manipulation of solutions of differential equations. The homework text assignments will frequently include problems requiring the student to use specialized software in the computer lab (Maple, MATLAB, PPLANE, and others). No prior programming experience is required, as the differential equations solver software will be made available and is user-friendly.

There will be four one-hour tests and a final exam which will either be comprehensive or will cover the first 3/4 of the course, in the case that the fourth test occurs on the final exam day. Several of the tests will have **take-home** components in addition to or in place of in-class components. Tests will be announced at least one week in advance, and approximate dates may be inferred from the topics list provided later in this document. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be more difficult than the original test. **Note: the fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on the day of the test prior to the testing time**.

Evaluation

The grade for the course will be based on the homework, computer assignments and projects (15%), the average of the four one hour tests (60%), and the final exam (25%). If any one-hour exam score (including a test not taken, but **excluding the fourth test if it is included on the final exam day)** is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 25% or (in this latter case) 40% of the total grade. Late homework assignments (if accepted at all) will receive at least a 20% to 50% reduction in credit, determined at the discretion of the instructor, based on various factors. Final course grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available for mathematics majors), you must earn at least a "C"- to obtain CREDIT.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

Textbook, Blackboard, and Other Resources

The text for this course will be Differential Equations and Boundary Value Problems: Computing and Modeling, by Edwards and Penney, fourth edition (2008). The first seven chapters and portions of chapter 8 will be covered in this course. Differential equations solver software will be made available on university computers and to individual students (PPLANE, MATLAB, others). A student Solutions Manual will be available for purchase in the bookstore. There is also a companion website for the text with more resources, located at http://wps.prenhall.com/esm_edwards_bvp_4/ ***Log in to the ULV Blackboard system and check the course listing there frequently for homework information/solutions and other course information.***

Academic Honesty and Classroom Etiquette

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. Cell phones, pagers, and any other electronic beeping devices must be turned off while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to the call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of cell phones to transmit text and images, cell phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class. You should expect to spend at least two hours studying outside of class for every hour spent in class. Of course, mileage may vary; if you wish to earn the best grade possible, you may have to study more! Each person has different study needs.

Office Hours

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA152, x4601) is (usually) available between 9am and 5pm.

Differential Equations Topics

Text: Differential Equations and Boundary Value Problems: Computing and Modeling, by Edwards and Penney, fourth edition (2008). This schedule provides for fifty 50-minute lectures (25 class days), leaving 6 lectures (3 days) free in a typical 56 lecture (28 day) course for tests.

<u>**Description of topic**</u>	<u>**Number of lectures**</u>
Introduction to differential equations; classification; D.E.'s and mathematical models	1
Integrals as general and particular solutions	1.5
Slope fields and solution curves; existence and uniqueness of solutions	1
Separable equations and applications	2
Linear first order equations and applications	1.5
Substitution methods and exact equations; Bernoulli equations	1.5
Population models	1
Equilibrium solutions and stability	1
Acceleration-velocity models	1.5

	12

Test I

Numerical approximation: Euler's method	1
Improved Euler's method; accuracy	1.5
The Runge-Kutta method; (Adams-Bashforth/Moulton methods?)	1
Introduction to second-order linear equations	1.5
General solutions of linear equations	1.5
Homogeneous equations with constant coefficients	1
Mechanical vibrations	1
Nonhomogeneous D.E.'s and the method of undetermined coeff; variation of parameters	2
Forced oscillations and resonance	1.5

	12

Test II

First-order systems and applications	1.5
Method of elimination	1.5
Numerical methods for systems	1
Matrices and linear systems	2
The eigenvalue method for homogeneous systems	2
(Multiple eigenvalue solutions; matrix exponentials and linear systems; nonhomogeneous linear systems)	
Stability and the phase plane	1
Linear and almost linear systems	1.5
Ecological models: predators and competitors	1
Nonlinear mechanical systems	1
Chaos in dynamical systems	1.5

	14

Test III

Laplace transforms and inverse transforms	1.5
Transformation of initial value problems	1.5
Translation and partial fractions	1.5
Derivatives, integrals, and products of transforms; convolution	1.5
Periodic and piecewise continuous input functions	1
Impulses and delta functions	1

Introduction and review of power series	1
Series solutions near ordinary points	1.5
Series solutions near regular singular points	1.5
(Frobenius' method: the exceptional cases; Bessel equations/functions and applications)	---
	12

Test IV; Semi-Comprehensive Final Exam

Spring, 2010
Michael Frantz

MATH 319 Vector Calculus - Syllabus

Course Designation

MATH 319 - Vector Calculus: An upper division undergraduate math course strongly recommended for all mathematics majors as well as some physical science and computer science majors. May be used as an alternative to Abstract Algebra for the B.A. in Mathematics.
(4 semester hours)

Course Description and Prerequisites

This course introduces the student to the basic notions of differential and integral calculus as applied to functions of several variables and vector-valued functions, with the primary emphasis in a three-dimensional setting. The basic theory will be enlarged to include line and surface integrals, culminating in the study of the divergence theorem, Green's theorem, and Stokes' theorem, as well as physical applications of these results. The prerequisite is MATH 311 (Calculus III) with a grade of "C" or better.

Learning Outcomes

A. Students will become familiar with the geometry, vocabulary, and terminology of mathematical functions in the context of two and three-dimensional space.
B. Students will learn the basic operations for length, inner products, cross products, and scalar products involving vectors, as well as determinants for matrices and divergence and curl operations for vector fields, along with their physical interpretations.
C. Student will obtain skills in formulating mathematical problems in cylindrical and spherical coordinates, and become proficient at the conversion of problems between rectangular, cylindrical, and spherical coordinate systems, as well as learning what properties make each system most appropriate for which types of geometric features.
D. Students will learn how to extend definitions, operations, and theorems from two and three-dimensional space to n-dimensional space.
E. Students will learn the effect that an increase from one to two independent variables has on the notions of limits and continuity of functions, how to calculate those limits when they exist, and how to determine the continuity (or not) of a function in higher dimensions.
F. Students will obtain skills in the differentiation of functions of several variables, including partial differentiation and directional derivatives, and use these to determine extrema (and constrained extrema via Lagrange multipliers).
G. Students will learn the theory behind multiple integrals, and the methods of their computation, including double and triple integrals in various coordinate systems, as well as the effect of smoothly transforming the region of integration in one and two dimensions.
H. Students will learn the definition of integration a scalar function or vector field along a path or over a surface, and become proficient at carrying out such integrations in a varied context of geometric settings.

I. Students will learn the theory behind and the methods of application of the classical theorems of vector analysis: Green's Theorem, Stokes' Theorem, and Gauss' Theorem, as well as the theory governing conservative vector fields.

J. Students will learn how to engage in nontrivial mathematical problem solving, both on an individual basis (homework) and as part of small groups (computer work and group projects).
K. Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments, while also recognizing that mathematical methods have limitations, and that undue reliance on intuition in higher dimensional mathematics can lead to contradictory and false results.
L. Students will acquire the ability to read, write, listen to, and speak about mathematics within the framework of higher dimensional geometry.

Assignments and Tests
Daily homework assignments will be made, including a number of exercises to be worked out by the student but not turned in, and several problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be due at the **beginning** of the **second class meeting** after it is assigned. ***Each student is personally responsible for determining what material was covered and what assignments made on any days of absence from class.*** The instructor ***reserves the right to actually grade only a subset*** of the problems handed in for grading. Students may be required to use a computer algebra system in the computer lab to solve assigned problems and undertake mathematical explorations.

There will be four one hour tests and a 75% comprehensive final exam. The fourth one-hour test and an exam covering the first 75% of the course will both be given on the final exam day, thus constituting a 100% comprehensive exam. Approximate test dates may be inferred from the topics list provided later in this document, and actual test dates will be confirmed at least one week in advance. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone before or on the day of the test prior to the testing time**.

Evaluation
The grade for the course will be based on a weighted average of the four one-hour tests (60%), the textbook homework assignments (20%), and the final exam (20%). If any one-hour test score (including a test not taken, but ***excluding the fourth test***) is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 20% or (in this latter case) 35% of the total grade. Late homework assignments (***if accepted at all***) will receive a 20% to 100% reduction in credit, determined at the discretion of the instructor, based on various factors. Final course grades will be determined by the following scale:

100 – 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

Note 1: If you choose the Credit/No Credit grading option, *you must earn at least a "C-" to obtain Credit*. This is a moot point for most students, as any course required for a major must be taken for a letter grade.

Note 2: This grading system is minimal in the sense that the student is guaranteed ***at least*** as high a grade as indicated by the above scale. A small amount of grade curving ***may*** make it possible at times for a 79 to be a "B-", or a 68 to be a "C-", for example.

Text and Computer Resources

The text for this course will be ***Vector Calculus***, by Marsden and Tromba (W.H. Freeman, 2003, 5th ed.) A student study guide is available and may or may not be in the bookstore at this time. It is the goal of the course to cover all of the topics in the text, with the exception of two or three selected optional sections. Maple, Derive, Matlab, and Mathematica will be available on computers in the PC labs in FH206 and FH207 and MA54 for doing graphics work and symbolic and numeric integrations, as well as sophisticated differentiations and changes of coordinates. A free but powerful program called Winplot is available for download at http://math.exeter.edu/rparris/winplot.html, which may prove useful for 3D plotting. Students will be expected to make use of at least one of these packages in working out many of the exercise sets. Adequate help will be given in class or in reserved times outside of class on their use. ***Log in to the ULV Blackboard system and check the course listing there frequently for homework information/solutions and other course information.***

Academic Honesty

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. Cell phones, pagers, and any other electronic beeping devices must be turned off while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to the call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of cell phones to transmit text and images, cell phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class. You should expect to spend at least two hours of high quality studying/homework time outside of class for every hour spent in class. Of course, mileage may vary; if you wish to earn the best grade possible, you may have to study more! Each person has different study needs.

Office Hours

My office number is 155A, located on the second floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909) 593-3511, ext. 4609. If I am not available, you may leave a message on my phone voice mail after 4 rings, or via email at mfrantz@laverne.edu. The Natural Sciences Office, in MA 152 (x4601) is also staffed from 8am to 5pm.

VECTOR CALCULUS TOPICS

Text: ***Vector Calculus***, by Marsden/Tromba (W.H. Freeman, 2003, 5th ed.)

Description of topic	Number of lectures
Introduction to vector calculus; Vectors in R^2 and R^3	1.0
The inner product, length, and distance	1.0
Matrices, determinants, and the cross product	1.0
Cylindrical and spherical coordinates	0.5
n-dimensional Euclidean space	0.5
The geometry of multivariate functions; using computers for plotting	1.0
Limits and continuity	1.5
Differentiation	1.5
Introduction to paths and curves	1.0
Properties of the derivative	1.0
Gradients and directional derivatives	1.0

TEST I	11
Iterated partial derivatives	1.0
Taylor's theorem	1.0
Extrema of real-valued functions	1.5
Constrained extrema and Lagrange multipliers	1.0
The implicit function theorem (if time permits)	0.5
Acceleration and Newton's Second Law	1.5
Arc length	0.5
Vector fields	1.0
Divergence and curl	1.0

TEST II	9
Introduction to multiple integration; the double integral over a rectangle	1.0
The double integral over more general regions	1.0
Changing the order of integration	1.0
The triple integral	2.0
The geometry of maps from R^2 to R^2	1.0
The change of variables theorem; the Jacobian	1.0
Applications of double and triple integrals	1.0
Improper integrals	1.0

TEST III	9
The path integral	1.0
Line integrals	1.0
Parameterized surfaces	1.0

Area of a surface	1.0
Integrals of scalar functions over surfaces	1.0
Surface integrals of vector fields	1.0
Green's theorem	1.0
Stokes' theorem	1.0
Conservative vector fields	1.0
Gauss' theorem	1.0
Applications	1.0

TEST IV; 75%-comprehensive Final Exam	11

This schedule provides material for 40 lectures (60 minutes each), leaving 4 lectures open in a typical 44 lecture course for three tests and final review.

Fall, 2007
Michael Frantz

MATH 320 LINEAR ALGEBRA -- SYLLABUS

Course Designation
MATH 320 - Linear Algebra: An upper division undergraduate math course required of all mathematics majors (B.A. or B.S.) and strongly recommended for students with computer science/engineering majors. (4 sem. hours)

Course Description and Prerequisites
This course introduces the student to the basic computational techniques and fundamental theory underlying the field of mathematics called linear algebra. The properties of matrices will be explored in order to devise sound techniques for the solution of systems of linear equations, as well as for the determination of other important quantities related to matrices and their applications. These properties arise out of the fundamental geometric and abstract concepts of vector spaces and linear transformations, necessitating exposure of the student to abstract mathematical proof and experience in the original formulation of deductive proofs from basic definitions and theorems. The assistance of the computer (Derive or Matlab) is employed on a regular basis where practical to reflect the realities of problem-solving in situations where linear algebra methods are employed in the real world. Prerequisite: MATH 305.

Goals
The goals of this course include developing the following skills and areas of knowledge: solution methods and theory for systems of linear equations, operations with and properties of real matrices, theory and computation of determinants, fundamental properties and theorems of vector spaces and linear transformations, eigenvalue/eigenvector computation, diagonalization and properties of symmetric matrices, and numerical methods for solutions of linear systems as well as eigenvalue computations. It is also required that students develop some proficiency at using the Derive or Matlab software packages to manipulate matrices and solve problems in linear algebra. In addition, the student should be able to devise, think through, and write out a valid, proper deductive mathematical proof in linear algebra by the end of the course. A final goal is that the student be exposed to a wide variety of real applications of the concepts mentioned above, and develop some facility for applying the methods to solve nontrivial applications problems.

Assignments and Tests
Homework assignments will be made each class day, including a number of exercises to be worked out by the student but not turned in, and several problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be due at the ***beginning*** of the class one week after it is assigned. The instructor *reserves the right to actually grade only a subset* of the problems handed in for grading. ***Each student is personally responsible for determining what material was covered and what assignments made on any days of absence from class.***

There will be four regular tests and a ¾ - comprehensive final exam. The second test will have a take-home component, and the fourth test will be a 100% take-home test, due at final exam time. The final exam will cover material from the first three tests. Approximate test dates may be inferred from the topics list provided later in this document, and actual test dates will be confirmed least one week in advance. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency), and may be considerably more difficult than the original test. **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone before or on the day of the test prior to the testing time**.

Evaluation

The grade for the course will be based on the homework and computer lab assignments (16%), the average of the four regular tests (64%), and the final exam (20%). If any regular test score (including a test not taken, but **excluding the fourth test)** is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 20% or (in this latter case) 36% of the total grade. Late homework assignments (if accepted at all) will receive a 20% to 100% reduction in value, *determined at the discretion of the instructor*, based on various factors, including degree of lateness. Final course grades will be determined by the following scale:

100 - 90	A	A-			
89 - 80	B+	B	B-		
79 - 70	C+	C	C-		
69 - 60	D+	D			
0 - 59	F				

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available for mathematics majors), you must earn at least a "C"- to obtain CREDIT.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

Textbook, Blackboard, Computer, and Other Resources

The text for this course will be Contemporary Linear Algebra, 1st edition (2003, Wiley) by Anton and Busby. A limited number of student solutions manuals have been ordered and should be available in the bookstore. The Derive and Matlab software will available for students to run in the computer labs (FH 206/207) or the math/phys/chem student rooms (MA 54/157). It is expected that all students will make use of this easy-to-use software throughout the course, and in fact, many assignments will require its use. The site www.contemplinalg.com contains a variety of student resources (but when last checked was not working; ask in class about this). ***Log in to the ULV Blackboard system and check the course listing there frequently for homework information and other course information.***

Academic Honesty and Classroom Etiquette

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. Cell phones, pagers, and any other electronic beeping devices must be turned off while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to the call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of cell phones to transmit text and images, cell phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class. You should expect to spend at least two hours studying outside of class for every hour spent in class.

Office Hours

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class, but will generally be in the late afternoon. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA152, x4601) is available from 8am to 5pm.

LINEAR ALGEBRA TOPICS

Text: Contemporary Linear Algebra, 1st edition (2003, Wiley), by Anton and Busby.

	Description of topic	Number of 100 min. classes
1.1	Intro. to the course; vectors and matrices in engineering and mathematics; n-space	1/3
1.2	Dot products and orthogonality	1/3
1.3	Vector equations of lines and planes	2/3
2.1	Introduction to systems of linear equations	2/3
	Using MATLAB	1/3
2.2	Solving linear systems by row reduction; Gaussian and Gauss-Jordan elimination	1
2.3	Applications of linear systems	1
3.1	Operations on matrices	1/3
3.2	Inverses; algebraic properties of matrices	2/3
3.3	Elementary matrices; a method for finding A^{-1}	2/3

TEST I		6
3.4	Subspaces and linear independence	1
3.5	The geometry of linear systems	2/3
3.6	Matrices with special forms	2/3
4.1	Determinants; cofactor expansion	2/3
4.2	Properties of determinants	2/3
4.3	Cramer's Rule; formula for A^{-1}; applications of determinants	2/3
4.4	A first look at eigenvalues and eigenvectors	2/3
5.1	Dynamical systems and Markov chains	1
5.3	*Gauss-Seidel and Jacobi iteration; sparse linear systems (optional, time permitting)*	
5.4	*Power method; application to internet search engines (optional, time permitting)*	

TEST II		6
6.1	Matrices as linear transformations	1/3
6.2	Geometry of linear operators	2/3
6.3	Kernel and range	2/3
6.4	Composition and invertibility of linear transformations	2/3
7.1	Basis and dimension	2/3
7.2	Properties of bases	1/3
7.3	The fundamental spaces of a matrix	2/3
7.4	The dimension theorem and its implications	1/2
7.5	The rank theorem and its implications	1/2
7.6	The pivot theorem and its implications	1/2
7.7	The projection theorem and its implications	1/2

TEST III		6

7.8	Best approximation and least squares	2/3
7.9	Orthonormal bases and the Gram-Schmidt process	2/3
7.11	Coordinates with respect to a basis	2/3
8.1	Matrix representations of linear transformations	1/2
8.2	Similarity and diagonalization	1/2
8.3	Orthogonal diagonalizability	1/2
9.1	Vector space axioms	1/2
9.2	Inner products; Fourier series	1/2
9.3	General linear transformations; isomorphism	1/2

		5

TEST IV will be a take-home test, handed out about two weeks before the end of the semester.

FINAL EXAM (over sections 1.1-7.7)

This schedule provides material for 23 instructional days of 100-minute classes in this 27 instructional day semester, leaving three class days available for tests and one class period for additional lecture time or a comprehensive review.

Spring, 2008
Michael Frantz

MATH 325 NUMBER THEORY -- SYLLABUS

COURSE DESIGNATION

MATH 325 - Number Theory: An upper division mathematics course recommended for majors, particularly for those interested in teaching mathematics, and required for the mathematics subject matter program. This course may also be useful for some computer science majors, depending on the area of specialization. (4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to the branch of mathematics known as classical number theory at a fairly elementary level, then proceeds to bring in more advanced topics at a higher level of sophistication to obtain a more comprehensive in-depth view of the subject. The standard topics include divisibility theory, linear and quadratic congruence theory, Diophantine equations, Fermat's theorem, number theoretic functions (tau, sigma), primitive roots, quadratic reciprocity, Fibonacci numbers, continued fractions, prime number theory, and recent developments in the field and with open problems. Applications of the theory will be emphasized, as well as aspects of computational number theory, particularly as applied to cryptography. The prerequisites include a year of calculus, and MATH 305 with a grade of at least “C-“. Due to the amount of "mathematical maturity" required by this course, it is generally recommended that it be taken in the junior or senior year only.

GOALS

The goals of this course include the following: to develop a basic understanding of the definitions, properties and theorems relating to the study of the integers; to develop and enhance the ability of the student to originate and construct sound mathematical proofs; and to give to the student an appreciation of the various historical backgrounds from which today's current unsolved problems come from, as well as an in-depth sampling of the broad applications in which number theory is being used today. The student should also expect to learn and develop methods of mathematical proof, and to communicate mathematics in a written format clearly and appropriately.

ASSIGNMENTS and TESTS

Daily homework assignments will be made, including a number of exercises to be worked by the student but not turned in, and a few problems which must be handed in and will be considered as part of the course grade. Each set of problems assigned to be graded will be due at the beginning of the second class meeting after it is assigned (normally, one week), unless otherwise noted in class.

There will be four one-hour tests, and a semi-comprehensive final exam. The fourth one-hour test will actually make up the first hour of the final exam period, and the remaining two hours of the final exam will be over the first 3/4 of the course. Most of the hour exams will also have take-home components. Test dates will be announced at least one week in advance and will be fairly predictable from the attached topics list. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be more difficult than the original test. **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on the day of the test, prior to the testing time**.

EVALUATION

The grade for the course will be based on the weighted average of the homework (20%), the four one hour tests (60%), and the final exam (20%). Late homework assignments (if accepted at all) will receive at least a 20% to 50% reduction in credit, determined at the discretion of the instructor, based on various factors. Final grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
59 - 0		F	

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available to mathematics majors), you must earn at least a "C-" to obtain CREDIT. In effect, this option sets a higher standard for passing the course.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B", or a 68.5 to be a "C", for example.

TEXT

The text for this course will be Elementary Number Theory and its Applications, fifth edition, 2005, by Kenneth Rosen. The following chapters and sections will be covered: Chapters 3-8, 12, and 13, as well as sections 1.5, 9.1, 10.1, 11.1, 11.2. Sections omitted include: 4.4, 4.6, 5.2, 5.3, 5.4, 6.2, 7.4, 12.5, and 13.3

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **NOT** include the practice of copying assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course.

OFFICE HOURS

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences Office Coordinator (Sharla, MA152, x4601) is usually available from 8am to 5pm.

NUMBER THEORY TOPICS

Text: Elementary Number Theory and its Applications, fifth edition, 2005, by Kenneth Rosen

Description of topic (relevant sections)	Number of 50 min. lectures
Introduction to course; divisibility; the greatest integer function (1.1, 1.5)	2
Prime numbers; distribution of primes; conjectures (3.1, 3.2)	2
Greatest common divisors (3.3)	2
Euclidean Algorithm (3.4)	1
Fundamental Theorem of Arithmetic (3.5)	2
Factorization methods; Fermat numbers (3.6)	1
Linear Diophantine equations (3.7)	2

TEST I (includes a take-home component)	12
Introduction to congruences and linear congruences (4.1, 4.2)	2
Chinese Remainder Theorem (4.3)	2
Systems of linear congruences (4.5)	1
Divisibility tests (5.1)	1
Check digits (5.5)	1
Wilson's Theorem; Fermat's Little Theorem (6.1)	2
Euler's theorem (6.3)	1
Euler's phi-function (7.1)	1
Sum and number of divisors; tau-function (7.2)	1
Perfect numbers and Mersenne primes (7.3)	1

TEST II (includes a take-home component)	13
Character ciphers, block and stream ciphers (8.1, 8.2)	2
Exponentiation ciphers (8.3)	1
Public-key cryptography (8.4)	2
Knapsack ciphers (8.5)	2
Cryptographic protocols and applications (8.6)	2
Order of an integer; primitive roots (9.1)	1

Pseudorandom numbers (10.1)	1

TEST III (includes a significant take-home component)	11
Quadratic residues and nonresidues (11.1)	2
Law of quadratic reciprocity (11.2)	1
Pythagorean triples (13.1)	1
Fermat's Last Theorem (13.2)	2
Decimal fractions (12.1)	1
Finite continued fractions (12.2)	2
Infinite and periodic continued fractions (12.3, 12.4)	2
Pell's equation (13.4)	1

TEST IV / FINAL EXAM (either may include a take-home component)	12

This schedule provides material for 48 lecture hours (50 minutes each), leaving 8 hours open out of the 56 available hours for the three tests, a final review day, and optional topics (if time permits!)

EXERCISE SETS FOR MATH 325 – Number Theory (Spring, 2008)

Text: Elementary Number Theory and its Applications, Rosen, 5th edition (2005), Addison Wesley Longman. All problems worth 10 points each unless indicated parenthetically: (20), for example. ***Note: The assignments and point values below are subject to change.***

SECTION REGULAR EXERCISES [EXERCISES TO BE HANDED IN] {EXTRA CREDIT}

1.1 7, 11, 21 [8(20),22(80)]
1.5 1-7,11,13,21,23,29-35 [6,8,10(20),12(20),22(20),24(15),26(15),28(20),30(20),32(20),34(20)]
3.1 1,5,15,21 [2(15),4(40),6(20),8(20),16(15),20(30)]
3.2 1,3,11 [2(20),6(20),8(20),10(30),12(20)] {13, 20}
3.3 1,3,5,15,17,(read 19),23 [2(30),4,6(20),12(20),14a(20),16(20),18,22(20)] {24}
3.4 1,3,5,7 [2(45),4,6(40),8(40)]
3.5 1,3,5,7,15,19,21,23,31,33,35,37,(read 41),45,47,(read 53),63,65,(read 68)

[2,4(40),6(30),8(20),16(20),18(20),20(20),22(20),30(60),32(40),34(20),36(20),40(20),44(40),46(20),
52,62(60),64,66(20)] {17, 24, 71}
3.6 1,3,21 [2(30),4(60),18(15)] {14}
3.7 1,3,5,7,9,15ab,17 [2(80),4(20),6(20),8(20),10(60),16(20),18(20),23(30)] {24}
4.1 1,3,5,7,9,15,17,19,21,23,33
[2(30),4(20),6(30),8(20),10(20),12(20),14(20),16(20),20(30),22(30),24,26(20),28(30),34(50)] {38 100pts}
4.2 1,3,5,7,9,11 [2(100),6(15),8(40),10(30),12(20),18(30)]
4.3 1,3,5,7,9,11 (read 27,28,29) [2(20),4(140),6(50 – use Derive),10(30),12(50),22(30)]
4.5 1 [2(40),4,6,8(30),9(70),10(30)]
5.1 1,3,25 [2(20),4(20),24(30)]

5.5 1,3,5,9,11,13,15,17,21ab,23,27 [2(15),6(15),8(25),10(20),12(30),14,16(20),18(20),24(30)]
6.1 1,3,5,7,9,11,13,15,17,19,21,23,29 [2,4(20),6,10,12,18(30),20(30),22(30),24(30)] {40}
6.3 1,5,7,9,11,13,15,17 [2,6(20),8(20),14(30)] {12}
7.1 1,3,5,7 [2(50),4(55),6(30),8(20)]
7.2 3,9,11 [1(80),2(65),4(20),8,10(20)]
7.3 1,3,15,29 [2(40),4(30),16(60),30(60)]
8.1 1,3,5,7,9,11,13,15 [2,4(20),6(30),8(30),10(20),12(50),14(80),16]
8.2 1,13,15,17,19,21,27,29,31,35,37
[2(30),14(40),16(40),18(60),20(60),26(40),28,30(20),34(20),36(30)]
{6,8,10}
8.3 1,3,5 [2(30),4(40)]
8.4 1,3,5,7 (look at 11,12) [2(30),4(20),6(40),8(40)]
8.5 1,5,7 [4(20),6(50)]
8.6 1,7 [2,6(80)]
9.1 1,3,5,7 [2(20),4(60),6(20),8(20)]
10.1 1,3,9,11 [2(20),4(20),10(20),12(20)]
11.1 1,3,5a,13,19 [2(40),4(20),20(40), $2x^2 + 3x + 1 = 0 \pmod 7$ (40); $25x^2 + 70x + 37 = 0 \pmod{13}$ (40);
plus 2 e-coin-flipping exercises]
11.2 5 [1(30),4(20)]
13.1 1,3,11,13 [2(20),4(20),12(20)]
13.2 [2(20),4(30)]
12.1 1,3,9 [6(60),24(20)]
12.2 1,3,5, [2(80),4(70),6(80)]
12.3 1,3 [2(80),4(30)]
12.4 1abc,3,5 [2acf(60),4ab(40),6(60)]
13.4 1,3,5,7(use Derive) [2(60),4(60),6(40)]

Michael Frantz

DISCRETE MATHEMATICS -- SYLLABUS

COURSE DESIGNATION

MATH 327 - Discrete Mathematics: An upper division undergraduate mathematics course recommended for all mathematics majors, and designated as a supportive requirement for computer science majors. (4 sem. hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to the topics and techniques of discrete mathematical methods and combinatorial reasoning. The algorithmic approach to problem solving is fundamental to the course and is explored in depth. Problem analyses lead to the development of algorithms and iterative and enumerative procedures, and suggest methods for evaluating efficiency and even existence of solutions. Mathematical maturity in the student is developed through the study of mathematical topic areas and structures quite different from what is found in the traditional subjects of calculus and differential equations; the notions of proof and valid logical reasoning are emphasized. Applications of these techniques in the field of computer science are an integral part of the course. The only prerequisite is Calculus I, not so much for the techniques and theorems of that course as for the mathematical maturity developed by completing one semester of calculus.

GOALS

The goals of this course include the following: to develop proficiency in the analysis of a variety of problems, and application of algorithmic, iterative and combinatorial methods for solving such problems, particularly in the area of computer science; to become familiar with the fundamental concepts and theorems of logic and set theory; to understand the notation and usage of functions and relations as mathematical tools; to become knowledgeable in the concepts, theorems and methods of graph theory, particularly as applied to applications in computer science; to develop mathematical reasoning ability and a sense for what constitutes a mathematical proof, as well as appropriate techniques for constructing proofs; and to develop an appreciation for the applications of structures and techniques developed in this course for the modeling and solution of a wide range of problems in computer science as well as other areas such as chemistry, botany, zoology, linguistics, geography, business, and the Internet.

ASSIGNMENTS and TESTS

Weekly homework assignments will be made, including a number of exercises to be worked out by the student but not turned in, and a number of problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be **due by 5:30pm the Friday of the week after the assignment is made.** Fax or e-mail submissions are permitted. The instructor reserves the right to actually grade only a subset of the problems handed in for grading. The use of e-mail for questions is particularly encouraged, depending on the nature of the query. There will be two in-class exams and a third (non-comprehensive) exam with both in-class and take-home components given on the final exam day. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on the day of the test prior to the testing time**.

EVALUATION

The grade for the course will be based on a weighted average of the homework and small group class work (25%) and the average of the four exams (75%). If one of the *first two* one-hour exam scores (including a missed test) is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 18.75% or (in this latter case) 37.5% of the total grade. Late homework assignments (if accepted at all) will receive a 20% to 100% reduction in value, determined at the discretion of the instructor, based on various factors, including degree of lateness. Final course grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available for mathematics majors), you must earn at least a "C"- to obtain CREDIT.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

TEXT/OTHER RESOURCES

The text for this course will be Discrete Mathematics and Its Applications, 5th edition, by Kenneth Rosen. The material covered will include all sections 1.1-1.8, 2.1-2.4, 2.7, 3.1-3.3, 3.5, 4.1-4.4, 5.1-5.2, 6.1-6.2, 6.5, 7.1, 7.3-7.5, 8.1-8.8, 9.1-9.5, and 10.1-10.4.

ACADEMIC HONESTY

Students are encouraged to work together on assignments to facilitate the learning process. Any form of dishonest behavior during a test may result in the failure of that test or possible dismissal from the course.

OFFICE HOURS

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA152, x4601) is available from 8am to 5pm.

DISCRETE MATHEMATICS TOPICS

Text: Discrete Mathematics and Its Applications, 5th edition, by Kenneth Rosen

Week 1 (February 4): Sections 1.1, 1.2, 1.3, 1.4
Logic, propositional equivalences, predicates and quantifiers, nested quantifiers

Week 2 (February 11): Section 1.5
Methods of proof

Week 3 (February 18): Sections 1.6, 1.7, 1.8, 2.1
Sets, set operations, functions, algorithms

Week 4 (February 25): Sections 2.2, 2.3, 2.4
Growth of functions, complexity of algorithms, integers and division

Week 5 (March 3): Sections 2.7, 3.2
Matrices, sequences and summations, introduction to mathematical induction

Week 6 (March 10): Sections 3.3, 3.4
Mathematical induction, recursive functions

Week 7 (March 17): Sections 4.1, 4.2
TEST I (1,2,3) basics of counting, pigeonhole principle

Week 8 (March 24): Sections 4.3, 4.4, 5.1
Permutations/combinations, binomial coefficients, discrete probability

Week 9 (March 31): Sections 5.3, 6.5, 7.1, 7.3
Probability theory, inclusion-exclusion, relations and properties, representing relations

Week 11 (April 14 – after Spring Break): Sections 7.4, 7.5, 8.1, 8.2
closures of relations, equivalence relations, intro. to graphs, graphs and terminology

Week 12 (April 21): Sections 8.3, 8.4, 8.5
TEST II (4,5,6) graph representation/isomorphism, connectivity, Euler and Hamilton paths

Week 13 (April 28): Sections 8.6, 8.7, 8.8
planar graphs, shortest path problems, graph coloring

Week 14 (May 5): Sections 9.1, 9.2, 9.3, 9.4, 9.5
Introduction to trees, applications of trees, tree traversal, spanning trees, minimum spanning trees

Week 15 (May 12): 10.1, 10.2, 10.3, 10.4, 10.5
Boolean functions, representing Boolean functions, logic gates, minimization of circuits

Week 16 (May 19): Test III (7,8,9); Finish misc. topics (recursive algorithms, recursion?); course review

Week 17 (May 26 – Final Exam Week): Final Exam, with Test IV (take-home) on Chapter 10 due

Fall, 2006
Michael Frantz

MATH 328 Abstract Algebra

Course Designation

MATH 328 - Abstract Algebra: An upper division undergraduate math course required for the B.S. mathematics major and strongly recommended for the B.A. mathematics major. (4 semester hours)

Course Description and Prerequisites

This course introduces the student to the existence of abstract algebraic systems in mathematics and shows how they evolve or can be constructed from other mathematical structures. The fundamental concepts of mathematical proof are utilized and developed throughout the course. Applications of algebraic structures in the physical world and in algebraic coding are discussed. Computer software is utilized to enhance understanding of various concepts. The prerequisite for this course is MATH 305 Transition to Advanced Mathematics.

Goals

The goals of this course include the following: to acquire a basic working knowledge of the fundamental abstract mathematical structures, including groups in particular, but also rings and fields (to the extent possible); to build up the theory culminating in the fundamental theorem of algebra; to understand various applications of abstract mathematical systems in modeling and solving real problems in the world outside the classroom; and to develop and refine the skills necessary for writing out valid, coherent mathematical proofs within the context of abstract algebra.

Assignments and Tests

Daily homework assignments will be made, including a number of exercises to be worked out by the student but not turned in, and several problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be due ***no later than 5pm on the day of the second class meeting after it is assigned***. ***Each student is personally responsible for determining what material was covered and what assignments made on any days of absence from class.***

There will be four 70-minute tests and a ¾ - comprehensive final exam. The fourth 70-minute test and a longer test covering the first ¾ of the course will both be given on the final exam day, thus comprising a comprehensive exam over the entire course content. Any of the four tests or the final exam may have a take-home component to them. Approximate test dates may be inferred from the topics list provided later in this document, and actual test dates will be confirmed least one week in advance. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone before or on the day of the test prior to the testing time**.

Evaluation

The grade for the course will be based on the weighted average of the four tests (60%), homework (15%), and the final exam (25%). If one of the *first three* test scores (including a missed test) is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 25% or (in this latter case) 40% of the total grade. Late homework assignments (if accepted at all) will receive a 20% to 100% reduction in value, *determined at the discretion of the instructor*, based on various factors, including degree of and reason for lateness. Final course grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59		F	

Note 1: **If you choose the Credit/No Credit grading option (not available for mathematics majors), *you must earn at least a "C-" to obtain Credit*.**

Note 2: This grading system is minimal in the sense that the student is guaranteed ***at least*** as high a grade as indicated by the above scale. A small amount of grade curving ***may*** make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

Special Note 3*:* Attendance records are not a formal part of the grading process; **however,** past experience indicates a ***high correlation*** between ***students who do not attend math classes regularly and/or do not turn in regular homework assignments***, and ***students who do not pass math courses***.

Text, Blackboard, and Other Resources

The text for this course will be Contemporary Abstract Algebra, 6^{th} edition (2006), by Gallian. The material covered will include most of chapters 0-7, 9, 10, 12-17, and selected topics from chapters 18-23 and 27, 28, and 31 (time permitting). Odd-numbered problem answers are given in the back of the text. There is apparently no printed student study guide for this new edition (yet?), but the URL http://www.d.umn.edu/~jgallian/ will allow you to choose among True/False quizzes for several chapters at a time, advice for students learning abstract algebra, flash cards for testing yourself, and computer software for the computer exercises in the text.

Academic Honesty, Classroom Etiquette, and Time Expectations

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. Cell phones, pagers, and any other electronic beeping devices must be turned off while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to the call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of cell phones to transmit text and images, cell phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class. You should expect to spend at least two hours studying outside of class for every hour spent in class. This means that for each of our 70 minute class sessions, you should plan to spend *at least* 2.5 hours *of quality time* studying outside of class. Of course, mileage may vary; if you wish to earn the best grade possible, you may have to study more! Each person has different study needs.

Office Hours

My office number is 155A, located on the second floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: 593-3511, ext. 4609. If I am not available, leave a message on my phone voice mail after 4 rings, or by email at frantzm@ulv.edu. The Natural Sciences Office, in MA 152 (x4601) is also staffed from 8am to 5pm.

Abstract Algebra Topics

Text: Contemporary Abstract Algebra, 6th edition (2006), by Joseph Gallian.

Description of topic	**Number of 70 minute lectures**
Chapter 1 – Introduction to Groups	
Introduction to course; symmetries of a square; dihedral groups	2
Chapter 0 - Preliminaries	
Properties of integers; modular arithmetic; mathematical induction; equivalence relations; functions (mappings)	2
Chapter 2 – Groups	
Definition and examples of groups; elementary properties of groups	2
Chapter 3 – Finite Groups; Subgroups	
Terminology and notation; subgroup tests; examples of subgroups	2
Review for Test I	1
TEST I on Chapters 0-3	1
Chapter 4 – Cyclic Groups	
Properties of cyclic groups; classification of subgroups of cyclic groups	2
Chapter 5 – Permutation Groups	
Definition and notation; cycle notation; properties of permutations; D_5 check-digit scheme	2
Chapter 6 – Isomorphisms	
Motivation; definition/examples; Cayley's theorem; properties of isomorphisms; automorphisms	2
Review for Test II	1

TEST II on Chapters 4-6 1

Chapter 7 – Cosets and Lagrange's Theorem
Properties of cosets; Lagrange's theorem and consequences;
an application of cosets to permutation groups; the rotation group of a cube
and a soccer ball 2

Chapter 8 – External Direct Products
Definition and Examples; Properties of External Direct Products; The Group of Units
Modulo *n* as an External Direct Product 1

Chapter 9 – Normal Subgroups and Factor Groups
Normal subgroups; factor groups; applications of factor groups;
(internal direct products) 2

Chapter 10 – Group Homomorphisms
Definition and examples; properties of homomorphisms; the First Isomorphism theorem 2

Review for Test III 1

TEST III on Chapters 7, 8, 9 and 10
1

Chapter 12 – Introduction to Rings
Motivation and definition; examples of rings; properties of rings; subrings 1

Chapter 13 – Integral Domains
Definition and examples; fields; characteristic of a ring 1

Chapter 14 – Ideals and Factor Rings
Ideals; factor rings; prime ideals and maximal ideals 2

Chapter 15 – Ring Homomorphisms
Definition and examples; properties of ring homomorphisms; the field of quotients 2

Chapter 16 – Polynomial Rings
Notation and terminology; the division algorithm and consequences 1

Chapter 17 – Factorization of Polynomials
Reducibility tests; irreducibility tests; unique factorization in Z[x];
weird dice: an application of unique factorization 1

Final Exam day: TEST IV on Chapters 12-17 and Final Exam on Chapters 1-10
This schedule provides material for 35 (70 minute) lectures, leaving 4 class periods open in a typical 39 lecture course for tests.

Selected topics from the following chapters, as time permits:

Chapter 18 – Divisibility in Integral Domains
Irreducibles, primes; historical discussion of Fermat's Last Theorem; unique factorization domains; Euclidean domains
Chapter 19 – Vector Spaces
Definition and examples; subspaces; linear independence

Chapter 20 – Extension Fields
The fundamental theorem of field theory; splitting fields; zeros of an irreducible polynomial

Chapter 21 – Algebraic Extensions
Characterization of extensions; finite extensions; properties of algebraic extensions

Chapter 22 – Finite Fields
Classification of finite fields; structure of finite fields; subfields of a finite field

Chapter 23 – Geometric Constructions
Historical discussion of geometric constructions; constructible numbers; angle-trisectors and circle-squarers

Chapter 27 – Symmetry Groups
Isometries; classification of finite plane symmetry groups; classification of finite groups of rotations in $\mathbf{R}^3$

Chapter 28 – Frieze Groups and Crystallographic Groups
The frieze groups; the crystallographic groups; identification of plane periodic patterns

Chapter 31 – Symmetry Groups
Introduction to algebraic coding theory; motivation; linear codes; parity-check matrix decoding; coset decoding; historical note: Reed-Solomon codes

Fall, 2004
Michael Frantz

Foundations of Geometry -- Syllabus

COURSE DESIGNATION

MATH 330 - Foundations of Geometry: An upper division mathematics course recommended for majors, particularly for those interested in teaching mathematics, and required for the mathematics single subject waiver program. (4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to the concept of the existence of more than one type of geometry, in the process forcing him/her to examine the foundations from which Euclidean geometry arose. Topics covered will include axiom systems and finite geometries, transformations, convexity, Euclidean and non-Euclidean geometries, constructions, projective geometry, geometric topology, and inversions. The prerequisites include a year of calculus, or linear algebra (MATH 320), or permission of the instructor. Due to the amount of "mathematical maturity" required by this course, it is recommended that it be taken in the junior or senior year only.

GOALS

The goals of this course include the following: to promote the conceptual understanding of the existence of many types of geometry in mathematics; to develop an appreciation for the historical contexts from which these geometries grew; to foster a familiarity with the basic definitions, axioms and theorems related to these geometries; and finally, to further develop and refine the ability of the student to originate and write out a sound mathematical proof.

ASSIGNMENTS and TESTS

Homework assignments to be turned in as part of the grade will be made for most chapter sections in the text. The due dates will be announced at the time the assignments are made. Each assignment will consist of a fair number of problems (usually with answers in the back of the text) for the student to work out but not hand in, and a few problems from each chapter that must be handed in and graded as part of the course evaluation. Late homework should be arranged for on a case by case basis with professor.

There will be four written tests, each approximately one hour long, as indicated in the list of course topics later in this document. The test dates will be announced in advance.

EVALUATION

The grade for the course will be based on the average of the four written tests and the homework score (20% each). Grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
59 - 0		F	

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available to mathematics majors), you must earn at least a "C-" to obtain CREDIT. In effect, this option sets a higher standard for passing the course.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B", or a 68.5 to be a "C", for example.

TEXT

The text for this course will be Modern Geometries, fifth edition, 1998, by James R. Smart. Approximately two-thirds of the text will be covered, including sections from all nine chapters.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does NOT include the practice of copying assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course.

OFFICE HOURS

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA152, x4601) is available from 8am to 5pm.

FOUNDATIONS OF GEOMETRY TOPICS

Text: <u>Modern Geometries</u>, fifth edition, by James R. Smart. **<u>Do</u>** problems in (parentheses); **<u>don't</u>** turn in. **<u>Turn in problems in [brackets]</u>**. Extra credit problems are in {braces}. ***Problems in general are 10 points each and proofs worth 30 points each, although there will be numerous exceptions. Extra credit problems and problems denoted by a checkmark in the text will always be worth a considerable number of points.***

Sets of Axioms and Finite Geometries

1.1 Introduction to Geometry (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15) [16]
1.2 Development of Modern Geometries (1,2,3,4,11,12,13) [5,6,7,8,9,10]
1.3 Introduction to Finite Geometries (4,6,7,8,9,10,11,12,13) [14,16]
1.4 Four-Line and Four-Point Geometries (1,4,6,7,8,9,11,14,16,17,18,20) [10,12,19,21,22,23,24]

Geometric Transformations

2.1 Introduction to Transformations (1,2,3,4,5,7,10,13,15,17,19,21,23,27,28,29) [none]
2.2 Groups of Transformations (7,8,9,10,11,12,13,14,17,21,22,23,24) [15,16,18,19,20] {25,27}
2.3 Euclidean Motions of the Plane (1,2,3,4,5,6,7,10,11,13,14,15,25) [20,21,22,23,24,30] {31}
2.5 Applic.'s of Transformations in Computer Graphics (3,4,5,6,7,8,9,10,11,21,22,23,24) [15,16,17,18,19,20]
2.6 Properties of the Group of Euclidean Motions (7,8,9,12,19,22) [3,4,5,6,23,27]
2.9 Introduction to the Geometry of Fractals and Fractal Dimensions (1,2,4,5,6,7,9,10,11,12,13) [3, plus additional items on fractals not in the text (120 pts) (get from professor)]
2.10 Examples and Applications of Fractals (1) [4]

TEST I

Convexity

3.1 Basic Concepts (1,2,4,8,9,10,11,12,13,14,17,18) [3,5,7,15,16,19,21]
3.2 Convex Sets and Supporting Lines (1,2,3,4,5,6,7,8,13,14,15,16,17,19) [9,10,11,12,18,20,25]
3.3 Convex Bodies in Two-Space (1,2,3,4,5,6,7,8,9,10,11,12,13, 17,19,21~~14,15,16,18~~) [14,16,20~~22~~] {24}
3.5 Convex Hulls (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,17,18,20,22,24,25,26) [6,16,23]
3.6 Width of a Set (1,2,3,4,5,6,7,8,9,10,11,12,13,14,19,20,22) [16,17,18,21] {29} (read article from prof.)
3.7 Helly's Theorem and Applications (3,8,9) [1,2,4,5,12,13, read extra article on Helly from prof.]

Modern Euclidean Geometry, Theory, and Applications

4.1 Fundamental Concepts and Theorems (2,3,4,5,6,7,8,9,10,11,12,13,31) [15,29]

4.2 Some Theorems Leading to Modern Synthetic Geometry (2,3,4,5,6,11,12,17,18) [None, but READ!]
4.3 The Nine-Point Circle and Early Nineteenth-Century Synthetic Geometry (1,2,3,4,5) [6,7,8,15a]
4.6 Golden Ratio, Tessellations, Packing Problems and Pick's Thm. (1,2,3,5,12,13,14,15,~~16~~) [READ] {18,19}
4.7 Extremum problems, geometric probability, fuzzy sets and Bezier Curves (8,13,14,15,16,17,18,21,22) [1,2,3,4,5,6,9,23] {28}

TEST I

Constructions

5.1 The Philosophy of Constructions (none) [7,12,13,14,15,16,17,18] {22}
5.2 Constructible Numbers (1,2,3,4,5,6,7,8,22) [9,10,11,12,13,16,17,18,19,20,23,25]
5.4 Constructions and Impossibility Proofs (1,2,3,4,5,6,7,8,9,10,12,15,16,17,20) [11,18,19] {23,26}
5.6 Constructions With Only One Instrument (none) [5,6,14,15) {7}

The Transformation of Inversion

6.1 Basic Concepts (1,2,3,4,5,6,7,8,9,10,12,13,14,15,16,18,19, 20, 21) [11]
6.2 Additional Properties and Invariants Under Inversion (1,14) [2,7,8,9,15,16,17,18] {21}

Projective Geometry

7.1 Fundamental Concepts (1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17) [5,20] {22}
7.2 Postulational Basis for Projective Geometry (11,12,13,14,15) [None, but be sure to READ!]
7.3 Duality and Some Consequences (1,2) [None, but be sure to READ!]
7.4 Harmonic sets (4,5,6,7,8,9,10) [2,3 and treasure hunt problem handout from prof.]
7.9 Conics [None, but be sure to READ!]
7.10 Construction of conics (1,2,3) [4,6,8,12,13] {18}

TEST III

Geometric Introduction to Topological Transformations

8.1 Topological Transformations (1,4,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,26,28,29,30,31) {34}
8.2 Simple Closed Curves (1,2,3,4,5,6,7,8,12,13,16,17) [None, but be sure to READ!]
8.3 Invariant Points and Networks (2-35) [36]
8.4 Introduction to the Topology of Surfaces (2,3,4,5,6,7,8,9,10,11,12) [None, but be sure to READ!]

8.5 Euler's Formula and the Map-Coloring Problem (1,2,3,5,6,7,8,9,10,11,12,13,23,26,27)
[14, Brooks' theorem problems on handout from prof. (170 pts)]

Non-Euclidean Geometries

9.1 Foundations of Euclidean and Non-Euclidean Geometries (1,2,3,4,22,23,24,25,26,27) [30]
9.2 Introduction to Hyperbolic Geometry (2,3,5,7,8,9,10,11,12,13,14,15) [None, but be sure to READ!]
9.3 Ideal Points and Omega Triangles (None) [None, but be sure to READ!]
9.4 Quadrilaterals and Triangles (1,2,4,5,6,7,10,11) [3,8,9]
9.5 Pairs of Lines and Areas of Triangular Regions (None) [None, but be sure to READ!]
9.7 Elliptic Geometry (None) [None, but be sure to READ!]
9.8 Consistency; Other Modern Geometries (1,2,3,4,7,8,9,10,11,12,13) [None, but READ!]
{21,26~~16~~}

TEST IV

Math 351 Probability **SYLLABUS** Spring, 2005

Instructor: Rick Simon
Office: MA 56A
☎ 593-3511 *x*4611
Email: simonr@ulv.edu

Office Hours: MWF 11:15-11:30 a.m.
TR 2-3 p.m.
W 3:30-4:30 p.m.
Other times available by appointment

Text: Ross, A First Course in Probability, 6th Edition (Prentice Hall). We will cover chapters 1-8, plus selected topics in chapters 9 and 10.

Course Description and Goals: You will learn the fundamentals of probability theory, including basic counting techniques and probability axioms, conditional probability, random variables, particular distributions, expected value, Chebyshev's Inequality, and the Central Limit Theorem.

Assignments: You are encouraged to work together on the problem assignments, which will be due about every 1-1/2 weeks. Late assignments will receive reduced credit. You should plan to work at least 8 hours per week outside of class. You will probably want to work more problems than those assigned to turn in for grading, especially from the self-test problems and exercises.

Quizzes: I expect you to read the textbook and to learn from your reading. I will occasionally give a quiz on material before lecturing on that material.

Test problems are often similar to homework problems, and quizzes are sometimes exact problems from homework. Homework and quizzes will comprise at least 35% of your final course grade, so you need to concentrate on this part of the course activity.

Topic Paper and Presentation: At some time(s) during the term you will give a presentation on a topic chosen from chapter 9, chapter 10, or another resource.

Performance Opportunities: There will be three 1-hour tests. The lowest test score may be replaced with your homework average or final exam score, whichever is higher. A late fee of $40 may be charged for a makeup test.

Ultimate Performance Opportunity: There will be a three-hour comprehensive final exam, which everyone must take.

Grades:

Tests	35%
Final	20%
Homework	25%
Quizzes	10%
Paper	5%
Presentation	5%
	100%

Attendance: You are expected to attend regularly, to be on time, and to be prepared for class discussion. Everyone is expected to participate actively in class. It is your responsibility to find out *from the other students* what information you miss when you are not in class.

Academic Honesty: You are strongly encouraged to work together and support each other; however, note there is a difference between "working together" and "copying". You should write up on your own any work to be turned in for grading. (See pages 65-6 of the ULV 2004-2005 Catalog.)

Approximate Course Schedule

Weeks	Chapter	Topics
1-2	1	Combinatorial techniques
2-3	2	Sample space, Events, Axioms and basic theory
4	3	Conditional prob., Bayes' Theory, Independence
		Performance Opportunity #1
5-6	4	Discrete random variables and distributions
7-8	5	Continuous random variables and distributions
9-10	6	Joint distributions, Conditional distributions
		Performance Opportunity #2
11-12	7	Expected value, Variance, Conditional expectation
13	8	Limit theorems
		Performance Opportunity #3
14	9,10	Selected topics

Assignments

Chapter 1

Pages 15-18, Problems: 1,3,11,18,20,21,32

Pages 18-22, Theoretical: 4,7,9, plus 24:

Prove *by induction:*

$$\sum_{k=1}^{n} k \binom{n}{k} = n \bullet 2^{n-1}$$

(See #12a)

Chapter 2 (Omit any 1)

Pages 53-58, Problems: 2,6,9,14,16,25,33,39

Pages 59-61, Theoretical: 1,2,3,9,13,17,20

Chapter 3 (Omit any 1)

Pages 104-15, Problems: 2,6,12,21,23,30,40,43,45

Pages 115-19, Theoretical: 2,4,5,18(continues to next page),24,29

Chapter 4 (Omit any 2)

Pages 171-80, Problems: 2,6,7,9,10,18,19,24,25,27,31,32,45,65,73

Pages 180-84, Theoretical: 3,5,12(Use #11),13,16,18

Chapter 5 (Omit any 1)

Pages 228-31, Problems: 1,3,5,6,10,13,15,21,24,40

Pages 232-35, Theoretical: 1,4,12,14,20

Chapter 6 (Omit any 1)

Pages 290-95, Problems: 1,7,11,12,27a,39,40,41,42a

Pages 296-99, Theoretical: 8,14,15,33

Chapter 7

Pages 379-89, Problems: 1,3,14,40,53

Pages 389-97, Theoretical: 1,2,9

Chapter 8

Pages 427-28, Problems: 1,2,4,7

Pages 429-30, Theoretical: 1,3,6

Remember, homework is ¼ of your grade!

January Interterm
Michael Frantz

NUMERICAL ALGORITHMS -- SYLLABUS

COURSE DESIGNATION

Math 362 - Numerical Algorithms: An upper division undergraduate mathematics/computer course strongly recommended for majors in mathematics and computer science. (4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course offers a thorough introduction to the standard techniques of numerical programming for the solution of scientific problems. Such techniques include finding roots of equations, interpolation, numerical differentiation and integration, solution of linear systems, curve-fitting, ordinary/partial differential equations (single ones and systems), optimization, data smoothing and Monte Carlo techniques. Many if not most problems arising in the sciences have mathematical formulations whose solutions must be approached by numerical approximation and iterative algorithms, techniques ideally carried out on a high-speed computer. This course will not be a mathematical modeling course, but rather will assume the formulation of each physical problem in some standard given format. A bird's-eye view will be given of the mathematical grounding for the algorithms throughout the course, admittedly somewhat superficial, but sufficient to prepare the student for a deeper study of numerical analysis if so desired. An important component of the course will be the understanding of the errors that can arise in numerical approximations, their source, magnitude, propagation and rate of growth. All students will be required to demonstrate knowledge of the algorithms taught in the course by writing a considerable number of high-level codes, testing and debugging them to a satisfactory performance level.

Prerequisites: Students must be experienced in a high-level programming language such as FORTRAN, Pascal, or some variation of C. Programming competence will be assumed; no programming will be taught in the course. Assistance will be provided with debugging code to the extent of the ability of the instructor. The most help will be available in the FORTRAN language. Passing grades in Calculus I and Calculus II are also required, and Calculus III is recommended but not required.

GOALS

The primary goal of this course is for the student to gain a working knowledge of some of the many methods for solving scientific problems on a modern computer. At the conclusion of the course, the student should understand the fundamental mathematical basis behind the standard computer algorithms used for solving both individual nonlinear equations and systems of linear equations, numerical differentiation and integration, interpolation, solving single ordinary differential equations and systems of the same, data approximation and smoothing, multivariate nonlinear optimization, and Monte Carlo methods. The student should also be able to demonstrate ability to code the appropriate algorithms for these techniques in a high-level computer programming language. Finally, the student should understand the role of error in numerical computing: where it arises from, how it spreads, how large it can grow and how quickly it can grow.

ASSIGNMENTS and TESTS

There will be reading and problem assignments from the text given at each class meeting; these problems will generally not have to be handed in, but may be discussed in class, and certainly should be worked out by all students in order to assure thorough comprehension of the subject material. In addition, other exercises will be assigned at each class meeting to be turned in for grading, consisting of two types: paper and pencil problems, and computer programming problems, some of which will be quite short and some of which may be fairly involved. The programming assignments will make up a significant component of the course evaluation process. Unless otherwise indicated in class, each assignment will be due at the beginning of the second class meeting after it is assigned.

Two approximately one-hour closed-book/notes tests will be given. There will be no comprehensive final exam. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be considerably more difficult than the original test. Note: there will be a $40.00 fee charged for any make-up test. If you will not be able to attend class the day of a test, please inform the instructor by phone or phone mail **or e-mail** on the day of the test prior to the testing time.

EVALUATION

The grade for the course will be based on a weighted average of the two tests (40%) and the program and exercise assignments (60%). SPECIAL NOTE: Students must receive a passing score on the test average to pass the course. Program assignment scores will not be permitted to boost a failing test average into the passing range. This rule takes precedence over the 40-60 evaluation ratio mentioned above. Late homework assignments (if accepted at all) will receive at least a 20% to 50% reduction in credit, determined at the discretion of the instructor, based on various factors. Grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

Note 1: If you choose the CREDIT/NO CREDIT grading option, you must earn at least a "C-" to obtain CREDIT. This is university policy, not personal policy.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

Note 3: The pace of this course is very rapid, four lectures with new mathematical content in each one every class day. Homework must be started on the same day it is assigned, in order to have it ready to turn in at the second class meeting after it is assigned. Do not allow yourself to fall behind in this course, as it will be very difficult to get caught up again! **Remember, every day of class is the equivalent of a full week of class in a regular semester!** Expect to spend a lot of time on reading and homework for each class day.

TEXT

The text for this course will be Numerical Mathematics and Computing, third edition, by Ward Cheney and David Kincaid. The course will cover most of the material in the first nine chapters and possibly some of chapters 10, 11 and 14, as time permits.

COMPUTERS

There are three computer labs available for students wishing to do their programming work on IBM-PC's, located in FH 206, FH 207, and in the AAIC building. There is a Macintosh lab available in the Learning Enhancement Center, but it is not known at this time what programming languages (if any) are available on the computers there. Pascal and C variations are available in the AAIC lab and FORTRAN is accessible on the VAX from FH 207. VAX dial-up numbers for those with modems: 392-2721 (9600 and higher baud) and 392-2720 (2400 baud). Use no parity, 8 data bits, 1 stop bit, full duplex mode, XMODEM protocol, and VT102 emulation.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **NOT** include the practice of "copying" programs, and if necessary, points may be deducted accordingly if in the opinion of the instructor the program is not predominantly original code written by the student handing it in. Naturally, programs will bear some resemblance to each other, as pseudocode will be provided by the textbook in many cases. This will be factored in. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course.

OFFICE HOURS

My office number is 155A, located on the second floor of the Mainiero Building (MA). Office hours will be from 3-5pm on Monday, Tuesday, Thursday and Friday. If you cannot make it during these hours, other times may be arranged privately. Feel free to drop by for help any time you are having problems. I encourage the use of E-mail and campus phone mail systems to communicate with me at any time of day. Leave messages freely or computer-phone me if I am working on the computer in my office or at home, although at times it may appear that I am working on the VAX when in fact I am not actively in a VAX session, i.e., I am not intentionally ignoring you, even though it may appear so. Office phone number: 593-3511 ext. 4609. VAX account: FRANTZM. If I am not available, messages may be left in the phone mail system or on my VAX account.

PROGRAM ASSIGNMENT FORMAT

All problems assigned to be turned in which involve writing computer programs should include: (1) a source program listing, clearly marked as to what section and problem it is, and (2) an output listing of what transpires on the screen when the program is executed.

NUMERICAL ALGORITHMS TOPICS

Text: Numerical Mathematics and Computing, third edition, by Ward Cheney and David Kincaid

Day	Description of topics	
1	Introduction to Course; Roots of Equations Bisection method Newton's method Secant method	
2	Aspects of Numerical Programming Programming Suggestions Review of Taylor Series Representation of Numbers in Other Bases	Mathematical Review
3	More Aspects of Numerical Programming Floating Point Representations Loss of Significance	
4	Interpolation and Numerical Differentiation Polynomial Interpolation Estimating Derivatives; Richardson Extrapolation	
5	Numerical Integration The Definite Integral The Trapezoid Rule Romberg Algorithm	
6	More on Numerical Integration Adaptive Simpson's Scheme Gaussian Quadrature Formulas	
7	Systems of Linear Equations Naive Gaussian Elimination Gaussian Elimination with Scaled Partial Pivoting	
8	More on Systems of Linear Equations Tridiagonal and banded systems (LU Factorization) **TEST I ON MATERIAL FROM FIRST**	

SEVEN LECTURES

Day	Description of topics
9	Approximation by Spline Functions First-Degree and Second-Degree Splines Natural Cubic Splines
10	Ordinary Differential Equations Taylor Series Methods Runge-Kutta Methods
11	Systems of ordinary differential equations Methods for First-Order Systems Higher-Order Systems and Equations (Adams-Moulton Methods)
12	Minimization of Multivariate Functions One-Variable case Multivariate Case
13	Least Squares Data Smoothing Monte Carlo Methods and Simulation
14	**TEST II ON REMAINING MATERIAL**

NOTE: the January classes ordinarily meet for 15 days for 4 hours per day (3.3 hours of actual lecture time per day).

Also note that only 14 lecture days have been scheduled, leaving one extra day to help fit in review sessions, assisted lab time, or other topics or more detail on the given topics, time permitting.

Fall, 2005
Michael Frantz

MATHEMATICAL MODELING -- SYLLABUS

COURSE DESIGNATION

MATH 375 - Mathematical Modeling: A upper division undergraduate math course optionally required for students in the Mathematics Teacher Preparation Program, and *strongly* recommended for the B.A./B.S. mathematics major. Also recommended for students in the physical sciences. (4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course serves as an introduction to the methods of mathematical modeling: what mathematical models are, how they are constructed, solved, analyzed, revised, and how results are articulated to clients. A wide variety of solution techniques will be examined, and extensive use made of numerical, symbolic and graphical techniques implemented on a wide variety of computer software. Modeling applications from biology, mechanical engineering, population dynamics, social engineering, and physics will be discussed. Written and oral presentations of models created by students form a key component of the course. All students enrolling in this course should have passed a complete sequence in the calculus of functions of one variable, up through Taylor series. At the University of La Verne, this means Calculus I, II and III. Math 315 Differential Equations and Math 319 Vector Calculus are also recommended, although not required.

GOALS

The goals of this course include the following: to understand what makes up a mathematical model, to become familiar with various approaches to creating and modifying models of real world situations using a wide variety of mathematical techniques and representations of moderate complexity, to become more adept at developing mathematical solutions to mathematical problems with the appropriate mathematical tools, to be able to contrast the benefits of various model representations and mathematical tools, to be able to extract the information provided by a model and to evaluate it for its reliability, to learn to articulate mathematical thoughts and discoveries to others both orally and in writing and with appropriate use of technology, to develop an ability to interpret the results obtained from a mathematical model and relate them back to the "real-world" problem, to learn to work both independently and as a member of a collaborative team, and to become proficient at using a wide variety of technological tools to assist in problem-solving and to develop a knowledge of what tools are the best for given situations.

ASSIGNMENTS and TESTS

Topical homework assignments from the text and from other sources will be made as extensions of problems related to the major topics of concern listed later in this syllabus. Each student will be involved in a number of projects of varying size throughout the course, sometimes requiring oral presentation, sometimes done individually or in a group, but always with an accompanying written report. These project problems will come from a list of suggested topics or out of student research and interest and must be approved by the instructor.

Note: a key component of this course will be the use of a wide variety of mathematical software packages. Some experience is assumed with Excel and a CAS (e.g. Derive, Mathematica or Maple) as well as with other public domain packages widely used by the Mathematics Department, such as differential equation solvers and other graphics programs (MATLAB, MDEP, MPP, Stella, etc.) Instruction and assistance will be available from the professor for those needing it.

EVALUATION

The grade for the course will be based on the homework (50%) and five modeling projects (one initial group project [10%], one or two individual projects [20%], and one final group project [20%]. (This exact prescription for projects is subject to change.) The group projects and probably at least one individual project will be presented to the class. Late homework assignments (if accepted at all) will receive a 20% to 100% reduction in value, *determined at the discretion of the instructor*, based on various factors, including degree of and reason for lateness. Final course grades will be determined by the following scale:

100 - 90	A	A-	
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

TEXT/COMPUTER RESOURCES

The text for this course will be A First Course in Mathematical Modeling, 3rd edition (2003, Brooks/Cole) by Giordano, Weir and Fox, although substantial portions of the content will also be provided in notes format from a wide variety of sources. The list of topics covered is subject to variation throughout the course. See the tentative listing later in this document. A CD-ROM accompanies the text with UMAP modules, spreadsheet solution files, and FORTRAN programs. The site www.mathmodels.org is associated with this text and contains modeling resource information and a database of mathematical models. ***Also, check the web page for this course frequently for homework information at faculty.ulv.edu/~frantzm/.***

<u>ACADEMIC HONESTY and CLASSROOM ETIQUETTE</u>

Students are *strongly* encouraged to help each other on problem assignments to facilitate the learning process. This does **<u>NOT</u>** include the practice of <u>copying</u> assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the failure of that test or possible course dismissal, as per university policy. Cell phones, pagers, and any other electronic beeping devices must be turned off or set to vibrate while in class. A first offense will bring a potentially embarrassing reminder from the professor; each offense after the first will result in a 10% reduction in the homework grade. Students are expected to be on time for the start of class.

<u>OFFICE HOURS</u>

My office number is 155A, located on the middle floor of the Mainiero (MA) building. Office hours will be announced during the first week of class, but will generally be in the late afternoon. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: (909)593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by e-mail (frantzm@ulv.edu) The Natural Sciences secretary (Sharla, MA152, x4601) is available from 8am to 5pm.

Mathematical Modeling --Topics

Text: <u>A First Course in Mathematical Modeling</u>, 3rd edition (2003, Brooks/Cole) by Giordano, Weir and Fox.

<u>Description of topic</u>		**<u>Approx. number of 50 min. lectures</u>**
Modeling Change		
	Introduction to mathematical modeling; proportionality	0.5
1.1	Modeling change with difference equations	0.5
1.2	Approximating change with difference equations	1
1.3	Solutions to dynamical systems	1.5
1.4	Systems of difference equations	1.5
The Modeling Process, Proportionality, and Geometric Similarity		
2.1	Mathematical models	1
2.2	Modeling using proportionality	1
2.3	Modeling using geometric similarity	1
2.4	Automobile gasoline mileage	1
2.5	Body weight height, strength, and agility	1

Model Fitting

Experimental Modeling

Simulation modeling

Discrete Probabilistic Modeling

Discrete Optimization Modeling

Dimensional Analysis and Similitude

Modeling with a Differential Equation

10.4	Graphical Solutions of autonomous differential equations	1
10.5	Numerical approximation methods	1

Modeling with Systems of Differential Equations

11.1	Graphical solutions of autonomous systems of first-order differential equations	1
11.2	A competitive hunter model	1
11.3	A predator-prey model	1
11.5	Euler's method for systems of differential equations	1

Continuous Optimization Modeling

12.1	An inventory problem: minimizing the cost of delivery and storage	1
12.2	A manufacturing problem: maximizing profit in producing competing products	1
12.3	Constrained continuous optimization	1
12.4	Managing renewable resources: the fishing industry	1

This schedule allows for 25 100-minute class periods in a semester that has 27 days of class, not including the final exam. The final group project presentations will occur on the final exam date. This will allow 200 minutes for the other minor project presentations, dates for which will be announced in class.

MA 389 Developmental Math
CRN 1200, Section 1, Monday, 4-6:50 PM, FH 20
CRN 1208, Section 2, Monday 7-9:50 PM, FH 20

Syllabus – Spring 2011

Instructor: Dr. Joan J. Marge
Email: jmarge@laverne.edu [indicate *Math 389* in subject box please]
My mailbox is located in Mainiero - Room 152
Conferencing: I will be happy to meet with you after class, or before a class by prior arrangement.
Home phone: 909/624-5099

Required Text: Elementary and Middle School Mathematics - Teaching Developmentally - John A. Van de Walle [Seventh Edition, 2010]
Optional - Field Experience Guide - Jamar Pickering [Seventh Edition]

In a completely rational society, the best of us would be teachers
and the rest of us would have to settle for less,
because passing civilization along from one generation to the next
ought to be the highest responsibility anyone could have. Lee Iacocca

Course Description: In this course, we shall examine the methodology of teaching and learning in general, and mathematical concepts in particular, to better prepare you to function as an elementary school teacher. We will study the epistemology of mathematics, the goals of math instruction, the nature of children's thinking about various math concepts, and various instructional approaches.

Our classroom format will combine both professor presentations and students' presentations. All students are encouraged to be *active participants* in the learning process. During the course of our time together, you will develop a portfolio of instructional materials that will be useful in your actual classrooms.

Goals and Objectives: Students will study and reflect upon:

A. Factors influencing math achievement
B. Problem solving
C. Effective teaching strategies and methodologies
D. Mastering mathematical concepts
E. CBEST & CSET questions in mathematics

To benefit from and succeed in this class:

- Attend every scheduled class. During class, we will NOT merely be reviewing what you have read in our textbook. We will discuss much more and enhance the theories/methodologies in the text.
- Try to find a buddy [or two] so that you can: share notes, and collect handouts for one another in the event of an emergency in which one of you must miss a class unexpectedly.
- Please place your name, course name/time and date on all papers [in upper right hand corner, please].
  - Save your money – don't use plastic or paper covers on papers/reports. Just staple them in upper left-hand corner.
  - All written work will be graded on content (i.e. concepts, development, clarity, etc.) and

organization of ideas (i.e. logic, order, and cohesion). You will not lose points for grammatical and/or spelling errors. However, these should NOT appear in your papers (especially in this computer age!!). I do mark them for your knowledge and help.

- Please make every effort to be in class on time!!! Respect your fellow classmates by arriving on time.
- Do read all your assignments! This is a wonderful, informative textbook, and you will greatly benefit from a careful reading of all assigned pages. Also, it is highly recommended that you keep this book for your personal library; it will come in handy as you are teaching.
- Review your class notes. Learn the language we are speaking here. Think critically how our discussions and your readings apply to teaching math, as well as other subjects.
- Organize your notes - organize your thoughts - and - organize your time!
- **ASK QUESTIONS**!!! If you have a question, never, ever be afraid to ask it in this class.

NCATE: College Wide Dispositions*: Based on the principles of best teaching practice to provide all students with a safe, nurturing, and supportive environment, the Liberal Studies students and teacher candidates in the College of Education and Organizational Leadership at University of La Verne are requested to review the following Dispositions. These three dispositions of character, intellect and caring are determined by the College to be necessary for quality teachers. Teacher candidates are strongly urged to demonstrate these dispositions in their daily teaching practice.*

1. *Dispositions of Character: Taking responsibility for one's actions, behaving in an ethical manner with integrity and honesty, and understanding professionalism that includes self-control, flexibility, and emotional maturity.*
2. *Disposition of Intellect: Demonstrating commitment to students and their families, to the profession, and to one's colleagues, and demonstrating a spirit of inquiry and lifelong learning to continuously enhance one's teaching practice.*
3. *Disposition of Caring: Demonstrating empathy and concern for others as well as the belief that all children can learn, being respectful, advocating for students and families, and developing social competence within different social and cultural situations.*

Your participation in this course demonstrates your commitment to the education field. Your understanding of the content and your participation in course activities with your peers are vital to your on-going learning. Your attendance affects your grade. Any student who misses 20% or more of class time shall receive either a failing grade or an "INC" grade (incomplete) at the discretion of the instructor and consistent with the policies outlined in the ULV catalog.

Assessment & Grading: During this semester, you will be responsible for the following assignments and exams, which will be assessed according to the percentage points indicated below:

		Points
1.	Exams:	
	- Midterm	150
	- Final paper	150
2.	Math lesson plan and presentation	100
3.	Board Game	50
4.	Classroom observation & report	100
5.	Teacher interview & report	100

6.	Journals (weekly)	75
7.	Newspaper Articles [2]	100
8.	Web lesson plan	35
9.	Homework	90
10.	Attendance and classroom participation.	50
	Total possible:	1000

All assignments must be turned in at the beginning of the class on the due date, or 10% of the total assignment points will be subtracted for each week beyond the due date. However, it is highly recommended that you turn in all assignments, even if late, otherwise you will earn a zero for that assignment. If you miss an exam you may make it up [but only for a valid excused absence, but you must make arrangements with me for the time and place.

[Please advise professor *in advance* if you know that you must be absent for a particular class meeting.]

Grading: Based on the total number of points earned:

1000 - 900		A	A-
899 - 800	B+	B	B-
799 - 700	C+	C	C-
699 - 600	D+	D	D-
599 - below	F		

Bear in mind, that in order for your grade to count, you must achieve a C- or better.

ULV Mission Statement: (paraphrased)

Values Orientation: encourages a philosophy of life that actively supports the health of the planet and its people.

Community & Diversity: develop an understanding and appreciation of the diversity of cultures which exist in our society (especially in our arena in Southern California), and appreciate this diversity by understanding the impact/dependence of humans in this environment in relationship to how they live and how they learn.

Lifelong Learning: encouraged to learn, think critically, do responsible research, and access and integrate information toward career flexibility and continued professional growth.

Community Service: since service is a primary goal of the educated person, experience the responsibilities and rewards of serving the human and ecological community.

Academic Honesty: Each student is responsible for performing all academic tasks in such a way that honesty is not in question. Unless an instructor defines an exception, students are expected to maintain the following standards of integrity:

1. All tests, term papers, oral and written assignments and recitations are to be the work of the student presenting the material.
2. Any use of wording, ideas, or findings of other persons, writers, or researchers required the explicit citation of the source, and, use of the exact wording required a quotation format.
3. Deliberately supplying material to a student for purposes of plagiarism is also deemed a culpable offense.

A faculty member who has proof that academic honesty has been violated may take appropriate disciplinary action, including the refusal of course credit. If a faculty member has reason to suspect academic dishonesty but is unable to prove it, s/he may require additional and/or revised work from the student. A faculty member shall bring to the attention of the appropriate dean all violations of academic honesty. The dean may place on probation, suspend, or expel any student who violates the academic honesty policy.

MA 389

Dr. Joan J. Marge

Meeting Dates, Topics & Assignments

<u>**Week**</u>/	<u>**Date**</u>	<u>**Topics**</u>	<u>**Assignments**</u>	<u>**Turn in**</u>
1	1/31	Why math? Syllabus What is ed? TIMMS Ed through the ages	Read Chapter 1	

2	2/7	T: Ch.1:Teaching math/ reforms/standards Current events M:Ch.8:Number concepts	p.11 #3, 5 Newspaper article[1]	
3	2/14	T: How we learn School environment Classroom observation Teacher interview M:Ch.9: Operational Meanings	Read Ch. 2, p.13-23 Journal [1]	Newspaper report[1] p.11 #3, 5
	2/21	Presidents' Day – no school		
4	2/28	T:**C**h.2: Doing Math M:Ch.10:Basic math facts	p.30 #3 Read Ch.2 p.23-29	Journal [1]
5	3/7	T:Ch.2: Understanding M:Ch.11:Place value	p.30 #4 Read Ch.3 p.32-47	p.30 #3
		Spring Break		
6	3/21	T:Ch. 3:Problem Solving Teaching methods M:Ch.12:Computation	p. 56 #1 Read Ch.3 p.47-56 Classroom Obs.	p.30 #4
7	3/28	T**:** Ch.3:Problem Solving Lesson Plans + Web Plans M:Ch.13:Estimation	Journal [2] Web Lesson Plan	p.56 #1 **Classroom Obs.**
8	4/4	T: Problem Solving Metacognition Discourse M:Ch.14:Algebraic Thinking	p.56 #7 Newspaper [2]	**Web Lesson Plan** Journal [2]
9	4/11	Math word problems Jasper/GSQ Board Games M:Ch.15 & 16:Fractions	Read Ch.4	p.56 #7 Newspaper [2]
10	4/18	Ch.4: Planning **Midterm** M:Ch.17:Decimals	p. 72 #4 Read Ch.5 Teacher Interview	
11	4/25	T:Ch.5:Assessment	Read Ch.6 pg.91 #1	p. 72 #4 **Teacher Interview**

		M:Ch.18:Ratio/proportion	Research Article	
12	5/2	T:Ch.6:Teaching *all* children Lesson plans M:Ch.19:Measurement Ch.20:Geometry	Read Ch.7 pg.109 #3 Journal [3] Board Game	pg.91 #1 **Research Article**
13	5/9	T:Ch.7:Technology M: Ch.21 & 22:Statistics	Lesson Plan	pg.109 #3 **Board Games** Journal [3]
14	5/16	Lesson Plan Presentations		**Lesson Plan Presentations**
15 ***FINAL meeting***	5/23	Lesson Plan Presentations		**Lesson Plan Presentations**

MATH 410 REAL ANALYSIS -- SYLLABUS

COURSE DESIGNATION

MATH 410 - Real Analysis: An upper division undergraduate math course serving as a recommended elective for both B.S. and B.A. mathematics majors during the late junior or senior year. This course is required by most graduate schools for any student wishing to do further graduate work in mathematics. (4 sem. hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to elementary topics in advanced calculus and real analysis. Subjects studied include various properties of the real number system, set theory, topological concepts, general metric spaces, the Heine-Borel and Weierstrass theorems of analysis, normal and uniform continuity, sequences and series of functions, differentiation and Riemann integration, and basic measure theory. The notion of abstract mathematical proof is developed and extended throughout the course at a higher level than would have been previously experienced by the average student. The prerequisites for this course are Math 311 (Calculus III), and Math 320 (Linear Algebra) or Math 328 (Abstract Algebra).

GOALS

The goals of this course include the following: to acquire a basic working knowledge of the fundamental definitions, theorems, and techniques of proof in abstract real analysis; to lay the foundations for and establish the validity of much of the mathematical theory which is taught without proof in the normal calculus sequence; to develop more abstract generalizations of specific results used in preceding mathematics courses; and to develop at a fairly high level the skills necessary for devising and writing out valid, coherent mathematical proofs.

ASSIGNMENTS and TESTS

Daily homework assignments will play an integral part of the course. Selected problems will be submitted for grading by the instructor.

There will be four 50-minute tests and a comprehensive final exam. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be more difficult than the original test. **Note: there will be a $15.00 fee charged for any make-up test**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on the day of the test prior to the testing time**.

EVALUATION

The grade for the course will be based on the average of the four 50-minute tests (60%), the graded homework (15%), and the final exam (25%). Late homework assignments will receive a reduction in credit. Grades will be determined by the following scale:

90 - 100	A (A-)
80 - 89	B (B+ B-)
70 - 79	C (C+ C-)
60 - 69	D (D+)
0 - 59	F

Note 1: If you choose the CREDIT/NO CREDIT grading option, <u>you</u> <u>must</u> <u>earn</u> <u>at</u> <u>least</u> <u>a</u> <u>"C-"</u> <u>to</u> <u>obtain</u> <u>CREDIT</u>. Math majors should <u>not</u> take this course with the CREDIT/NO CREDIT option.

Note 2: This grading system is minimal in the sense that the student is guaranteed <u>at</u> <u>least</u> as high a grade as indicated by the above scale. A small amount of grade curving <u>may</u> make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

TEXT

A suggested text for this course is <u>Elementary Classical Analysis</u> by Jerrold E. Marsden, published by Freeman (latest edition), or the equivalent. The material covered should include the first nine chapters.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **<u>NOT</u>** include the practice of <u>copying</u> assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course.

REAL ANALYSIS TOPICS

Text: <u>Elementary Classical Analysis</u>, latest edition, by Jerrold E. Marsden (W.H. Freeman)

Description of topic	Number of lectures	
Sets and Functions	1	
The real line	1	
Euclidean n-space: R^n		1
Open sets; interior of a set	1	
Accumulation points	1	
Closure of a set; boundary of a set	1	
Sequences		1
Series in R and R^n	1	

	8	
TEST I		
Compact sets: Heine-Borel and Weierstrass theorems		1
Path-connected sets; connected sets	1	
Continuity		1
Images of compact and connected sets	1	
Operations on continuous mappings	1	
Boundedness of continuous functions on compact sets	1	
Intermediate-Value theorem	1	
Uniform continuity	1	
Pointwise and uniform convergence	1	
The Weierstrass M-test		1
Integration and differentiation of series	1	
The space of continuous functions	1	
Arzela-Ascoli theorem		1
Stone-Weierstrass theorem	1	
Dirichlet and Abel tests	1	
Power series and Cesaro and Abel summability	1	

	16	
TEST II		
Definition of the derivative	1	
Matrix representation of derivatives	1	
Continuity of differentiable mappings; differentiable paths	1	
Conditions for differentiability		1
Chain rule (composite mapping theorem)	1	
Product rule and gradients	1	
Mean-Value theorem	1	
Taylor's theorem and higher derivatives	1	
Maxima and minima	1	
Inverse function theorem	1	
Implicit function theorem	1	
Constrained extrema and Lagrange multipliers		1

	12	
TEST III		
Review of integration in R and R^2; integrable functions	1	
Volume and sets of measure zero	1	
Lebesque's theorem	1	
Properties of the integral	1	
Fundamental theorem of calculus	1	
Improper integrals	1	
Convergence theorems		1
The Dirac delta function	1	
Fubini's theorem	1	
Change of variables theorem	1	
Polar coordinates	1	
Spherical coordinates, cylindrical coordinates		1

	12	

TEST IV

This schedule provides material for 48 lectures (50 minutes each), leaving 7 lectures open in a typical 55 lecture course for tests, review, and optional topics or applications.

Michael Frantz

COMPLEX ANALYSIS -- SYLLABUS

COURSE DESIGNATION

MATH 412 - Complex Analysis: An upper division undergraduate math course serving as a recommended elective for both B.S. and B.A. mathematics majors during the late junior or senior year. This course is highly recommended for any student wishing to pursue further graduate work in mathematics. (4 sem. hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to elementary topics in the theory of functions of one complex variable. Subjects studied include various properties of the complex number system, analytic functions, complex differentiation and integration, Cauchy's integral theorem, series, residues and poles, conformal mappings, and various applications of theorems of complex analysis to real applications in applied mathematics. The notion of abstract mathematical proof is developed and extended throughout the course at a higher level than would have been previously experienced by the average student. The prerequisites for this course are Math 311 (Calculus III), and Math 320 (Linear Algebra) or Math 328 (Abstract Algebra). Math 410 (Real Analysis) is suggested but not required as a prerequisite.

GOALS

The goals of this course include the following: to acquire a basic working knowledge of the fundamental definitions, theorems, and techniques of proof in complex real analysis; to develop a certain level of proficiency in performing computations relative to complex differentiation, integration and series manipulation; to learn the applications of the various theoretical results in this field to solving numerous real-world problems which lend themselves to solution by these techniques; and to continue to develop at a fairly high level the skills necessary for devising and writing out valid, coherent mathematical proofs.

ASSIGNMENTS and TESTS

Daily homework assignments will play an integral part of the course. Selected problems will be submitted for grading by the instructor.

There will be four 50-minute tests and a comprehensive final exam. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency) and may be more difficult than the original test. **Note: there will be a $40.00 fee charged for any**

make-up test. If you will not be able to attend class the day of a test, **please inform the instructor by phone on the day of the test prior to the testing time**.

EVALUATION

The grade for the course will be based on the average of the four 50-minute tests (60%), the graded homework (15%), and the final exam (25%). Late homework assignments will receive a reduction in credit. Grades will be determined by the following scale:

90 - 100	A (A-)
80 - 89	B (B+ B-)
70 - 79	C (C+ C-)
60 - 69	D (D+)
0 - 59	F

Note 1: If you choose the CREDIT/NO CREDIT grading option, you must earn at least a "C-" to obtain CREDIT. Math majors should not take this course with the CREDIT/NO CREDIT option.

Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

TEXT

The text for this course is Basic Complex Analysis by Jerrold E. Marsden and Michael J. Hoffman, published by W.F. Freeman, 3rd edition (1999). The material covered will include most of the first five chapters.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **NOT** include the practice of copying assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course.

COMPLEX ANALYSIS TOPICS

Text: Basic Complex Analysis, third edition (1999), by Jerrold E. Marsden and Michael J. Hoffman, published by W.H. Freeman.

Description of topic	Number of lectures
Properties of the complex numbers	2
Elementary functions	2
Continuous functions	2
Analytic functions	2
Differentiation of the elementary functions	2

	10
TEST I	
Contour integrals	2
Cauchy's theorem: intuitive	1
Cauchy's theorem: formal	2
Cauchy's integral formula	2
Maximum modulus theorem and harmonic functions	2

	9
TEST II	
Convergent series of analytic functions	2
Power series and Taylor's theorem	2
Laurent's series and classification of singularities	3
Calculation of residues	2
The Residue theorem	2
Evaluation of definite integrals	3
Evaluation of infinite series and partial-fraction expansions	2

	16
TEST III	
Basic theory of conformal mappings	2
Fractional linear transformations	2
Schwarz-Christoffel transformations	2
Applications of conformal mapping: Laplace's eq., heat, fluids,	3
Mapping properties of complex analytic functions: Julia sets	*3*

	12
TEST IV	

This schedule provides material for 47 lectures (50 minutes each), leaving 8 lectures open in a typical 55 lecture course for tests, review, and optional topics or applications.

Michael Frantz

ADVANCED ENGINEERING MATH -- SYLLABUS

COURSE DESIGNATION

MATH 418 - Advanced Engineering Math: An upper division undergraduate math course recommended for math majors and optical engineering majors in particular. (4 semester hours)

COURSE DESCRIPTION and PREREQUISITES

This course introduces the student to the mathematical concepts, theory, and methods of solution for problems in physics and engineering. Various topics examined include ordinary and partial differential equations, Laplace transform methods, Fourier series and transforms, and key results and applications from vector analysis. Prereq.: MATH 311.

GOALS

The goals of this course include the following: to master various solution methods of first and second order ordinary differential equations and to become acquainted with their applications in modeling physical situations; to acquire skill in using Laplace transform methods in solving differential equations; to become familiar with Fourier series and transforms and the methods of problem solution involving these concepts; to develop an understanding of the underlying physical motivation for the heat and wave equations, as well as methods of solutions for these; and to obtain a working knowledge of the key results in vector analysis in terms of physical applications, including the theorems of Gauss and Stokes.

ASSIGNMENTS and TESTS

Daily homework assignments will be made, including a number of exercises to be worked by the student but not turned in, and several problems which may be handed in and graded. Each problem set to be graded will be due at the beginning of the second class meeting after it is assigned. The homework may or may not be used in calculating the course grade, depending on test scores (see next section), so it is **strongly recommended** that all students put some effort into the graded homework problems.

There will be four 50-minute tests and a comprehensive final exam. Tests will be announced at least one week in advance, and approximate test dates may be inferred from the topics list provided later in this document. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone on or prior to the day of the test, and prior to the testing time**.

EVALUATION

The grade for the course will be based on the homework and computer lab assignments (15%), the average of the four one hour tests (60%), the final exam (20%), and various aspects of class participation and small group activities (5%). If any one-hour exam score (including a test not taken, but **excluding the fourth test)** is lower than the final exam score, it will be replaced by the final exam score, so that the final exam may count either 20% or (in this latter case) 35% of the total grade. Late homework assignments (if accepted at all) will receive at least a 20% to 50% reduction in credit, determined at the discretion of the instructor, based on various factors. Final course grades will be determined by the following scale:

100 - 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59	F		

Note 1: If you choose the CREDIT/NO CREDIT grading option (not available for mathematics majors), you must earn at least a "C"- to obtain CREDIT.
Note 2: This grading system is minimal in the sense that the student is guaranteed at least as high a grade as indicated by the above scale. A small amount of grade curving may make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

TEXT

The text for this course will be Advanced Engineering Mathematics, by Peter V. O'Neil (second edition). The material covered will include most of chapters 1, 2, 4, 9, 11, 12 and 13.

ACADEMIC HONESTY

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does **NOT** include the practice of copying assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the failure of that test or possible course dismissal, as per university policy.

OFFICE HOURS

My office number is 56B, located on the bottom floor of the Mainiero (MA) building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or v-ball!). Office phone number: 593-3511, ext. 4609. If I am not available, leave a message on my phone voice-mail after 4 rings, or by electronic mail on the VAX computer (FRANTZM). The Natural Sciences secretary (Sharla) is also available, at ext. 4601 from 8am to 5pm.

ADVANCED ENGINEERING MATH TOPICS

Text: Advanced Engineering Mathematics, by O'Neil, second edition (Wadsworth).

Description of topic	Number of lectures
Introduction to differential equations	0.5
Separable equations; applications	1
Homogeneous equations	1
Exact equations	1
Integrating factors, Bernoulli equations	1
Linear first order equations	1

	5.5
Second order linear equations: existence, uniqueness	1
Homogeneous second order linear equations	1
Constant coefficients: three cases	2
Damped and undamped motion of a mass on a spring	1
Nonhomogeneous linear second order equations	1
Particular solutions of nonhomogeneous second order equations	1
Forced oscillations of a mass on a spring	1

	8
Introduction to and calculation of Laplace transforms	1.5
Calculation of inverse Laplace transforms	2
Applications of transforms to problem solving	1
Convolution	1
Laplace transform solution of differential equations	1
Power series solutions of d.e.'s about ordinary points	1

	7.5
Review of vectors: dot and cross products, lines, planes	1
Vector functions	1
Vector fields	1
Gradient	1
Divergence and curl	1
Line integrals	1.5
Green's Theorem	1.5
Potential theory in the plane	1
Surfaces and surface integrals	1
Theorems of Gauss and Stokes; applications	3

	13
Fourier series	3
Multiple Fourier series	1
Finite Fourier transforms	1
Fourier transforms	1
Fast Fourier transform	1

	7

The heat and wave equations	2
Fourier series solutions	2
Laplace transform solutions	1
Fourier transform solutions	1

	6

This schedule provides material for 47 lectures (50 minutes each), leaving 5 lectures open in a typical 52 lecture course for tests, review, and optional topics or applications.

Fall, 2010
Michael Frantz

MATH 482 History of Mathematics

Course Designation
MATH 482 – History of Mathematics: An upper division undergraduate mathematics course providing upper division elective credit for all mathematics majors; particularly recommended for mathematics majors intending to pursue a career in teaching. (4 semester hours)

Course Description and Prerequisites
This is both a mathematics course and a history course. Throughout the course of history, mathematics has changed the way people view the world. We will look at an overview of the development of mathematics from ancient times (Egypt, Mesopotamia), through the Classic Greek period, the Medieval and Renaissance periods, and finally the transition from calculus into the more abstract mathematics of the 19th and 20th centuries, with emphasis on the sociopolitical context of various advances and the roles played by diverse cultures. We will work many problems from a number of mathematical subfields, utilizing whenever appropriate the mathematical tools, notation and approaches relevant to each particular culture and time in history. The prerequisite is MATH 201 (Calculus I), with a grade of "C-" or better, or the instructor's approval.

Learning Outcomes

A. Students will become familiar with the notation, tools, methods and major developments of mathematics across the span of recorded human history.
B. Students will become acquainted with the lives of major mathematicians in history and their most significant accomplishments.
C. Students will be exposed to the relationships between sociopolitical change and mathematical developments.
D. Students will improve their capabilities in reading mathematics texts.
E. Students will develop and improve their skills in proving mathematical theorems.
F. Students will improve their abilities in solving mathematical problems.
G. Students will improve their logical, analytical, and abstract thinking skills.
H. Students will improve their skills in communicating mathematics, both orally and in writing.

Assignments and Tests
Daily homework assignments will be made, including a number of exercises to be worked out by the student but not turned in, and several problems which must be handed in and will be graded and considered as part of the course grade. Each problem set to be graded will be due by 5pm of the day of the second class meeting after it is assigned. There will be four exams, with the fourth one given on the final exam day. The approximate test dates for the other three exams may be

inferred from the topics list provided later in this document, and actual test dates will be confirmed least one week in advance. Make-up tests will only be given for absences deemed justifiable by the instructor (e.g., illness, family emergency). **Note: the university fee for a make-up test is $40.00**. If you will not be able to attend class the day of a test, **please inform the instructor by phone before or on the day of the test prior to the testing time**.

Evaluation

The grade for the course will be based on the homework assignments (25%), the four exams (50%), a paper (15%), paper presentation (5%), and class participation (5%). Late homework assignments (if accepted at all) will receive a 20% to 100% reduction in value, determined at the discretion of the instructor, based on various factors, including degree of lateness. Final course grades will be determined by the following scale:

100 – 90		A	A-
89 - 80	B+	B	B-
79 - 70	C+	C	C-
69 - 60	D+	D	
0 - 59		F	

Note 1: **If you choose the Credit/No Credit grading option (not available for mathematics majors),** ***you must earn at least a "C-" to obtain Credit.*** ***Note 2:*** This grading system is minimal in the sense that the student is guaranteed ***at least*** as high a grade as indicated by the above scale. A small amount of grade curving ***may*** make it possible at times for a 79 to be a "B-", or a 68.5 to be a "C-", for example.

Special Note 3*:* Attendance records are not a formal part of the grading process; **however,** past experience indicates a ***high correlation*** between ***students who do not attend math classes regularly and/or do not turn in regular homework assignments***, and ***students who do not pass math courses***.

Participation

Due to the unique nature of the class, it is important for *every* student to participate actively *every* day. Participation means being in class (on time and alert!), asking thoughtful questions, and joining in the discussion. A student who earns full participation credit will be one who contributes to discussions in a manner that makes it clear that all preparation is complete (mainly required readings) and even more importantly, that ideas have developed through reflection and synthesis of the preparation material and the discussion up to that point. Meaningful class participation is signified by more than quantity or volume of oral expression in class. High marks in this area also require listening which is respectfully quiet, focused on the speaker (to the exclusion of all activities other than note-taking), and consistently attentive right up until the end of class. Not only do these practices help to maximize the learning potential for the individual, but they are also a matter of common courtesy and respect for both the instructor and fellow classmates. Short reading quizzes will be utilized if it is perceived that students are coming unprepared to class.

Paper

A paper of not less than ten and (preferably) not more than sixteen full double-spaced pages (*not counting title page and citations*) will be assigned, and the final draft due on December 8. You will need to submit both a hard copy and an electronic version (preferably as a Word attachment to an e-mail message). The topic selected must be approved by the instructor. A half-page statement of your proposed topic will be requested around the end of October, and a mandatory first draft of the paper will be due November 24. A few suggestions for possible topics are included below. **Your research for the paper *must* include at least three non-internet references (books, periodicals, journals), including at least one book reference.** The paper will be graded for content and style (including spelling and grammar). For an online version of the Diana Hacker writing manual used at ULV with all MLA styles (and others), and for some nice example papers with correct citations, see http://www.dianahacker.com/resdoc/home.html. You cannot go wrong by spending time on this site: http://www.dianahacker.com/writersref/ If you are an A+ English student, you may ignore all this advice. All others: ignore at your peril! SafeAssign will be used for plagiarism checking.

Presentation

You will be expected to give a 10-15 minute presentation to the class on the content of your paper on Wednesday and Friday, December 8 and 10, the last two days of lecture for the semester.

An Abbreviated List of Suggestions for Term Paper Topics (many other topics are possible!)

1. A biography of a mathematician
2. The three famous problems of antiquity
3. The history of π
4. The history of e
5. The history of algebra
6. The history of notation (possibly restricted to a particular field)
7. The development of logarithms
8. The development of trigonometry
9. Non-Euclidean geometry
10. Projective geometry
11. The development of number theory
12. The Pythagorean Theorem
13. Computing machines
14. Fermat's last theorem
15. Any other topic receiving instructor approval

Texts, Blackboard, and Other Resources

The texts for this course will be History of Mathematics, 7th edition (2009, McGraw-Hill), by David Burton, and Journey Through Genius, by William Dunham. It is planned that the course should cover all chapters of both books. Answers and partial answers to selected problems are given in the back of the Burton text. Each chapter in the Burton book has numerous resource materials referenced for further student investigation, and various web relevant sites will be announced throughout the course. ***Please log on to the ULV Blackboard system and check the course listing there frequently for homework information/solutions and other course information.***

Academic Honesty, Classroom Etiquette, and Time Expectations

Students are encouraged to help each other on problem assignments to facilitate the learning process. This does ***not*** include the practice of *copying* assignments, and if necessary, points will be deducted accordingly. Any form of dishonest behavior during a test may result in the immediate failure of that test or possible dismissal from the course. Please consult the university catalog for the complete university policy on academic dishonesty. The use of wireless phones and pagers (including texting) is not permitted during class, and such devices must be silenced while class is in session. If students are found to be in violation of this, the device will be collected for the remainder of the class, or, if s/he feels the need to respond to a call or page, the student will be excused from the classroom until the next time the class meets. Due to the capability of wireless phones to transmit text and images, wireless phone usage during a test may result in the immediate failure of that test or possible dismissal from the course. Students are expected to be *on time* for the start of class. You should expect to spend at least two hours of high quality studying/homework time outside of class for every hour spent in class. Of course, mileage may vary; if you wish to earn the best grade possible, you may have to study more! Each person has different study needs.

Office Hours

My office number is MB 155A, located on the second floor of the Mainiero Building. Office hours will be announced during the first week of class. Feel free to drop by for help any time you are having problems, or simply to talk about mathematics (or whatever!) Office phone number: 593-3511, ext. 4609. If I am not available, leave a message on my phone voice mail after 4 rings, or by email at mfrantz@laverne.edu. The Natural Science Division office, in MB 152 (x4601) is also staffed from approximately 8am to 5pm.

HISTORY OF MATHEMATICS SCHEDULE OF TOPICS

Texts: History of Mathematics, 7th ed. (2009), by David Burton; Journey Through Genius, by William Dunham.
(Subject to change!) Chapter Bn is Chapter ‘n’ from Burton, Dm is Chapter ‘m’ from Dunham

Date	Material Covered (***read in advance and be prepared to discuss!***)
8/30 M	Chapter B1: Early Number Systems and Symbols (students exempt the first day from being prepared)
9/1 W	Continued: Chapter B1
9/3 F	Chapter B2: Mathematics in Early Civilizations
9/8 W	Continued: Chapter B2
9/10 F	Continued: Chapter B2; Chapter D1: Hippocrates’ Quadrature of the Lune
9/13 M	Chapter B3: The Beginnings of Greek Mathematics (also, start reading Chapters D2, D3, D4, D5)
9/15 W	Continued: Chapter B3 (keep reading Chapters D2, D3, D4, D5)
9/17 F	Continued: Chapter B3 (keep reading Chapters D2, D3, D4, D5)
9/20 M	Continued: Chapter B3 (keep reading Chapters D2, D3, D4, D5)
9/22 W	Chapter B4: The Alexandrian School: Euclid (keep reading Chapters D2, D3, D4, D5)
9/24 F	Continued: Chapter B4; Chapters D2, D3, D4, D5

9/27 M	Continued: Chapter B4, D2, D3, D4, D5
9/29 W	Continued: Chapters D2, D3, D4, D5
10/1 F	Chapter B5: The Twilight of Greek Mathematics: Diophantus
10/4 M	Continued: Chapter B5
10/6 W	Continued: Chapter B5
10/8 F	***Test I on Chapters B1-B4, D1-D5***
10/11 M	Chapter B6: The First Awakening: Fibonacci
10/13 W	Continued: Chapter B6
10/15 F	Chapter B7: The Renaissance of Mathematics: Tartaglia and Cardano Chapter D6: Cardano and the Solution of the Cubic
10/18 M	Continued: Chapters B7, D6
10/20 W	Continued: Chapters B7, D6
10/22 F	Chapter B8: The Mechanical World: Descartes and Newton Chapter D7:A Gem from Isaac Newton
10/25 M	Continued: Chapters B8, D7
10/27 W	Continued: Chapters B8, D7
10/29 F	***Test II on Chapters B5-B7, D6***
11/1 M	Continued: Chapters B8, D7
11/3 W	Chapter B9: The Development of Probability Theory: Pascal, Bernoulli, and Laplace Chapter D8: The Bernoullis and the Harmonic Series
11/5 F	Continued: Chapters B9, D8
11/8 M	Continued: Chapters B9, D8
11/10 W	Chapter B10: The Revival of Number Theory: Fermat, Euler, and Gauss Chapter D10: A Sampler of Euler's Number Theory
11/12 F	Continued: Chapters B10, D10
11/15 M	Continued: Chapters B10, D10
11/17 W	Chapter B11: Nineteenth-Century Contributions: Lobachevsky to Hilbert (start reading D11, D12)
11/19 F	Continued: Chapter B11 (keep reading D11, D12)
11/22 M	Continued: Chapter B11 (keep reading D11, D12)
11/24 W	***Test III on Chapters B8-B10, D7-D10***
11/29 M	Chapter B12: Transition to the Twentieth Century: Cantor and Kronecker Chapter D11: The Non-Denumerability of the Continuum Chapter D12: Cantor and the Transfinite Realm
12/1 W	Continued: Chapters B12, D11,D12
12/3 F	Continued: Chapters B12, D11, D12
12/6 M	Chapter B13: Extensions and Generalizations: Hardy, Hausdorff, and Noether
12/8/W	Paper Presentations I
12/10 F	Paper Presentations II
12/15 W	***Test IV on Final Exam day***

ASSIGNMENTS FOR MATH 482 -- HISTORY OF MATHEMATICS (Fall, 2010)

Some problems (or parts of problems) are assigned for the student to practice on and for purposes of class discussion, while others are to be handed in and graded. Many problems have solutions in the back of the text. Unless otherwise announced, problem sets will be due by 5pm one week after the day they are assigned. Odd problems are *generally* assigned for the student to practice on and for purposes of class discussion, while the even problems are to be handed in and graded. Problems in [square brackets] are to be turned in for grading. Problems in {set braces} are for extra credit. ***This list is not final: problem sets are subject to deletions or additions or changing point values,*** but it is probably around 90% correct, for those students who like to look and work ahead in the text. All problems to be turned in for [grading] or {extra credit} are worth 10 points for each part each unless otherwise indicated with a suffix like (20).

Texts: History of Mathematics, 7th ed. (2009), by David Burton; Journey Through Genius, by William Dunham.

1.2 1ace, 2ab, 3ac, 5ace, 6ac, 11ace, 12ace [1bdf, 2cd, 3b(20)d(20), 4(20), 5bdf, 6bd, 11bdf, 12bdf]
1.3 1def, 2a, 3, 4, 5, 6cde, 7, 9, 13cde, 14, 15 [1abc, 2bc, 6abf, 13abf] {16}
2.3 1ab, 2bd, 3a, 6, 7, 10, 11, 12, 13, 14, 15(2/5), 16 [1cd, 2ace, 3bc, 4a(20), 8(20), 9, 15(2/3)(20),
19(30), 20(30), 22(20), 23(30)]
2.4 1a, 3, 4, 6 [2(20)]
2.5 [1(60), 3(20), 4, 6(30), 7(20), 11(20)] {13}
2.6 [1, 2(15), 7(15)]
3.2 1, 3, 4ac, 6 [2(20), 4bd, 5(20), 8(60), 9] {13}
3.3 [1(30), 2(30), 3(30), 4(20), 15(20), 16(30), 17(40), 18(40), 19(50), 22(30), 23] {21}
3.4 [1(30), 4, 5(40), 8(15)] {7}
3.5 3 [5(30)] {7}
4.2 Know/understand the statements of problems 1-10 [12(20)]
4.3 1ace, 3, 5, 6, 10ac, 13, 16ab, 21, 23 [1bd, 10b(20), 11(40), 12(20), 15(30), 16(50), 24(20)] {25,26}
4.4 [1(35), 2(30), 3(20), 4(30), 5(120), 6, 7(20)]
4.5 Look at / know 10 and 11 [1(50), 2(20), 4(30), 5(20), 6(20)]
5.3 14ac, 15ac [1, 2(30), 3, 4, 5, 6, 7, 8, 9(20), 10, 11(20), 12(15), 13(15), 14b, 15b(25), 16(30), 17(30),18(30), 19(30), 20(20), 21(40), 22(60), 23(40)]
5.4 2ace [1(40), 2bd, 3, 4(20), 5(20), 6(40)] {#5: 20 EC pts for deriving the trig identity used}
5.5 1ad, 2 [1bc, 4, 5, 7(20), 9, 10, 11, 12, 13, 14, 15(20), 16(20), 18, 20(30), 21(30)] {8}
6.3 1, 5 [2(40), 8(20)]
7.3 1ac, 3ace, 5, 6, 7, 8, 14ac [1bd(40), 2(40), 3b(20)d(10)f(20), 4(20), 9(20), 10(30), 11(30), 12(40), 13(20), 14b(30), 16(20)]
7.4 1c, 2, 3 [1b(40), 4(40), 5(50)] {6}

8.1 [13(20)] {11}
8.2 8a [5(15), 7(20), 8bc]
8.3 [2(30)]
8.4 [12(40),13(30)]
9.2 1ace, 4, 5a [1bdf(90), 5b(30)]
9.3 1, 2, 3, 4ac, 5, 6ac, 7a, 8, 9ac, 11ac, 13a, 14a [4bd, 6b, 7b, 9bd, 11b(20), 13b, 14b]
10.1 2, 7 [1, 12(20)]
10.3 1a, 2, 5a, look at / know 12, and use for 13a; 16ac [1b(15), 4(30), 5bc(55), 8(30), 13bc, 16b]