Millikin University
Student Learning in the Mathematics and Computer Science Major

By Daniel Miller
Due July 1, 2011

**Executive Summary**

The Department of Mathematics supports Millikin's Mission in that the Department works:

1. To prepare students for professional success.
    a. Applied mathematics – we provide core mathematical experiences and a range of application areas to prepare students for work or graduate study.
    b. Mathematics education – we prepare students for the Illinois State Certification Exam, give them experience in teaching, and keep them current on the use of technology in mathematics education.

2. To prepare students for democratic citizenship in a diverse and dynamic global environment.
    a. Applied mathematics- we provide fundamental tools to analyze dynamic events that will inform public policy.
    b. Mathematics education- in a world where political leaders are becoming increasingly numbers driven, we provide the teachers the skills to empower children by enhancing their ability to reason quantitatively.

3. To prepare students for a personal life of meaning and value we help our students develop the intellectual framework, and instill in them the mindset, that will enable them to remain life-long learners. Our students are taught to think rigorously and rationally, and to revel in the sheer pleasure of thinking.

Additionally, the department has specific goals for two of its majors Applied Mathematics, and Mathematics Education. These goals clarify and document the department's desire to produce highly qualified and successful majors. The University completed the paperwork for the Actuarial Science program to receive VEE credit for applied statistical methods (through 2011), time series (through 2013), corporate finance (through 2014), and economics (through 2014). A complete assessment of this program will be completed by Dr. Beck with consolation from the School of Business when the program is viewed as sustainable. We expect the only assessment criteria beyond those of mathematics major will be to track actuarial exam scores for student who choose this option.

The assessment results for data collected from July 2010- July 2011 constitute the department's ongoing systemic attempt to quantify student achievement within the department. The results suggest that for students in both Mathematics and Mathematics Education program goals are being met. Additionally, Mathematics Education maintains NCATE special program accreditation from NCTM. There should be no additional

assessment data necessary for the mathematics education major beyond what is collected for the yearly NCATE report.

Report

Goals

The Department of Mathematics supports the mission of the university in preparing students for professional success, democratic citizenship in a global community, and a personal life of meaning and value. The mission of the department is to produce graduates who achieve the following learning outcome goals:

1. Applied Mathematics

An applied mathematics major will

a. be able to integrate and differentiate functions,
b. be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view,
c. be able to read and construct mathematical proofs in analysis and algebra, and
d. be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

2. Mathematics Education

A mathematics education major will

a. be able to pass the Illinois high school mathematics certification exam,
b. know in broad terms the history of calculus, algebra, and probability,
c. have prepared at least 2 lesson plans in mathematics, and
d. have served as an teaching intern for a member of the mathematics faculty

These goals also reflect a connection to Millikin's Mission in that the Department works:

4. To prepare students for professional success.
    a. Applied mathematics – we provide core mathematical experiences and a range of application areas to prepare students for work or graduate study.
    b. Mathematics education – we prepare students for the Illinois State Certification Exam, give them experience in teaching, and keep them current on the use of technology in mathematics education.
    c. Computer science – we train students in fundamental programming techniques and theory so that they can learn new technologies in this rapidly changing field.

5. To prepare students for democratic citizenship in a diverse and dynamic global environment.
    a. Applied mathematics- we provide fundamental tools to analyze dynamic events that will inform public policy.

b. Mathematics education- in a world where political leaders are becoming increasingly numbers driven, we provide the teachers the skills to empower children by enhancing their ability to reason quantitatively.
c. Computer science- we provide the skills necessary for students to succeed in an increasingly technological world

3. To prepare students for a personal life of meaning and value we help our students develop the intellectual framework, and instill in them the mindset, that will enable them to remain life-long learners. Our students are taught to think rigorously and rationally, and to revel in the sheer pleasure of thinking.

Snapshot

The Department of Mathematics guides students in the completion of three different majors: mathematics education, applied mathematics and actuarial science. Currently, 25 students are following one of our major programs of study. The Department also serves elementary education students with mathematics concentrations, currently 5.

General Description. The Department of Mathematics includes the disciplines of mathematics and statistics. The department offers mathematic majors with options in Applied Mathematics, Mathematics- Secondary Teaching, and Actuarial Science. Additionally, a minor in Applied Mathematics is offered. Elementary Education majors may take a concentration in mathematics. The curriculum is structured to meet the overlapping needs of students who fall in one or more of the following categories:

- those who plan to become high school mathematics teachers;
- those who intend to pursue graduate work in applied mathematics, computer science, or other related fields; and
- those who will apply mathematics and/or computer science in the natural sciences, social sciences, business or other areas of quantitative studies such as actuarial science.

Additional Comments.

- The three majors offered in the Department share courses and faculty. The applied mathematics and mathematics secondary education majors are particularly entwined with students taking common courses and interacting with the same faculty members. In many respects these two majors cannot be disentangled for analysis.
- Students can earn either the Bachelor of Arts or Bachelor of Science. The choice of B.A. or B.S. depends entirely on the student's interest in studying a foreign language. There is no distinction in Departmental coursework between the B.A. and B.S. degrees. Therefore, this report will not separate the B.A. from the B.S.

- All fulltime tenure-track members of the Department have doctorate degrees. (See Table 1.) The department continues to **rely heavily** on adjunct faculty for most of our developmental offerings (12 of 22).

Description Applied Mathematics**.** The applied mathematics major is for students interested in immediate employment or further study in applied mathematics or in actuarial sciences. Applied mathematics majors take a minimum of 33 credit hours in mathematics. The core courses and required advanced courses are those specified in *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004* by the Committee on the Undergraduate Program in Mathematics of The Mathematical Association of America.

Description Mathematics Education. The Mathematics-Secondary Teaching major is a rigorous course of study in mathematics and education. The major has 38 required credit hours in mathematics. Unique among institutions of comparable size we require a mathematics teaching internship experience as part of our program. During this experience the student is paired with a member of the faculty in teaching an undergraduate mathematics course.

Description Actuarial Science Concentration. This option is a rigorous treatment of the mathematics and business skills necessary for a major to enter the workforce as an entry-level actuary. Students who completed this option and all highly recommended courses in business will be prepared to take the first two Actuarial Examinations (1/P and 2/FM) of the Casualty Actuarial Society and the Society of Actuaries. The department is currently working with Tabor School of Business to offer additional course to our majors to prepare them for additional exams. Currently through this corporation, Millikin students can obtain Verification of Educational Experiences (VEE) credit from the Society of Actuaries (SOA) in Applied Statistical Methods (through 2013), Corporate Finance (through 2014), and Economics (through 2014) (see table in appendix).

<u>The Learning Story</u>

Applied mathematics and mathematics education majors follow nearly the same curriculum within the Department. The Department believes that to be a good mathematics teacher one needs to know mathematics. Therefore, the education majors are expected to successfully compete with the applied majors in most of their mathematics courses. The program assumes entering students can start with calculus the fall of their freshmen year. Additionally, education majors are advised to have completed the core of their mathematics courses by the spring of their junior year so that they are prepared for the state certification examination that must be passed prior to being placed for student teaching.

The applied mathematics curriculum focuses on the integration of mathematical theory and mathematical practice. Our majors learn concepts and techniques appropriate for actuarial science, ecological modeling, engineering, numerical analysis, and statistical inference. We assume that most of our applied mathematics major will seek employment in commerce or industry, but the curriculum also prepares them for post-graduate work in mathematics.

The current curriculum maps are included as Appendix 1-2.

Assessment Methods

All students are required to pass the Millikin mathematics placement exam prior to taking a QR course or receive an equivalent math ACT score. The Department expects our majors to score an ACT math sub score of 28 or higher or a placement score of 5 (the suggested score for placement into Calculus I) The Department will be reviewing the entrance requirements for Calculus I during the 2011-2011 academic year. Students are assessed within our programs in numerous ways: course exams, problem sets, and written and oral demonstrations. Additionally, the Department requires every student in Mathematics Education to complete an internship. Written evaluations from these experiences including evaluation by the students' supervisors are kept. Mathematics Education majors take and pass the state certification examination and submit to a portfolio review. Applied Mathematics majors lead a graduate school like seminar their last semester.

Assessing the Applied Mathematics Major Goals

An applied mathematics major will

1. be able to integrate and differentiate functions,

   All Applied Mathematics majors are required to take and pass both Calculus I and Calculus II to graduate with an Applied Mathematics degree. It is the consensus of the department that it would not be possible to pass these two courses without the ability to integrate and differentiate functions. Therefore, verifying the completion of these two courses by all Applied Mathematics majors will assess fulfillment of this goal. Additionally, the department chair will collect copies of all Calculus I and Calculus II final exams each semester to verify the assertion that integration and differentiation of functions was necessary to pass the exams.

   a. In the spring of 2011 the department chair collected copies of all Calculus I and II final exams. The instructors for each course were asked to verify that no student could pass the exam without having knowledge how to integrate and differentiate functions. The department chair then independently verified this conclusion. The collected data in being maintained by the departmental chair and is included at the end of this document.

2. be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view,

   All Applied Mathematics majors are required to take and pass Discrete Mathematics, Differential Equations, and Numerical Analysis. It is the consensus of the department that it would not be possible to pass these three courses without the ability to express and interpret mathematical relationships from numerical, graphical and symbolic points of view. Therefore verifying the completion of these courses by all Applied Mathematics majors will assess fulfillment of this goal. Additionally, the department chair will collect copies of all Discrete Mathematics, Differential Equations, and Numerical Analysis

final exams each semester to verify the assertion that expressing and interpreting mathematical relationships from numerical, graphical and symbolic points of view was necessary to pass the exams.

a. See attached final exams and reviews of these finals by the individual faculty members.

3. be able to read and construct mathematical proofs in analysis and algebra, and

   All Applied Mathematics majors are required to take and pass Discrete Mathematics, Calculus III and Linear Algebra. It is the consensus of the department that it would not be possible to pass these three courses without the ability to read and construct mathematical proofs in analysis and algebra. Therefore verifying the completion of these two courses by all Applied Mathematics majors will assess fulfillment of this goal. Additionally, the department chair will collect copies of all Discrete Mathematics, Calculus III and Linear Algebra final exams each semester to verify the assertion that reading and constructing mathematical proofs in analysis and algebra was necessary to pass the exams.

   a. Discrete Mathematics, Calculus III and Linear Algebra were all offered this year. A copy of the final exams from Calculus III and Linear Algebra are attached. A review of these exams support the contention that it would not be possible to pass these three courses without the ability to read and construct mathematical proofs in analysis and algebra. See attached final exams and reviews of these finals by the individual faculty members.

4. be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

   All Mathematics majors are required to take Calculus I and II and Discrete Mathematics. The final exams from all sections of these courses will be review by the department chair to ensure that these routinely contain problems from biology, physics, chemistry, economics or computer science. Specifically, physics will be covered in Calculus I; biology, chemistry, and economics in Calculus II, and computer science applications in Discrete Mathematics.

   a. This review was completed and verified that the exam contained appropriate problems involving biology, physics, chemistry, economics or computer science. All final exams for these courses are attached. Again, see attached final exams and reviews of these finals by the individual faculty members.

Assessing the Mathematics Education Major Goals

A mathematics education major will

1. be able to pass the Illinois high school mathematics certification exam,

   The department chair will verify that each Mathematics Education major has

passed the state certification exam prior to student teaching. Additionally, the chair will note and analyze the subject area sub scores on an ongoing basis to determine the need for curricular change.

a. All students passed the state secondary content exam (4 of 4)! Note the state wide passing rate was below 50%.
b. The program is nationally accredited!!

2. know in broad terms the history of calculus, algebra, and probability,

All Mathematics Education majors are required to take and pass Mathematics History to graduate with an Mathematics Education degree. It is the consensus of the department that it would not be possible to pass this course without knowing in broad terms the history of calculus, algebra, and probability. Therefore verifying the completion of this course by all Mathematics Education majors will assess fulfillment of this goal. Additionally, the department chair will audit the Mathematics History syllabus each semester to verify the assertion that the assignments cover the history of calculus, algebra, and probability. Samples of student work will also be collected.

a. Math History syllabus was collected and reviewed along with student work (see attached)

3. have prepared at least 2 lesson plans in mathematics, and

All Mathematics Education majors will be required to submit 2 graded lesson plans to the department chair prior to student teaching. These lesson plan may come from a variety of courses; MA 425 Teaching Secondary and Middle School Mathematics, MA 471 Mathematics Internship, or any other education course that required the completion of a mathematics lesson plan.

a. Lesson plans for MA 425 and MA471 were collected and review by the department chair. Starting in 2011 Dr. Paula Stickles will take over this assessment.

4. have served as an teaching intern for a member of the mathematics faculty

In support of this goal, all Mathematics Education majors are required to take and pass the departmental teaching internship MA 471 to graduate with an Mathematics Education degree. The departmental chair will collect and analyze the end of course reflection required for this internship to determine the effectiveness of the experience.

a. All secondary mathematics majors taking MA 471 were required to complete an end of course reflection. The chair has reviewed these reflections. Starting in 2011 Dr. Paula Stickles will take over this assessment.

Assessing the Actuarial Science Major Goals.
An assessment program for the new actuarial science is also under development. Currently the number of students in the program is too small to accurately access.

Analysis of Assessment Results

The assessment data collected for 2009-2010 constitutes the department's second systemic attempt to quantify student achievement within the department. The results suggest that for students in both Mathematics and Mathematics Education program goals are being met. Assessment of the Actuarial Science program will be delayed until enrollment increases.

Improvement Plan

- Assign a permanent faculty member to oversee MA 471 as part of load
- Redesign the developmental and QR sequence to better match the current student body and faculty lines
- Develop a new method for calculus placement
- Obtain a fulltime faculty line for developmental mathematics at the instructor level
- Obtain a funding line within the department for undergraduate research
- Develop an intradepartmental marketing program

**Again the department anticipates having at least TEN uncovered classes for the Fall 2011 semester in the traditional program if no staffing changes are made. Additionally, PACE will request at least eight more (see fall request below) in the 2011-2012 academic year. If this is not enough justification for on additional faculty line there need to be a move, from the administration, to reduce university requirements in mathematics! Believing this will not occur, the department will submit a Fall 2011 course schedule that contains no more than two uncovered courses.**

**PACE Fall 2012 University Studies Course Needs**
**Mathematics**

**1 section MA 100**
**1 section MA 106**
**1 section MA 112**
**1 section MA 125**

Student Publications and Presentations
Department of Mathematics
2010-2011

Lee, E., Lee, S., Elliot, D., Mathy, K., and **Walker, D.** Interval Estimation for Extreme Value Parameter with Censored Data, ISRN Applied Mathematics (2011), Article ID 687343, 1-12.

**Weber, D.** Zero-Divisor Graphs and Lattices of Finite Commutative Rings, Rose-Hullman Undergraduate Math Journal, 12 (2011), no. 1, 58-70.

Coté, B., Ewing, C., Huhn, M. and Plaut, C., **Weber, D.** Cut-sets in Zero-Divisor Graphs of Finite Commutative Rings, Communications in Algebra, 39 (2011), no. 8, 2849-2864

Stickles, P. and **Morin, M.** Conference Presenation. Undergraduate Fellows Program AKA Getting an Undergraduate to Do Your work and Enjoy it! Annual Meeting of the Illinois Council of Teachers of Mathematics. Springfield, IL, sixty minutes (October 2011)

Stickles, J., **Helding, C., and Morin, M.** Conference Presentation. Undergraduate Teaching Internship Program at Millikin University, Annual Meeting of the Illinois Council of Teachers of Mathematics. Springfield, IL, sixty minutes (October 2011)

**Weber, D.** James Millikin Scholar Project. Zero-Divisor Graphs and Zero-Divisor Lattices of Finite Commutative Rings. Received Outstanding JMS Project Award. (May 2011)

Stickles, P., **Helding, C., and Smith, B.** Conference Presenation. Authentic Teaching Experiences in Secondary Mathematics Methods Courses. Annual Meeting of the National Council of Teachers of Mathematics. Indianapolis, IN, sixty minutes (April 2011)

**Bloome, L.** Conference Presentation. Compressed Zero-divisor Graphs of Finite Commutative Rings, Rose-Hulman Undergraduate Mathematics Conference, Terre Haute, IN, twenty minutes (March 2011)

**Luciano, G.** Conference Presentation. Using Data Mining to Determine Academic Success in College, Rose-Hulman Undergraduate Mathematics Conference, Terre Haute, IN, twenty minutes (March 2011)

**Weber, D.,** Conference Presentation. A Preliminary Look at Compressed Zero-Divisor Graphs and Zero-Divisor Lattices, Rose-Hulman Undergraduate Mathematics Conference, Terre Haute, IN, twenty minutes (March 2011)

**Bloome, L. and Weber, D.** Poster Presentation. Compressed Zero-Divisor Graphs and Zero-Divisor Lattices of Finite Commutative Rings, Joint Mathematics Meetings, New Orleans, LA. (One of twenty $100 prize winners out of over 250 posters. (January 2011)

Coté, B., Ewing, C., Huhn, M. and Plaut, C., **Weber, D.** Cut-sets in Cut-Vertices in the Zero-Divisor Graph of , Rose-Hulman Undergraduate Math Journal, 11 (2010), no. 1, 1-8.

**Bloome, L.** Conference Presentation. Compressed Zero-divisor Graphs of Finite Commutative Rings, Millikin Undergraduate Mathematics Research Conference, Decatur, IL, twenty minutes (November 2010)

**Luciano, G.** Conference Presentation. Using Data Mining to Analyze Admissions Data, Millikin Undergraduate Mathematics Research Conference, Decatur, IL, twenty minutes (November 2010)

**Weber, D.,** Conference Presentation. Zero-Divisor Lattices on Commutative Rings, Millikin Undergraduate Mathematics Research Conference, Decatur, IL, twenty minutes (November 2010)

**Weber, D.,** Conference Presentation. Cut-Vertices and Cut-Sets on Zero-Divisor Graphs, Special Session in Commutative Rings, AMS Sectional Meeting, St. Paul, MN, twenty minutes (April 2010)

**Weber, D.,** Conference Presentation. Cut-Sets in Zero-Divisor Graphs of Finite Commutative Rings, Rose-Hulman Undergraduate Mathematics Conference, Terre Haute, IN, twenty minutes (March 2010)

**Arn, R.** and Miller, D., Conference Presentation. Combatting Noise in Imaging Systems, Rose-Hulman Institute of Technology Undergraduate Mathematics Research Conference, Terre Haute, IN, twenty minutes (March 2010)

**Weber, D**., Poster Presentation. Cut-Sets and Cut-Vertices on Zero-Divisor Graphs, Joint Mathematics Meeting, San Francisco, CA (January 2010)

Table 1. Full time faculty: Mathematics

| Faculty | Highest Degree | Rank | Tenure Status | Year Hired | Specialty Field | Courses taught |
|---|---|---|---|---|---|---|
| James Rauff | Ph.D. | Professor | Tenured | 1988 | Formal Languages, Computational Linguistics, Ethnomathematics. | Discrete Math, Computing Theory, History of Math, Linear Algebra, Calculus, Remedial Algebra. |
| Randal Beck | Ph.D. | Associate Professor | Tenured | 1979 | Partial Differential Equations, Statistics. | Calculus, Statistics, Differential Equations. |
| Daniel Miller | Ph.D. | Professor | Tenured | 1997 | Mathematics Education, Geometry, Educational Technology. | Teaching Methods, Precalculus, Geometry, Remedial Algebra |
| Joe Stickles | Ph.D. | Professor | Tenured | 2006 | Ring Theory. | Calculus, Liberal Arts Mathematics, Abstract Algebra. |
| Eun-Joo Lee | Ph.D. | Assistant Professor | Tenure-track | 2006 | Mathematical Statistics. | Statistics, Calculus. |
| Paula Stickles | Ph.D. | Associate Professor | Tenured | 2011 | Problem Solving/Posing, Mathematical Modeling | Secondary Methods, Calculus, Mathematics Content for Elementary Teachers |

Appendix 1

Curriculum Matrix
Applied Mathematics

| | MA 140 | MA 208 | MA 240 | MA 303 | MA 304 | MA 305 | MA 313 | MA 340 | MA 403 | MA 440 | MA 499 | | MA 308 | MA 314 | MA 320 | MA 420 | MA 472 | MA 491 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal 1 | ■ | | ■ | ▒ | ■ | ■ | ■ | ■ | | | | ▒ | | ■ | | | | ▒ |
| Goal 2 | ■ | ▒ | ■ | ▒ | ■ | ■ | ■ | ■ | | | ■ | ▒ | ▒ | ■ | ▒ | | | ▒ |
| Goal 3 | | ■ | | ■ | ▒ | ▒ | | | ■ | ■ | ■ | ▒ | ■ | ▒ | ■ | ■ | | ▒ |
| Goal 4 | ▒ | ▒ | ▒ | ▒ | ▒ | ■ | ■ | ▒ | | | ■ | ▒ | ■ | ▒ | ▒ | ▒ | ■ | ▒ |
| | | | | Required Course | | | | | | | | ▒ | Elective Courses (Two-required) | | | | | |

An applied mathematics major will

Goal 1: be able to integrate and differentiate functions.

Goal 2: be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view.

Goal 3: be able to read and construct mathematical proofs in analysis and algebra.

Goal 4: be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

Appendix 2

Curriculum Matrix
Mathematics Education

| | MA 140 | MA 240 | MA 208 | MA 301 | MA 303 | MA 304 | MA 320 | MA 425 | MA 471 | | MA 340 | MA 403 | MA 305 | MA 313 | MA 314 | MA 420 | MA 440 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal 1 | | | | | | | | | | | | | | | | | |
| Goal 2 | | | | | | | | | | | | | | | | | |
| Goal 3 | | | | | | | | | | | | | | | | | |
| Goal 4 | | | | | | | | | | | | | | | | | |
| | | Required Course | | | | | | | | | Elective Courses (Two-required) | | | | | | |

Goal 1: A mathematics education major will be able to pass the Illinois high school mathematics certification exam.

Goal 2: A mathematics education major will know in broad terms the history of calculus, algebra, and probability.

Goal 3: A mathematics education major will have prepared at least 4 lesson plans.

Goal 4: A mathematics education major will have served as a teaching intern for a member of the mathematics faculty.

Detailed Assessment of Selected Courses and Final Exams

**Assessment of MA 140-01 Final Exam for Fall 2010**

***Goal*: An applied mathematics major will be able to integrate and differentiate functions.**

***Assessment of goal*:**

**Differentiation: Of the 12 problems on this final exam, problems 2, 3, 4, and 5 on the calculator part, and problems 1a, 4, and 5 on the non-calculator part either explicitly or implicitly required the students to take a derivative of some function in order to be able to solve the problem. Problem 1(a) on the non-calculator part required the students to understand the definition of the derivative. Problem 5 on the non-calculator part required the students to connect the first derivative of a function with the function increasing or decreasing and to connect the second derivative with the concavity of the function. Problem 2 on the calculator part required the students to apply differentiation techniques without having an explicitly stated function. Problem 3 on the calculator part required students to connect the derivative to optimizing a quantity given certain restrictions. Problem 4 on the calculator part required students to connect the derivative to a change in quantities with respect to time (related rates). Problem 5 on the calculator part required the student to connect the first derivative of a function with the function increasing or decreasing and to connect the second derivative with concavity of the function.**

**Integration: Of the 12 problems on this final exam, problems 1(b), 3, and 6 on the non-calculator part, and problems 6(a) and 6(b) on the calculator part either explicitly or implicitly required students to integrate some function in order to be able to solve the problem. Problem 1(b) on the non-calculator part required the students to understand the definition of the definite integral to obtain the exact value of the definite integral. Problems 3 and 6 either explicitly or implicitly required students to integrate some function in order to be able to solve the problem.**

**As nearly every problem on this final exam involved either differentiation or integration (or both), it would be impossible for a student to pass this exam without knowing how to differentiate or integrate functions.**

***Goal*: An applied mathematics major will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics, or computer science.**

***Assessment of Goal*: Problem 6 on the calculator part dealt with estimating integrals from a table of values. Since science students will be making inferences using experimental data, the ability to estimate derivatives and integrals from a table of values will be extremely useful. Problem 3 on the calculator part required students to determine the minimum value of some physical quantity. Though this particular problem did not explicitly bring in physics or chemistry per se, the technique required to solve this problem *does* occur in solving problems in physics and chemistry, and therefore, students who successfully completed this problem have learned a technique they can use to solve application problems in physics and chemistry. Also, problem 4 on the calculator part involved differentiation to determine the rate of change of a physical quantity with respect to another physical quantity, which is a topic from physics.**

MA140 Fall 2011
Final Non-calculator p

MA140 Fall 2011
Final Calculator portic

**Assessment of MA 140-01 Final Exam for Spring 2011**

***Goal*: An applied mathematics major will be able to integrate and differentiate functions.**

***Assessment of goal*:**

**Differentiation: Of the 18 problems on this final exam, problems 2, 4, 5, and 6 on the calculator part, and problems 1, 5, 6, and 7 on the non-calculator part either explicitly or implicitly required the students to take a derivative of some function in order to be able to solve the problem. Problem 1 on the non-calculator part required the students to understand the definition of the derivative. Problem 7 on the non-calculator part required the students to connect the first derivative of a function with the function increasing or decreasing and to connect the second derivative with the concavity of the function. Problem 2 on the calculator part required the students to apply differentiation techniques without having an explicitly stated function. Problem 4 on the calculator part required students to connect the derivative to optimizing a quantity given certain restrictions. Problem 5 on the calculator part required students to connect the derivative to a change in quantities with respect to time (related rates).**

**Integration: Of the 12 problems on this final exam, problems 2, 8, and 9 on the non-calculator part, and problem 7 on the calculator part either explicitly or implicitly required students to integrate some function in order to be able to solve the problem. Problem 2 on the non-calculator part required the students to understand the definition of the definite integral to obtain the exact value of the definite integral. The remain problems either explicitly or implicitly required students to integrate some function in order to be able to solve the problem.**

**As nearly every problem on this final exam involved either differentiation or integration (or both), it would be impossible for a student to pass this exam without knowing how to differentiate or integrate functions.**

***Goal*: An applied mathematics major will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics, or computer science.**

***Assessment of Goal*: Problem 7 on the calculator part dealt with estimating integrals from a table of values; in particular. Since science students will be making inferences using experimental data, the ability to estimate derivatives and integrals from a table of values will be extremely useful. Problem 4 on the calculator part required students to determine the minimum value of some physical quantity. Though this particular problem did not explicitly bring in physics or chemistry per se, the technique required to solve this problem *does* occur in solving problems in physics and chemistry, and therefore, students who successfully completed this problem have learned a technique they can use to solve application problems in physics and chemistry. Also, problem 5 on the calculator part involved differentiation to determine the rate of change of a physical quantity with respect to another physical quantity, which is a topic from physics.**

MA140 Spring 2011
Final

**Assessment of MA240 01 Final Exam for Fall 2010**

*Goal*: An applied mathematics major will be able to integrate and differentiate functions.

*Assessment of goal*: Problems 1, 3, 8, 9, and 10 of the final exam required the students (directly or indirectly) to integrate or differentiate a function. Therefore, it is necessary for students to be able to integrate and differentiate functions in order to pass the final exam.

*Goal*: An applied mathematics major will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

*Assessment of goal*: Problems 10 required students to apply calculus to solve an application problem. While the application is more related to chemistry than any other field, the techniques used can be applied to a number of fields. Therefore, students who successfully complete this problem will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

**Assessment of MA403 01 Final Exam for Fall 2010**

*Goal*: An applied mathematics major will be to read and construct mathematical proofs in analysis and algebra.

*Assessment of goal*: Every problem of this final exam required students either to read or to construct mathematical proofs in algebra. Therefore, it would be impossible for a student to pass this exam without being successful at reading and constructing mathematical proofs in algebra.

# MA 403 - Abstract Algebra - Final Exam - Fall 2010

**Directions**: Answer the following questions on the paper provided. Please begin each new problem on a separate sheet of paper and only write on one side of the paper. Show all your work. An answer with no work receives NO credit.

1. (1 point each) Answer the following with either **TRUE** or **FALSE**.

   (a) If $K \trianglelefteq H$ and $H \trianglelefteq G$, then $K \trianglelefteq G$.

   (b) If $H$ and $G/H$ are abelian, then $G$ is abelian.

   (c) If $G$ is a finite abelian group and $p$ is a prime such that $p \mid |G|$, then $G$ has an element of order $p$.

   (d) In a commutative ring $R$ with identity, if $ax = bx$, then $a = b$.

   (e) The characteristic of an integral domain is either 0 or prime.

   (f) A finite division ring is a field.

   (g) If $I$ is an ideal of a ring $R$, then $I$ is a subring of $R$.

   (h) If $P$ is a prime ideal of $R$, and if $Q$ is a prime ideal of $S$, then $P \times Q$ is a prime ideal of $R \times S$.

   (i) If $M$ is a maximal ideal of a ring $R$, then $M$ is a prime ideal of $R$.

   (j) So what? I'm still a rock star. I got my rock moves, and I don't need you.

2. (1 point each) Find (no justification necessary):

   (a) a ring without identity,

   (b) a unit in $\mathbb{Z}_{18}$ other than 1,

   (c) a nonzero zero-divisor in $\mathbb{Z}_{99}$,

   (d) an integral domain that is not a field,

   (e) a division ring that is not a field,

   (f) an ideal of $\mathbb{Z}$ that is not prime,

   (g) a prime ideal of $\mathbb{Z} \times \mathbb{Z}$ that is not maximal,

   (h) a maximal ideal in $\mathbb{R}[x]$,

   (i) $\text{nil}(\mathbb{Z}_{36})$ (recall that for a commutative ring $R$, $\text{nil}(R) = \{a \in R \mid a^n = 0 \text{ for some } n \in \mathbb{Z}^+\}$), and

   (j) $\text{nil}(R)$, if $R$ is an integral domain.

(OVER)

# MATH 403 - Take-Home Final Exam - Fall 2010

**Please read the statement below and sign your name on the line provided. This form should be handed in with your work when you turn it in. This portion of the exam is worth 100 points and is due at 2:00 pm on Friday, December 17, 2010. No late examinations will be accepted.**

**By my signature below, I acknowledge that I have not collaborated with anyone while preparing this examination. I understand that any verbal, written, electronic, or other form of communication with another person (besides Dr. Stickles) in reference to this exam constitutes collaboration. I understand that I may use other written sources (the textbook for the course, my notes, other textbooks in the library, websites, etc.). However, if I use a written source in completion of a problem, I understand that I must cite these sources appropriately and that I must provide more detail than is contained in the written source. If it is determined that I have collaborated with another person, if I used a written source without proper citation, or if I used a written source with proper citation but did not provide more detail than is included in the written source, I understand that I will receive a zero on this exam.**

_____

**Signature**

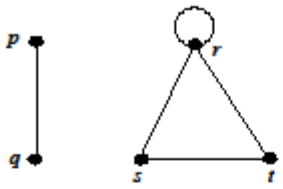
_____

**Name (printed)**

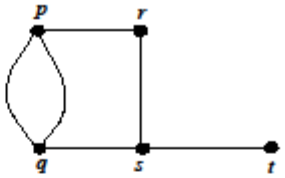
**Assessment of MA208 01 Final Exam for Fall 2010**

*Goal*: An applied mathematics major will be to read and construct mathematical proofs in analysis and algebra.

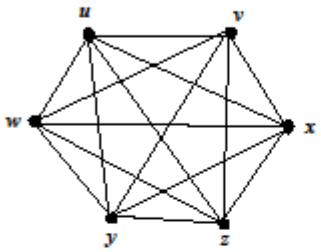
*Assessment of goal*: Problems 17-20 require students to construct proofs, while the rest of the exam requires students to understand the concepts presented in proofs in order to complete the problems. Therefore, students must be successful in reading and constructing mathematical proofs in analysis and algebra in order to pass this exam.



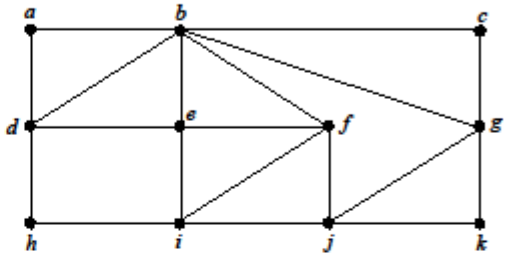

Graph *A*



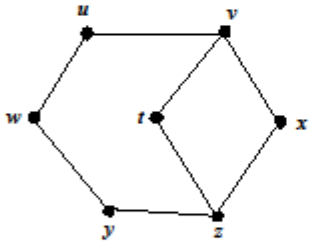

Graph *B*



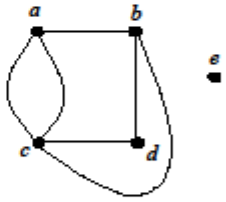

Graph *C*



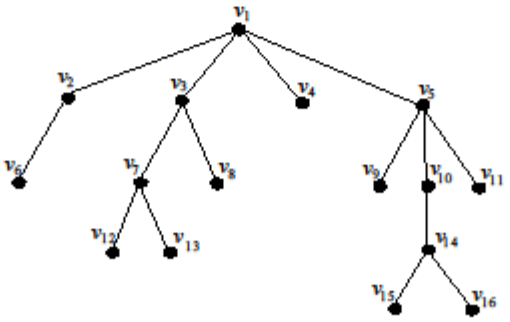

Graph *D*




Graph *E*




Graph *F*




Graph *G*

7. Consider the plane curve represented by the parametric equations $x = t^3 - 12t + 2$, $y = t^2 - 6t + 5$.

(a) (4 points) Find where the curve crosses the $x$-axis.

(b) (4 points) Find an equation of the line tangent to this curve at the rightmost point where the curve crosses the $x$-axis.

(c) (4 points) Find the coordinates of the points at which the curve has horizontal tangents.

(d) (4 points) Find the coordinates of the points at which the curve has vertical tangents.

**Assessment of MA320 for Spring 2010**

*Goal:* A mathematics education major will know, in broad terms, the history of calculus, algebra and probability theory.

*Assessment of goal:*

The final exam is attached. Questions directly addressing the goal are marked in pink. Students would have been unable to pass the final exam or the course without a knowledge, in broad terms, of algebra, calculus and probability.

**See Departmental copy for exam.**

**Assessment of MA 304 for Fall 2010**

**See departmental copy for exam.**

**Assessment of MA 340 for Fall 2010**

**See departmental copy for exam.**

**Approved Courses for VEE - (October 13, 2011)**

The VEE requirement is jointly sponsored by the Society of Actuaries (SOA), Casualty Actuarial Society (CAS) and Canadian Institute of Actuaries (CIA).
***MILLIKIN U Illinois***

Applied Statistical Methods
MA 220 Statistical Methods MA 225 Time Series **2013**

Corporate Finance
FI 340 Introduction to Financial Management **2014**

Economics
EC 100 Principles of Macroeconomics **2014**
EC 110Principles of Macroeconomics **2014**