# Contents

DEPARTMENT OF MATHEMATICS AND STATISTICS
UNDERGRADUATE PROGRAM DIRECTORY

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# I. INTRODUCTION

## A. The Field of Mathematics

Mathematics begins with simple questions in arithmetic. This has led to harder and harder questions involving a huge array of techniques. Perhaps the best way of understanding the scope of mathematics is to look at some examples of questions that mathematicians have worked on and are working on.

• A prime number is an integer that cannot be factored into the product of two smaller integers. Every number can be written as the product of primes. Thus primes are the building blocks of the integers. It is easy to tell if you have a prime number, but can you give a method for deciding whether a number, say one with 200 digits, is prime that works quickly? Can you give a method that works quickly for factoring a number into prime factors? These are simple questions, but efforts to answer them have led to much elegant and deep mathematics. And the answers to these questions are useful. Many of the encryption devices we use every day are based on the fact that we **can** quickly tell if a number is prime and we **cannot** quickly factor numbers.

• Is the planetary system stable? In other words taking into account only gravity will the planets keep revolving around the sun or will they fall into the sun or will they move farther and farther away from the sun? We assume that the sun does not change and that there are no visitors to the planetary system. Efforts to answer this question have led to the study of chaos and fractals.

• Diseases sometimes appear in geographical clusters. When do these clusters indicate that the disease is caused by something in the environment near the cluster? More generally one can ask how does exposure to a certain substance effect the probability of an individual developing a certain kind of cancer? Often one can find two explanations that describe a data set equally well. Which is the better explanation? These are examples of a broad array of questions having to do with using imperfect and incomplete data to understand the behavior of complicated systems.

• The rapid advance in genetics has led to a plethora of problems that have a large mathematical component. We describe one technique and a pair of problems arising from this technique. A micro-array tells us which genes in

an organism are being expressed at a single instant. This tells us roughly what proteins are being manufactured at that time. For example from a single yeast cell we obtain information about the productions of 5,000 kinds of protein. If we repeat this experiment 12 times we seem to have the information needed to get a picture of the biochemical pathways of the organism. This knowledge will help us understand, for example, how undifferentiated stem cells become blood cells or muscle cells, or how diseases harm an organism.

But there are several challenges to overcome. First micro-array readings are prone to noise which could come from tiny differences in the measurement methods or initial conditions (for example ambient temperature). One needs to mathematically model this noise in order to compensate for it. The second challenge is to develop methods of handling the huge amount of data produced by micro-arrays. How does one find patterns in this set of data. This is called data mining. Clearly techniques for analyzing a huge data base can be used in many endeavors - for example ecology.

## B. Mathematics Majors

The goal of the mathematics program at the University of Massachusetts has three aspects. First the students learn basic material such as linear algebra, differential equations, and statistics needed to successfully attack a wide range of problems. Second, they learn to think with rigor. Lastly they learn to approach apparently unsolvable problems by studying simpler problems, doing experiments and bringing together different concepts.

All majors must complete a calculus sequence and courses in linear algebra, modern algebra and analysis. Each major has wide freedom of choice in upper-division courses and can, with the assistance of a faculty advisor, tailor a program to their interests and career goals. For example, one can prepare for a career in actuarial work, statistical analysis, computer programming, data processing, industry, government, or secondary school teaching. One can also prepare for graduate study in mathematics, statistics, computer science and other fields or professional programs in business, law, medicine and education.

# II. GRADUATION REQUIREMENTS FOR MATHEMATICS MAJORS

Mathematics majors are subject to three sets of graduation requirements:

1. Requirements imposed upon all undergraduate students in the University
2. Requirements for all students in the College of Natural Sciences and Mathematics, and
3. Requirements established by the Department of Mathematics and Statistics.

All of these will be satisfied by completing the requirements in a period of no more than ten semesters, including semesters at other colleges.

Since it is your responsibility to ensure that all requirements are fulfilled by graduation time, it would be wise for you to use this section of the leaflet as a check-list for keeping track of your progress. Major requirements are ultimately audited by the Chief Undergraduate Advisor, those of the College of Natural Sciences and Mathematics by the College of Arts and Sciences advisory office in Machmer E-24, and those of the University in the Records Office, 207 Whitmore.

For a definitive statement of the universiiy's graduation requirements see the brochure "Academic Regulations: 2006-2007" at www.umass.edu/registrar.

## A. College and University Requirements

### 1. Graduation Credit Requirement

A total of at least 120 graduation credits, exclusive of courses numbered below 100, is required. All credits earned in any school or college within the University, all advanced placement credits, and all transfer credits accepted by the University, including those earned through the College Level Examination Program (CLEP), may be counted toward this total. However, a student must successfully complete a minimum of 45 **residence** credits to be considered for a baccalaureate degree. For this purpose, residence credits are credits earned for work done while registered on the Amherst campus of the University of Massachusetts or while enrolled in one of the University's formal exchange programs; transfer credits, advanced placement credits based

on the College Entrance Examination Board's high school Advanced Placement tests, CLEP credits, and military service credits do **not** count toward residency requirements.

In addition, students must complete their final 30 credits in residence, residence in this sense meaning continuous enrollment in a degree-granting major program and registration in UMass Amherst courses. Petitions for permission to take any of the final 30 credits in absentia must be submitted to the Chief Undergraduate Advisor prior to enrollment in the course(s), on the Prior Approval for Completing the Senior Year in Absentia form available from the Registrar's Office, 213 Whitmore. Students may not complete their senior year in absentia in the Division of Continuing Education.

Although advanced placement, transfer, and CLEP credits in the appropriate areas of study may be applied toward College and University requirements, CLEP and advanced placement credits may or may not apply to General Education requirements. CLEP credits cannot be used to satisfy Departmental requirements unless approved by the Chief Undergraduate Advisor. Transferred courses will be credited towards Departmental graduation requirements only after evaluation by the Chief Undergraduate Advisor: any such evaluation must be initiated by the student.

**NOTE:** The University does not accept CLEP scores in foreign languages.

### 2. Cumulative Quality Point Average Requirement

A cumulative quality point average of at least 2.00, both overall and in the major, is required.

### 3. Foreign Language Requirement

Satisfied by any one of the following:

1. Successful completion of a foreign language course at the fourth-semester (Intermediate II) level. (Intermediate II or Intermediate Intensive Courses number 240-249). Intermediate II courses may be graded on a Pass/Fail basis.

2. Degree credit equivalent to such a course earned through an appropriate score on a College Board Foreign Language, Achievement Test (SAT II) or a College Board Advance Placement Test.

3. Satisfactory completion **in high school** of either a fourth-level foreign language course, or else a third-level course in one foreign language and a second-level course in another.

4. Successful completion of one year in a high school in which English is not the language of instruction.

5. Successful completion of a semester or a year's study abroad program which leads to foreign language proficiency at the fourth semester (Intermediate II) level as approved by the appropriate language department.

6. Proficiency demonstrated in a test designed by a University of Massachusetts language department or a test administered and validated by a local faculty member if the language is one not offered by a department at the University.

**Students who have not satisfied the Foreign Language Requirement upon admission to the College of Natural Science and Mathematics should elect a foreign language course each semester in residence until the requirement has been satisfied.** This regulation applies even to students who are planning to declare, at some later date, a major which is not in the College of Natural Sciences and Mathematics.

Students enrolled in the College of Natural Sciences and Mathematics cannot apply their pass/fail option to foreign language courses at the first three levels of proficiency (either semesters of the elementary level or the first semester of the intermediate level). Foreign language courses at the second intermediate level **may** be elected on a pass/fail basis. **Exception:** College of Natural Sciences and Mathematics students who have previously satisfied their Foreign Language Requirement are allowed to take elementary or intermediate level courses in other foreign languages on a pass/fail basis.

Students who are certified by the Disability Services Office as having a significant hearing impairment that is seriously limiting to the auditory reception of language may fulfill the Foreign Language requirement either by demonstrating proficiency in American Sign Language at the intermediate level, or by completing two semesters (6 cr.) of foreign language, plus two courses (6 cr.) taught in English on the history, culture, or litereature of non-English speaking countries or regions. These courses must be in addition to courses used to fulfill the General Education requirements, and may not be graded

on a Pass/Fail basis. A list of courses that may be used in this manner is available from the Arts and Sciences Advising Office.

## 4. General Education Requirements

See the Guide to Undergraduate programs or go to: www.umass.edu/registrar and douwnload the Academic Regulations file.

**Basic Mathematics Skill and Analytic Reasoning**
All students must satisfy the R1 (Basic Math Skills) requirement for graduation.

1. **Basic Mathematics Skills R(1)**
   **R1/R2 Joint Satisfaction**: In May of 2005, and effective retroactively, the registrar enacted a policy which states that *any course taken within the Department of Mathematics and Statistics that satisfied the R2 (Reasoning) requirement for graduation now also satisfies the R1 requirement. This applies to the following courses:*

   - **Math:** 113, 121, 127, 128, 131, 132, 233, 235, 456.
   - **Stats:** 111, 240 (previously labeled (140), 501, 515, 516.

   A continuously updated list of such coursees, **including certain R2 course in other departments (eg: RES-ECON 211 and 212, etc...),** can be viewed at:

   http://www.umass.edu/registrar/registration/$r1_r2_$requirements.htm

   In addition, *the following courses that do not currently carry R2 satisfication* **do** *satisfy the R1 requirement:*

   - **Math:** 011, 012, 100, 101- 102 (must have both), 104, 114, 300, 331.

2. **R1(Basic Math Skills) Exemption Test:**
   The R1 Exemption Test is **not** the same as the Math Placement Test (see below). The R1 Exemption Test is only a test of basic math

skills; nothing else. Passing this test will satisfy the R1 requirement for graduation, but will not result in the awarding of any credits. This test is **not** currently online, nor will it be anytime soon. This test is administered several times each semester though the **Department of Mathematics and Statistics**. More information on this test, including topics, dates, location, requirements, and posting of results can be found at:

http//www.math.umass.edu/ beaulieu/exemption.html

If you have any further questions that cannot be answered by the contacts above, you may reach Jeff Beaulieu, by email at: beaulieu@math.umass.edu or by phone at 545-6032.

3. **Math Placement Test:** The Math Placement Test is **not** the same as the R1 Exemption Test. The Placement Test is now taken by students online before orientation. Because it is online, it is no longer connected to R1 satisfaction. A student's score on the Placement Test is used only as a guide as to where that student currently is in his/her math ability (whether it be arithmetic or on the doorstep of calculus). The Placement Test is administered through the **New Students Program.** Access to this test, as well as more information on who should take it, can be found on their website at:

   http://www.umass.edu/newstudent/academics/placementtests/

4. **Analytic Reasoning (R2)**
   This requirement is fulfilled by completing one Analytic Reasoning course labeled R2.

5. **Writing**
   This requirement consists of two semester courses, one in the freshman year and one in the junior year. Neither course can be taken on a pass/fail basis.

   (a) **Freshman-Year Writing Requirement (CW)**
   All freshmen and all transfer students who have not yet passed an approved freshman writing course are required to take the Writing

Program Placement Tests, and they may do so only once. Based upont he results of that test, students are:

- exempted from the Freshman-Year Writing Requirement, **or**
- placed in English WP 112 (College Writing) which fulfills the Freshman-Year Writing Requirement, **or**
- placed in English WP 111 (Basic Writing) which prepares students to take English WP 112 and thereby fulfill the Freshman-Year Writing Requirement.

(b) **Junior-Year Writing Requirement**
Having completed their Freshman-Year Writing Requirement, Students wait until their junior year to fulfill the Junior-Year Writing Requirement by taking the approriate course within the major department. For most mathematics majors this course is Mathematics 370 (Topics in Mathematical Writing), which will be offered both semesters of the 2006-2007 academic year. Permission of the Chief Undergraduate Advisor is required to substitute another writing course for Math 370. Double majors whose primary major is not mathematics will satisfy this requirement upon successful completion of the Junior-Year Writing Requirement in the primary major - no further permission is necessary.

(c) **Writing Program Exemptions Policy**

**The Freshman-Year Writing Requirement**
Exemplary performance on the Writing Program Placement Test qualifies the student for a waiver of the Freshman-Year Writing Requirement, but **without credit**.

Exemption from the Freshman-year Writing Requirement, **with credit,** is granted to students who earn a total score of 1400 or more on the SAT Verbal Aptitude and English Achievement Tests or who earn a 4 or 5 on the Advanced Placement Language and Composition Test.

Student who earn a 4 or a 5 on the Advanced Placement Literature and Composition Test are **not** exempted from the Freshman-Year Writing Requirement but receive three credits in English toward their "AL" General Education Requirement.

**The Junior-Year Writing Requirement**
There is **no exemption** from the Junior-Year Writing Requirement.

Further information about policies or regulations relating to the Writing Requirement can be obtained from the Writing Program Office, Bartlett 305A, Tel. 545-0610.

### 5. Additional College of Natural Science and Mathematics Requirements for the B.A. and B.S. Degrees

Mathematics majors wishing to earn the **B.A. degree** must complete two additional 3-credit courses in the College of Arts and Sciences but taught outside the College of Natural Sciences and Mathematics, i.e., taught in the College of Humanities and Fine Arts or by the College of Social and Behavioral Sciences. These courses need to carry a General Education designation but must **not** be graded pass/fail. **NOTE: a corollary of this requirement is that it is impossible to do a triple major with one major from each of the three college and earn a B.A.!**

In addition to completing the Foreign Language requirement, all students pursuing a Bachelor of Science in the College must earn a minimum of 60 credits in courses offered by the College or the Department of Psychology or other approved related courses. Theses include credits earned to satisfy General Education and major requirements.

**(New requirements for the Mathematics Major have been established as of September 2003. Majors enrolled before this date may elect to stay with the current requirements or change to the new requirements. Students entering the Mathematics Major for the Fall 2003 semester or later must do the new requirement listed below.)**

## B. New Requirements for Mathematics Majors Effective Fall 2003

The requirements for a degree provide the student with maximum flexibility in designing an overall course of study to meet his or her scientific, educational and career goals. The beginning courses emphasize computational

skills, problem solving, and the understanding of basic concepts. As students progress, they must solve problems that are less and less routine and more abstract or intricate. Some upper-level courses emphasize proofs and the understanding of abstract structures, while others emphasize advanced computational methods or the formulation and analysis of mathematical or statistical models of reality. A number of the courses involve the use of computers in a fundamental manner in the development of the material covered.

Specific requirements for a major in mathematics are given in 1-6 below. All courses used to satisfy these requirements must be completed with a passing grade, but not with a "P". A cumulative quality point average of 2.00 is required in all Mathematics and Statistics courses taken.

1. Differential and integral calculus: Math 131 and 132.
2. Multivariable calculus and linear algebra: Math 233 and 235.
3. Introduction to abstract mathematics: Math 300 or CMPSCI 250 (may be waived by the Chief Undergraduate Advisor for exceptionally well-prepared students).
4. Computer programming: CMPSCI 121 or equivalent.
5. Writing in mathematics: Math 370
6. Completion of the requirements of one of the concentrations detailed below (Applied Mathematics, General Individual, Mathematical Computing, Pure Mathematics, Statistics or Teaching). At most four of the courses used to satisfy the concentration requirements may be taken outside the Department of Mathematics and Statistics. The Chief Undergraduate Advisor must approve all such courses taken outside the Department. The grades earned in the courses that satisfy the concentration requirement must average C or higher.

**Concentrations**
Students will need to pick from one of the following concentration:

**Applied Mathematics Concentration** prepares the student for a career as a mathematician in government or industry. Requirements:

- Advanced calculus: Math 425
- Differential equations: Math 331

- Linear algebra for applied mathematics: Math 545
- At least one of the following courses: Math 456, 532, 534, 552.
- At least three additional courses numbered 400 or higher with the approval of the chief undergraduate advisor, these may be appropriate courses outside the department.

**General Concentration** provides the student with broad training in abstract mathematics, statistics, and computing. Requirements:

- Algebra: Math 411 or 511 **and** one of Math 412, 271, 512, 545
- Statistics: Stat 515 **and** 516
- Analysis: Math 425 **and** 523
- Scientific Computing: Math 551 **and** 552

**Individually designed concentration** permits students, in consultation with their academic advisor, to design their own concentration so as to explore thoroughly a theme in mathematics or statistics or to investigate connections between mathematics and/or statistics and another field, such as biology or economics. An individual concentration must include eight courses numbered 400 or above, of at least three credits each. At least four of these eight courses must be in mathematics or statistics. In consultation with their academic advisor, students propose a plan for the eight courses to be used to fulfill the requirements of the individual concentration. No later than the end of the semester in which students are taking Math 300 or during the second semester of the students' sophomore year, whichever comes first, students will: prepare the plan in writing, secure approval of the plan by their advisor, and submit the written plan for approval to the chief undergraduate advisor. No later than the end of the junior year, students review the plan with their academic advisor. If any changes are proposed to the original plan, students will: prepare a revised plan in writing, secure approval of the revised plan by their advisor, and then submit the revised plan for approval to the chief undergraduate advisor.

**Teaching Concentration** provides the student with the knowledge of mathematics and statistics required by the Commonwealth as an 8-12 teacher of mathematics. Requirements:

- Abstract Algebra: Math 411

- Mathematical Modeling: Math 456
- Discrete/finite mathematics: Math 455
- Geometry: Math 461 **and** 462
- Probability and Statistics: Stat 501 followed by Stat 515
- Use of technology: Math 551
- **NOTE: Since Math 236 and Math 503 are not being offered, in order to fulfill the requirements of the teaching concentration, the student may substitute another course in the Department that has a substantial computer component for this requirement. Each semester, the Chief Undergraduate Advisor will publish a list of such substitute courses. Past examples of such courses have been Math 471 Number Theory and Math 532 Topics in Ordinary Differential Equation. The suitability of a course is decided semester by semester.**

**Mathematical Computing Concentration** prepares the student for careers that require both knowledge of advanced mathematics and extensive knowledge of computer programming. Requirements:

- Computer programming: Cmpsci 250 **or** Math 455
- Two courses that focus on programming: (Cmpsci 287 and Cmpsci 311) **or** on theory (Cmpsci 401 and Math 513/Cmpsci 575)
- Three courses chosen from the following:
  Cmpsci 401,
  Math 411 **or** Math 511
  Math 412 **or** Math 512
  Math 471
  Math 513/Cmpsci 575
  Math 551
  Math 552
  Stat 515
  Stat 516
- At least two additional courses numbered 400 or higher. With the approval of the chief undergraduate advisor, these may be appropriate courses outside the department.

**Pure Mathematics Concentration** prepares the student for graduate study in mathematics. Requirements:

- Algebra: Math 411 **or** Math 511
- Complex variables: Math 421
- Advanced multivariate calculus: Math 425
- Analysis: Math 523
- At least one of the following courses:
  Math 412
  Math 512
  Math 563
- At least one "applied mathematic" course either chosen from the following list or another course with sufficient applied mathematical content approved by the chief undergraduate advisor:
  Math 331
  Math 456
  Math 532
  Math 534
  Math 551
  Math 552
  Stat 516
- At least two additional courses numbered 400 or higher. With the approval of the chief undergraduate advisor, these may be appropriate courses outside the department.

**Statistics Concentration** prepares the student for a career as an applied statistician or for graduate study in statistics. Requirements:

- Advanced multivariable calculus: Math 425
- Algebra: Math 545 or Math 411 or Math 511
- Introduction to statistics: Stat 515 and Stat 516
- At least one of the following:
  Stat 505
  Stat 506
  Stat 511

- At least three additional courses numbered 400 or higher. With the approval of the chief undergraduate advisor, these may be appropriate courses outside the department.

## C. Department Requirements for Mathematics Majors Prior to 2003

**(New requirements for the Mathematics Major have been established as of September 2003. A student who has declared themselves a math major as of May 2003 has a choice between the new and old requirements. All new math majors will be held to the new requirements. )**

Please contact the Undergraduate Advising Office if you have any questions regarding this requirement.

## D. Requirements for a Degree with Honors

All candidates for graduation with honors must have a minimum of 48 graded credits in residence. Student with a QPA of 3.20 or better automatically graduate Cum Laude. In order to graduate Magna Cum Laude or Summa Cum Laude, a student must be enrolled in Commonwealth College and complete either Commonwealth College Honors, Commonwealth College Departmental Honors or Commonwealth College Interdisciplinary Honors. This section describes only the Departmental (Mathematics) Honors Program; for information on the other two options, please consult Commonwealth College.

Students are encouraged to join the Departmental Honors Program as soon as possible. The requirements for Departmental Honors are as follows:

1. **Completion of the Mathematics Major Requirements**
2. **The standard lower division Commonwealth College Requirements:**
   EnglWP 112H (or approved substitution or exemption); a GenEd Honors course; a GenEd "I" Honors Course; and the Dean's Book Series. A grade of B or higher is required for these courses to count towards Honors.

3. **Two Honors Math/Stat Courses at 400-level or higher with a grade of B or higher.**
   The Department offers several regularly scheduled 500-level Honors Courses. Alternately, a student may satisfy this requirement via Graduate Courses (600-level or higher) or Honors Independent Study Courses. Under exceptional circumstances, and with the prior approval of both the instructor and the Honors Coordinator, students may also obtain Honors Credit for a 400-level course by adding an Honors Colloquium.

4. **Honors Thesis with a grade of B or higher**
   This is the culmination of the Departmental Honors Program. Students are encouraged to fulfill this requirement by taking the Math 499C and Math 499D Capstone Course Sequence in their senior year. These courses will allow the student to participate in a group project on some mathematical topic (which will vary each year). Alternately, a student may fulfill this requirement via an Independent Study Thesis (Math 499Y and Math 499T) with a Department faculty member. For this option, it is the student's responsibility to find a faculty member willing to supervise their work; they are encouraged to have fiinalized the arrangements by the end of their junior year.

5. **Grade Requirements**

   (a) For graduate Cum Laude, an overall QPA of 3.20 is required.

   (b) For graduation Magna Cum Laude, an overall QPA of 3.50 and at least a B+ in Math 499C/D or Math 499Y/T.

   (c) For graduation Summa Cum Laude, an overall QPA of 3.80 and at least a A- in Math 499C/D or Math 499Y/T.

For further information or to join the Departmental Honors Program, contact the Department Honors Coordinator, Tom Weston.

# III. THE MINOR IN MATHEMATICS

The requirements for the minor in mathematics are:

1. **Grade Requirement**
   A cumulative quality point average of at least 2.00 in all Mathematics and Statistics courses taken is required. In the case of repeated courses only the improved grades will be used to compute this average.

No course used to satisfy requirements 2 through 5 below can be taken on a pass/fail basis.

2. **Calculus**
   Math 132-132 and Math 233 or the equivalent.

3. **Computer Science**
   Proficiency in a computer programming language. May be satisfied by Cmpsci 121, Cmpsci 187, EC-Eng 242 or equivalent.

4. **Linear Algebra**
   Math 235

5. **Upper-division Courses**
   Four upper-division courses of at least 3 credits each.

   At least **two** of these four courses must be taken in the Department. **One** of the four courses may be in a field other than mathematics or statistics - however, courses used for this purpose must be approved by the Chief Undergraduate Advisor (the general criteria are that the mathematical sciences content be of sufficiently high quality and quantity and that the course content not duplicate that of another course being used to satisfy this requirement).

A special note to Computer Science, Engineering, Chemistry and Physics Majors. Courses that you use to satisfy your major requirements may also apply toward this one upper-division course requirement of the mathematics major or minor. You are encouraged to contact Professor Norman for specifics.

The minor must be completed within the ten semesters allowed for the completion of all graduation requirements, including the major. During the student's final semester the Chief Undergraduate Advisor must be provided with a transcript in order that formal certification of completion of the requirements for the minor can be filed with the registrar. **A minor cannot be completed after graduation.**

**NOTE: To prospective minors. You cannot register for the minor unless you have completed all the requirements or you are in the process of completing them in the semester for which you apply for the minor.**

# IV. DEPARTMENTAL COURSES FOR MAJORS AND MINORS AND THEIR PROJECTED PATTERN OF OFFERING

| Course Number and Title | | Pattern of Offering |
|---|---|---|
| | **Lower-division Mathematics Courses** | |
| 131 | Calculus I | Fall, Spring, and Summer |
| 132 | Calculus II | Fall, Spring, and Summer |
| 132H | Calculus I (Honors) | Fall and Spring |
| 196 | Independent Study | By arrangement |
| 233 | Multivariate Calculus | Fall, Spring, and Summer |
| 233H | Multivariate Calculus (Honors) | Fall and Spring |
| 235 | Introduction to Linear Algebra | Fall and Spring |
| 291A | Problem Solving Seminar | Fall |
| 296 | Independent Study | By arrangement |
| 300 | Fundamental Concepts of Mathematics | Fall and Spring |
| | **Upper-division Mathematics Courses** | |
| 331 | Ordinary Differential Equations for Scientists and Engineers | Fall, Spring, Summer |
| 441 | Introduction to Math. of Finance | Fall, Spring |
| 396 | Independent Study | By arrangement |
| 397A | Mathematical Foundation of Act. Sci. | Irregular |
| 411 | Introduction to Abstract Algebra I | Fall and Spring |
| 412 | Introduction to Abstract Algebra II | Spring |
| 421 | Complex Variables | Fall and Spring |
| 425 | Advanced Multivariate Calculus | Fall and Spring |
| 455 | Introduction to Discrete Structures | Spring |
| 456 | Mathematical Modeling | Spring |
| 461 | Affine and Projective Geometry I | Fall |
| 462 | Affine and Projective Geometry II | Spring |
| 471 | Theory of Numbers | Fall |
| 475 | History of Mathematics | Irregular |
| 491A | Mathematics Majors' Seminar I | Fall |
| 492A | Mathematics Majors' Seminar II | Spring |
| 496 | Independent Study | By arrangement |
| 499P | Honors Thesis | By arrangement |

| | | |
|---|---|---|
| 499T | Honors Thesis | By arrangement |
| 499Y | Honors Thesis | By arrangement |
| 511 | Abstract Algebra I | Irregular |
| 523 | Introduction to Modern Analysis | Fall and Spring |
| 532 | Topics in Ordinary Differential Equations | Fall |
| 534 | Intro. to Partial Differential Equations | Spring |
| 545 | Linear Algebra for Applied Mathematics | Spring |
| 551 | Numerical Analysis I | Fall |
| 552 | Numerical Analysis II | Spring (Every other year) |
| 563 | Introduction to Differential Geometry | Spring, Irregular |
| 596 | Independent Study | By arrangement |

**Upper-division Statistics Courses**

| | | |
|---|---|---|
| 496 | Independent Study | By arrangement |
| 499P | Honors Project | By arrangement |
| 499T | Honors Thesis | By arrangement |
| 501 | Methods of Applied Statistics | Fall and Spring |
| 505 | Regression and Analysis of Variance | Fall |
| 506 | Design of Experiments | Spring |
| 511 | Multivariate Statistical Methods | Irregular |
| 515 | Introduction to Statistics I | Fall and Spring |
| 516 | Introduction to Statistics II | Spring |
| 596 | Independent Study | By arrangement |
| 597ABCD | Statistical Computing | Fall |

## A. Advice on Selecting Statistics Courses for Math Majors

Familiarity with statistics can open up a whole world of employment possibilities for students. The most obvious of these are the well established niches for statisticians such as the pharmaceutical industry, governmental agencies that measure and report data, etc. However, the purview of statistics is expanding more rapidly than ever. In recent years strong connections have been forged between statistics and finance and various branches of engineering and computer science such as machine learning, speech recognition, computer vision, data mining, neural networks and expert systems. In addition, the connection to medicine through statistical genetics represents what might be one of the most important contributions of statistics in the next century. For these reasons, a modicum of training in statistics can serve as springboard to many different career endeavors. We offer several different

suggestions for students depending on the emphasis they expect to place on statistics.

While we do not have an official concentration in statistics, we propose the following for students whose primary focus is statistics.

- **Junior Year** Stat 515-516
- **Senior Year** Stat 505 and/or Stat 506 and/or Stat 511

Stat 515-516 provides a serious calculus-based introduction to probability and statistics. Stat 505 (Applied Regression) and Stat 506 (Applied Experimental Design) introduces the student to the more applied side of statistics including an exposure to the role of computation. We recommend that one or both of these be the first choice, with Stat 511 (Multivariate Statistics) being the last choice.

For student seeking a less comprehensive exposure Stat 515-516 is the best choice. If a student wants only one course, the choice is between Stat 515 (much of which focuses on probability and distributions and actually does very little statistics) or Stat 501 (a very applied course focusing on statistics and data analysis, incorporating computing using Minitab). Stat 501 can serve as a basis for moving on to further applied courses.

The listed prerequisite for ST505 and 506 is successful completion of either Stat 501 or Stat 516. The only sequences of courses that should be regarded as satisfying the upper level requirement are the ones below. While the strong student can make the jump from Stat 501 to Stat 505 or Stat 506, the 501-505 and 501-506 sequences are not generally recommended.

- Stat 515-516
- Stat 505-506
- Stat 501-505
- Stat 501-506

# V. ADVANCED PLACEMENT CREDIT IN MATHEMATICS

Any student who earns a score of 4 or 5 on the College Entrance Examination Board (CEEB) Advanced Placement Calculus BC Test will receive 8

advanced placement credits and exemption from Calculus I and II.

Any student who earns a score of 4 or 5 on the CEEB Advanced Placement Calculus AB Test will receive 4 advanced placement credits and exemption from Calculus I.

Any student who has taken calculus in high school but either has not taken the CEEB Advanced Placement Calculus AB or BC Test or else has taken one of these tests and failed to earn a score of 4 or 5 can earn credit by passing with a grade of C or better, the first time it is taken, a college calculus course more advanced than beginning calculus. In this case the credit awarded will be equal to the credit given for the course(s) skipped. To receive this credit the student must report to the Mathematics Advising Office, LGRT 1521E, after passing the course and bring along proof of its successful completion in the form of a grade report or transcript.

**NOTE:** The Department of Mathematics and Statistics **does not** credit on the basis of a student's score on the Mathematics Placement Examination or on the Basic Mathematics Skills Exemption Examination.

# VI. OPPORTUNITIES FOR UNDERGRADUATE MAJORS

## A. Math Club

The Math Club is a group open to all undergraduates who are interested in math or math related subjects. The club organizes talks, films, contests, problem and help sessions, information meetings on courses, jobs and anything else that might come up. The Mathematics Department sponsors the club and provides resources for the club including a graduate student advisor. The club meets weekly. For more information contact Penny Ridgdill: her email is ridgdill@math.umass.edu. The URL for the web page of the math club is: www.math.umass.edu/ridgdill/mathclub.html.

## B. Research Experiences for Undergraduates (REU)

Each summer a few undergraduate students undertake a research project mentored by a faculty member. These are paid full-time positions. In the past students have worked on questions in number theory, differential geometry, topology, complex variables, wavelets, and analysis. Some of these

projects have resulted in presentations on the web. All of the sites for REU programs can be found at:
www.nsf.gov/hom/crssprgm/reu/reu98dms.htm

## C. Mathematical Competitions

### 1. Annual Mathematics Competition

The Henry Jacob Mathematics Competition was started in 1986. It is open to all freshmen and sophomore degree students on the Amherst campus of the University of Massachusetts, **except** for Continuing Education students. Problems on the two-hour test given in the spring semester are taken from precalculus and calculus, allowing freshmen to compete on the same level as sophomores. The first, second, and third place awards were $1600, $1000, and $400, respectively.

For more information, contact then Mathematics Department at 545-2762.

### 2. Annual Putnam Mathematical Competition

The William Lowell Putnam Examination is a competitive examination in collegiate mathematics held under the auspices of the Mathematical Association of America. It is given in December of each year to contestants from colleges and universities in the United States and Canada. Cash prizes and scholarships are awarded to winning individuals and teams. Moreover, the names of the contestants who do well are published, and doing well is very helpful in getting into some graduate schools and receiving fellowships.

The University of Massachusetts usually enters a team in the competition along with a number of individual contestants. Since the problems on the Putnam Examination are quite different from those encountered in the usual undergraduate courses in mathematics, the University of Massachusetts (like many other schools) has a special course, Math 291A, to help prepare students to take this examination and to help the Department select its team. This course describes a number of general methods of attacking problems and gives the student a great deal of practice in solving a wide variety of interesting and unusual problems; in addition, it carries one credit, may be repeated for credit, has no prerequisites, and is open to any undergraduate. Many students find that Math 291A is an extremely fascinating, fun course and one that is useful in rounding out their mathematical training.

For more information, contact Professor Haskell Cohen,
email haskell@math.umass.edu

# VII. COMPUTER FACILITIES

For class use, the Department has a computer-equipped video projection room in LGRT 219; a new 20 station computer lab for classes in LGRT 110 that also functions afternoons and evenings as a drop-in help center for certain lower-level courses; and portable computer and projection equipment for several other locations.

# VIII. STUDENT MEMBERSHIPS IN PROFESSIONAL ORGANIZATIONS

## A. Student Chapter of the Mathematical Association of America

The mathematical Association of America (MAA) is the largest professional organization in the world devoted to mathematics at the college level. Its long-range goals are to promote excellence in the teaching of mathematics, to cultivate mathematical talent, and to enhance public awareness of mathematics. It currently has some 34,000 members, approximately 20% of whom are students.

The Department has a charter student chapter of the MAA and encourages its majors to become members. Among the many valuable benefits enjoyed by student chapter members are a free subscription to FOCUS (The newsletter of the MAA), career information, help with job placement or graduate applications, contact with the mathematics community, opportunities to meet students with similar interests, and eligibility for travel grants to meetings and special conferences.

Application forms can be obtained from Christine Richotte, LGRT 1521E, and further information about the MAA can be obtained from the Chief Undergraduate Advisor, LGRT 1521E, tel. 545-2282.

### B. National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics (NCTM) is the largest organization in the world dedicated to the improvement of mathematics education and to the needs of teachers of mathematics.

Mathematics majors interested in becoming teachers are encouraged to become student member of NCTM. Members receive subscriptions to the NCTM journal MATHEMATICS TEACHER and/or the NCTM journal ARITHMETIC TEACHER, and they receive a newsletter, as well as notices concerning special meetings, workshops, etc. Membership application forms can be obtained from Christine Richotte, LGRT 1521E, and additional information about NCTM can be obtained from the Chief Undergraduate Advisor, LGRT 1521E, tel. 545-2282.

## IX. CAREER OPPORTUNITIES FOR MATHEMATICS MAJORS

In the past half century there has been a noticeable increase in the importance of mathematics to our society. The need for trained mathematicians at all levels is on the rise as the use of computers and automation has spread to almost all sectors of our economy. Solutions of many technological and engineering problems on which our survival quite literally depends will involve a high level of mathematical thought. Today, someone entering business or government will be expected to know far more mathematics than was expected of the college graduate ten years ago. This is especially true of professionals working in the biological and social sciences, as well as of those working in finance and business management.

There are many different areas of business where mathematical training is essential. Actuarial work, production management, and business forecasting are but a few. A major in mathematics, focusing on statistics, augmented by a minor in computer science and by courses in accounting, economics, general business finance, or industrial engineering, for example would provide a solid basis for a business career.

A mathematics major who wishes to prepare for a career in a government agency, such as the National Security Agency or the Department of Defense, or in a technically-related or service-oriented industry would do well to focus

on statistics and applied mathematics and to complete a minor in computer science.

There is a demand for qualified mathematics teachers in the nation's secondary schools.

Advanced work in mathematics and/or statistics should make for more attractive employment opportunities. Most Ph.D.s find employment in academic positions, while those holding Master's degrees usually take positions in government or industry.

Finally, it should be noted that a significant number of students with an undergraduate major in mathematics go on to graduate or professional degrees in fields other than mathematics. Recent majors have pursued graduate work in business, law, computer science, operations research, philosophy, biostatistics, medicine and oceanography.

Further information or advice regarding careers in mathematics and the mathematical sciences, including graduate work in mathematics and/or statistics, can be obtained from the Chief Undergraduate Advisor, Professor Peter Norman, LGRT 1521E, tel. 545-2282, email: norman@math.umass.edu and from the Campus Career Network office.

# X. WEB SITES ON CAREERS IN MATHEMATICS

**Actuarial Science**
Web Sites: http://soa.org/
http://BeAnActuary.org/
http://www.soa.org/eande/index.asp (This site has information on actuarial examinations.)

**Applied Mathematics**
www.siam.org/careers

**Careers for Women in Mathematics**
http://www.awm-math.org/ctcbrochure/toc.html
http://www.awm-math.org

**Careers in Mathematics**
http://www.ams.org/careers]

**Careers in Statistics**
http://www.amstat.org/careers/

**Careers in the Mathematical Sciences**
http:// www.maa.org

**Others**
http://www.math.ohiou.edu/math/alumni99.html. This is alumni news and gives ideas by giving people's job history.

# XI. SUGGESTED ELECTIVES FOR MATHEMATICS MAJORS WITH INTERESTS IN VARIOUS FIELDS

It is **essential** that all mathematics majors learn some probability and statistics, become acquainted with computers, and study other fields where mathematics plays a significant role.

The following are recommendations for elective courses to be taken by mathematics majors with interests in various fields.

## A. Actuarial Science

Actuaries are business executives who use mathematical skills to define, analyze, and solve complex business and social problems arising in the insurance and pension fields. They create and manage programs to reduce the financial impact of expected and unexpected events such as illness, accidents, unemployment, or premature death. Actuaries must understand the entire operation of the insurance and pension fields because their evaluations often influence company policies and practices. The actuary has a good command of applied mathematics and statistics, financial markets, tax and insurance law, regulatory requirements, accounting, etc.

Professional status is attained through fellowship in one of the actuarial societies. Fellowship is earned, and most of the theoretical training is provided,

by passing a series of rigorous examinations sponsored by the societies.

Mathematics majors who are interested in the actuarial field should include courses in finance, economics, computing, operations research, and communication skills in their program. The Web site below has information.

www.soa.org

For additional information, advice, and assistance, contact: Professor Peter Norman, LGRT 1521E tel. 545-2282.

## B. Computer Programming and Data Processing

It is convenient to consider two levels of proficiency.

### 1. Application Programmers

Application programmers are professional programmers who tailor existing algorithms to fit the specific needs of their employer. Courses in economics and management (accounting, finance, etc.) are also useful.

### 2. Systems Programmers and Prospective Computer Science Graduate Students

Systems programmers normally do graduate work in computer science. They should plan on thorough coverage of the material in above. Successful completion of a major in mathematics and a minor in computer science is good preparation for the graduate program in Computer Science.

For further information, contact:
Professor Murray Eisenberg, LGRT 1335G, Tel. 545-2859, email murray@math.umass.edu.

## C. Graduate Study in Mathematics

A terminal Master's degree can lead to a wide variety of nonacademic positions if the degree program is oriented toward applications, or a teaching position at the high school or community college level. Most new Ph.D's in mathematics find employment in academic institutions, while some take positions in government, business, or industry.

There are about 1500 colleges and universities in the United States, most of which seek people with a Ph.D. to fill faculty positions involving varied mixtures of teaching and research responsibilities. This job market has been tight in recent years, but is showing improvement due to a nationwide wave of faculty retirements coupled with growth in the traditional college-age population. Those who go into graduate programs intending to teach at the college level need to acquire the broadest possible foundation in both theoretical and applied subjects, along with experience in communicating mathematics, in order to compete successfully in this market.

The growth of microelectronics, computers, and other information-age technologies, along with financial services, has produced a strong demand in the nonacademic world for mathematically trained persons who are willing to apply their skills to technical problems. Employers are still reluctant to hire mathematicians whose interests are purely theoretical. But for those who have prepared themselves well, having gained a broad background not only in mathematics but also in some allied fields, many opportunities are now available.

### 1. Pure Mathematics

For a student planning to do graduate work in pure mathematics, the following courses are recommended: Math 411-412 (Introduction to Abstract Algebra) or Math 511-512 (Abstract Algebra). Math 421 (Complex Variables), Math 425 (Advanced Multivariate Calculus), Math 523 (Topics in Ordinary Differential Equations), Math 534 (Introduction to Partial Differential Equations), Math 545 (Linear Algebra for Applied Mathematics), and Math 563 (Introduction to Differential Geometry).

Talented students should also consider participating in the Mathematics Honors Program or enrolling in beginning graduate level courses such as Math 611 (Algebra I), Math 671 (Topology I), or Math 621 (Complex Analysis). A qualified undergraduate may register for a graduate course in mathematics, subject to the permission of the instructor of the course, the Graduate Program Director, and the student's advisor.

Since many graduate schools require some reading knowledge in a foreign language, it is suggested that this proficiency be acquired as part of the undergraduate program. The recommended languages for mathematics majors are French, German, and possibly Russian.

### 2. Applied Mathematics

Many, if not most, of the great classical mathematical ideas arose in connection with applied problems. With the current surge in technological development, there is a large variety of mathematical problems originating not only in the traditional areas of physics and engineering (e.g., fluids and other materials, remote sensing, meteorology, aerospace) but also in such diverse fields as computer science (e.g, security of data, data compression), biology (e.g., biofluid dynamics, genetics), ecology (e.g., competition among species) and finance (e.g., options pricing). The problems are of substantial mathematical interest and often are amenable only to numerical solution on large-scale computers. Students interested in applied mathematics should develop strength in applied analysis, scientific computing and related areas: Math 425 (Advanced Multivariate Calculus), Math 331 (Ordinary Differential Equations for Scientists and Engineers), Math 551-552 (Scientific Computating/Numerical Analysis I and II), Math 532 (Topics and Ordinary Differential Equations), Math 534 (Introduction to Partial Differential Equation), Math 545 (Linear Algebra for Applied Mathematics) and Stat 515-516 (Introduction to Statistics I and II). Topics in more "pure" areas are often highly useful: Math 411-412 (Abstract Algebra I and II), Math 421 (Complex Variables) and Math 523 (Introduction to Modern Analysis).

Talented students interested in applied mathematics should also consider participating in the Mathematics Honors Program (see section II, C) or enrolling in beginning graduate level courses such as Math 651 (Numerical Analysis I), Math 697P (Mathematical Methods in Engineering I) Stat 607 (Mathematical Statistics I ) or Math 621 (Complex Analysis).

Since applied mathematicians, either in industry or in the academic world, will work on problems formulated outside of mathematics, it is important that they learn something of the fields from which the applications arise. Students can prepare for this by taking courses in engineering, physics, biology, etc.

## D. Industrial Work

Mathematicians in this category are frequently associated with a mathematical consultant group that is part of a large industrial firm. Because of the computer revolution, it is strongly recommended that students desiring this type of employment receive a solid background in computer programming

(see Part C, section 1). Students who combine applied mathematics courses with courses in computer programming, numerical analysis, computational modeling, differential equations, statistics, and probability frequently obtain stimulating positions.

General areas of possible industrial employment include planetary exploration (NASA and contractors), high-technology industries (many located in Massachusetts), missile guidance systems (U.S. military contractors), energy conversion, and operations research. Since the specific work a person does will vary a great deal from one industry to another, the student should try to obtain general understanding of those branches of mathematics applicable to physical problems. Courses in applied mathematics, as well as those listed below, will help the student reach this goal.

| | |
|---|---|
| Physics 261 | General Physics III |
| Physics 283 | Physics III |
| Chem 111 | General Chemistry for Science and Engineering Majors |
| ECE 211 | Circuit Analysis I |
| ECE 212 | Circuit Analysis II |
| MIE 379 | Operations Research I |
| MIE 380 | Operations Research II |
| MIE 230 | Thermodynamics I |
| MIE 330 | Thermodynamics II |
| CmpSci 121 | Introduction to Problem Solving with Computers |
| CmpSci 187 | Programming with Data Structures |
| CmpSci 287 | The Structure and Interpretation of Computer Programs |
| CmpSci 320 | Intro. Software Engineering |
| CmpSci 377 | Operating Systems |

For more information contact:
Professor Nathaniel Whitaker, LGRT 1424, tel. 545-1572,
email whitaker@math.umass.edu

## E. Probability and Statistics

Statistics is now used in business, industry, government, and virtually every field of science. Consequently, some training in statistics, probability, and computing is likely to enhance considerably your job opportunities after graduation, especially in insurance and actuarial work, in the pharmaceutical industry, in other businesses, and in government. A master's degree in

statistics offers good employment opportunities. In addition to taking basic courses in statistics (e.g. Stat 515, Stat 516, etc.), students interested in probability and statistics should make sure that their background in calculus (including advanced multivariate calculus) and linear algebra is strong, since these are the most important mathematical tools in statistics. These courses will also be indispensable for students going on to graduate school in mathematics or statistics.

For more information contact:
Professor John Buonaccorsi, LGRT 1435K, tel. 545-2809
email johnpb@math.umass.edu

## F. Secondary School Teaching

Mathematics Majors wishing to obtain the intermediate equivalent of the Massachusetts certification to teach mathematics at the middle or high school level must include in their program courses that satisfy the Commonwealth's Standard I requirements on subject matter knowledge, must complete the School of Education's Secondary Teacher Education Program and must achieve a passing score on both sections of the Massachusetts Educator's Certification Test (MECT).

Any student who is interested in becoming a middle or high school mathematics teacher should contact the Secondary Education Advising Office, 121 Furcolo Hall, tel. 545-4397 or stepadv@pdvc.umass.edu. Application to the program should be made as soon as possible. The application deadline is March 1st for undergraduates (for Fall admission). The following policies concerning admission to preparation programs for educators and admission to the practicum are in response to Federal Title II and Commonwealth of Massachusetts guidelines. The policies are effective for candidates entering the programs in September 2000 and thereafter.

**Admission to Program.** In addition to meeting other University, College, School of Education, and individual program admission criteria, undergraduate students must achieve a passing score on the Communication and Literacy Skills Test of the Massachusetts Educator Certification Tests (MECT) prior to admission into professional preparation programs for educators.

**Admission to Practicum.** In addition to meeting other preparation program requirements, each student in a program for which there is an MECT

Subject Test must pass the appropriate Subject Test as a prerequisite for enrolling in his or her practicum. (If the student's program requires two practicums, the student must pass the Subject Test before his or her second practicum begins.)

The school of Education's Secondary Teacher Education Program includes student-teaching which requires a full semester during which regular courses cannot be taken. Consequently, students interested in teaching should plan to get most of their requirements out of the way before their student-teaching, and they should take note of the fact that they will have one less semester to satisfy Departmental, College, and University requirements.

The Commonwealth's **Standard I Subject Matter Knowledge** for mathematics states:

- "The effective teacher of mathematics has completed the college's or university's requirements for a major in mathematics, or the equivalent, by demonstrating knowledge of:

1. mathematics, including: algebra, geometry, analytical geometry, trigonometry, calculus, number theory, probability and statistics, and the history of mathematics:
2. how to use computers in mathematics;
3. modes of inquiry and methods of research in mathematics;
4. relationships between mathematics and other fields of knowledge"

Shown below is, for each of these requirements, a list of the courses that can be used to satisfy it. The recommended course is underlined.

1. Mathematics
   (a) algebra, analytical geometry, trigonometry, calculus: Math 233
   (b) geometry: Math <u>461</u>, 462
   (c) number theory: Math 411, <u>471</u>
   (d) probability and statistics: Stat <u>501</u>, 515
   (e) history of mathematics: Math 370, 461, <u>475</u>

2. How to use computers in mathematics: Math 451, 503, Educ 597O: Teaching Math with Computers

3. Modes of inquiry and methods of research: Math 300, 411, 456, 523

4. Relationships between mathematics and other fields: Physics 151-153 or 171-173, or Math 331, Math 456. Also Math 532, 534, 545.

Completion of the School of Education's Secondary Teacher Education Program (STEP) for Prospective Middle and High School Teachers of Mathematics requires the following courses:

Students may enroll in 1)-3) below prior to applying to STEP: in 4)-7) the student must be a STEP student prior to enrolling.

| | | |
|---|---|---|
| 1) | Educ 524 | Work of the Middle and High School Teacher (3 credits) |
| 2) | Psych 305 | Educational Psychology - or an alternative course option Psych 355 - Adolescent Psychology Educ 693I - Psychology in the Classroom (3 credits) |
| 3) | Educ 497I | Tutoring in Schools - or an alternative course option |
| 4) | Educ 592S | Pre-Practicum (2 credits) |
| 5) | Educ 511 | Teaching Mathematics in Middle and High School (3 credits) Math-Methods - taught in Fall only |
| 6) | Educ 510 & 615J | The Teacher in the Classroom (2 credits) Education and the Law (1 credit) Taken while student teaching) |
| 7) | Educ 500M(503) | Student Teaching (5-9) or |

| | |
|---|---|
| Educ 500S (504) | Student Teaching (9-12) or Both<br>for 5-12 certification (12 credits) |

Further information concerning these admission policies may be obtained by contacting the director of the professional preparation program in which a student is interested or contacting the Office of Teacher Education, School of Education, 125 Furcolo Hall (413) 545-2701 or STEP information office, 121B Furcolo Hall (413) 545-4397 or Professor Peter Norman, LGRT 1521E, tel. 54-2282, email norman@math.umass.edu.

# XII. CO-OPS AND INTERNSHIPS

Co-ops and internships offer students the opportunity to work in occupations they might be interested in pursuing after graduation. Besides gaining first-hand information about these occupations prior to graduation, students gain valuable work experience, establish links to the professional world, and usually clarify their academic and career goals.

Co-ops are primarily full time positions for which students receive pay but no academic credit. Internships may be full-time or part-time, always carry academic credits and are sometimes paid.

Information on Departmental requirements for co-ops and internships can be obtained from the Chief Undergraduate Advisor, Professor Peter Norman, LGRT 1521E, tel. 545-2282, email norman@math.umass.edu.

# XIII. MISCELLANEOUS INFORMATION

## A. Approval of Courses To Be Taken at Other Schools

Students who wish to take courses at other institutions during the summer months or while on leave from the University, either to help them fulfill requirements or to make them eligible for an earlier graduation date, MUST have their proposed course of study evaluated IN ADVANCE. Mathematics majors planning to use courses to be taken at other schools to satisfy Departmental graduation requirements must obtain prior approval of these courses with the Chief Undergraduate Advisor:

There are three different prior approval forms:

### 1. Prior Approval Form

This form is to be used by those students who intend to fulfill degree requirements through the completion of courses at other institutions (including other UMass campuses and the National Student Exchange Program) or through the College Level Examination Program (CLEP). The form is available in the Records Office, 207 Whitmore and requires the approval of the Chief Undergraduate Advisor (for courses to be used to satisfy Departmental graduation requirements), Transfer Affairs (for courses to be used for elective credit and/or to fulfill University General Education requirements), a CASIAC dean (for Foreign language courses to be used to satisfy the College of Arts and Sciences' Foreign Language Requirement), and an academic dean (for students on academic probation or suspension).

**NOTE:** The Office of Transfer Affairs' signature is required on all Prior Approval forms.

Student who **expect to complete** degree requirements by taking the proposed course(s) or who are participating in an international exchange or study abroad program should process the form(s) described in 2 and/or 3 below, **not** the Prior Approval form.

### 2. Prior Approval Form for Completing the Senior Year in Absentia

This form is to be used only when the student has accumulated 90 or more credits and intends to **complete** degree requirements or do any portion of the senior year while not in regular attendance at the University, i.e., by taking courses at other institutions (including other UMass campuses), by taking courses by examination, or by earning CLEP credits. This form is available in the Records Office, 207 Whitmore, and requires the approval of the Chief Undergraduate Advisor, an academic dean, and the Office of Transfer Affairs.

### 3. International Program Prior Approval Forms

Students planning to study abroad must file an International Preliminary Registration/Approval form before they depart for study abroad and a Transfer of international Credit form after they return. Both forms are available in the International Programs Office, William S. Clark International Center, Goodell Building, tel., 545-2710, and require the approval

of the Chief Undergraduate Advisor (for courses to be used to satisfy Departmental graduation requirements), a CASIAC dean (for courses used to satisfy College requirements), the Office of Transfer Affairs (for courses to be used for elective credit and/or to fulfill University General Education requirements), and the International Programs Office.

In addition, students spending any part of their senior year abroad must file a Prior Approval Form for Completing the Senior Year in Absentia. This form is described in 2 above.