DEPARTMENT OF MATHEMATICS
MILLERSVILLE UNIVERSITY

2019-20 STUDENT HANDBOOK
FOR MATHEMATICS MAJORS AND MINORS

Contents

Welcome to the Mathematics Department at Millersville University

Wickersham Hall:

The home for all mathematics professors' offices and all mathematics courses for majors is Wickersham Hall.

You may find the following information to be helpful.

- Get to know your professors, locate their offices and visit them during office hours
- The building has Wifi hubs throughout the building
- A 35-station computer lab is located in room 108
- Room 107 & 204 are Quiet Student Study Rooms
- The Mathematics Assistance Center, room 100, offers free drop-in tutoring – hours will be posted after the first week of classes.
- The department office is located in Wickersham 208

Your Faculty Advisor:

Although it is ultimately your responsibility to make sure that you meet all program requirements to obtain your degree, you have been assigned a faculty advisor who can help you to make appropriate choices. Feel free to use your advisor often. He/she has access to your Degree Audit Report (DARs), which provides a complete record of your academic progress (courses, grades, etc.). He/she is kept officially informed of all university and department regulations. Your advisor can help you plan a program of study tailored to meet your needs. You need to meet him/her before registration to plan your courses and to receive your Term Advisement Pin (TAP), to sign course withdrawal forms, **and your application for graduation**. Schedule an appointment with your advisor before your time for registration each semester. In addition, visit him/her whenever you have any questions about academic policies or when you are considering any change of plans. Do not rely on your intuition or advice from other students. Go to your faculty advisor for help on all curricular matters.

I. THE FIELD OF MATHEMATICS IN A CHANGING WORLD

A General Perspective

Mathematics is one of the oldest of human intellectual achievements, and yet it also one of the most contemporary. From very primitive beginnings, it has developed into a field so vast and complex that it is now quite difficult for anyone to comprehend more than a relatively small portion of the total field. Today the applications of mathematics are so numerous and far-reaching that virtually every area of human intellectual activity has come under its influence. Increasingly, we are living in a mathematical age.

Modern technology is heavily dependent upon mathematics. Almost everyone in today's high technology workforce is required to use some mathematics, although often only in a limited, specialized form. The type and extent of the mathematics used varies greatly from job to job. There are relatively few true "mathematicians" -- people who are occupied chiefly by doing mathematics. More commonly, mathematics is only one part of a job. In fact, an employer may even prefer to call its mathematicians by another name, such as engineer, analyst, statistician, or actuary.

Through training in mathematics, one develops valuable skills in quantitative thinking, logical analysis, and problem solving. These skills are important in a wide variety of jobs. A college degree in mathematics does not limit the graduate to a specific area of employment. It is rather a general foundation upon which graduates may develop a variety of career options. These options include areas that are only indirectly related to mathematics.

Of those people who call themselves mathematicians we may distinguish three categories: pure mathematicians, applied mathematicians, and mathematics educators. The pure mathematician is concerned chiefly with mathematical theory. He/she produces new mathematics by observing or creating new abstract patterns and/or by proving new theorems about existing theory. He/she is responsible for developing and interrelating ideas, rather than for applying them to the practical world. Most pure mathematicians are found on college and university faculties.

The applied mathematician has a very different task. Armed with an understanding of the relevant mathematical techniques, he/she must be able to analyze a "real world" problem, translate it into a mathematical framework, solve the abstract problem, and then interpret the solution to the management or client who posed the problem. Often the solution must be explained to people who do not understand the mathematics used. Thus, the applied mathematician must also be skilled at communication.

The mathematics educator is someone who is trained in mathematical content with an emphasis in the utilization of various and effective pedagogy (teaching strategies). He/she may serve as a teacher in the K-12 school system, in a supervisory or mathematics specialist position, or as a professor at the college level. We have all experienced being taught mathematics, and are thus well aware of the need for effective teaching. If civilization as we know it is to survive and flourish, its accumulated mathematical wealth must be passed on to the younger generations by a meaningful, relevant, knowledgeable, creative and sympathetic teaching profession.

At Millersville, the mathematics offerings are designed to be consistent with the general perspective described above. For the major, we offer a wide assortment of courses. Whether interested in pure mathematics, applied mathematics, or mathematics education, a student can put together a program of study that amply fulfills his/her educational and career goals. We also offer a large number of courses that are taken by students other than math majors -- provided as a service to other departments.

II. CAREERS FOR A MATHEMATICS MAJOR

A. General Remarks

The jobs available to college mathematics graduates are quite varied and somewhat surprising. By its very nature, mathematics is a most general subject. This generality is the source of its applicability. Indeed, no other scientific field has such universal applicability.

Because of this generality, a college degree in mathematics is not necessarily intended to prepare a student for a specific job. Instead, a college mathematics program is designed to develop the student's skills in quantitative thinking, pattern recognition and analysis, rigorous logical deduction, and problem solving--and to teach the student some classical mathematical theory and techniques of generally recognized importance. Employers in a variety of fields welcome applicants with this type of versatile background.

In seeking employment, the college graduate must demonstrate his/her maturity, depth of knowledge, and readiness to accept specific on-the-job training. It is often said that a college degree signifies that the graduate has "learned how to learn". It is not likely that a mathematics graduate will find a job that involves only mathematics, or even that precisely "fits" his/her training. More likely, the job will involve doing something related to mathematics, in which mathematical training is necessary but not sufficient in itself. It may require learning about a previously unfamiliar area of application. Thus, in looking forward to future employment, a student should develop flexible career goals. In addition to acquiring a solid mathematical training, he/she should take courses in computer science and one or more areas of potential application, and should cultivate good communication skills.

B. Careers in Industry

A mathematician in industry is hired because he/she can contribute, as an intelligent member of a team, to some on-going problem or function of the industry. The company specifies the problem and the employee works within these specifications.

The company often supplements the employee's general education with more specific on-the-job training. This may include advanced-level academic work, especially if the employee demonstrates unusual motivation, dedication and promise. The more interesting and responsible jobs may require a master's or doctoral degree.

Several broad categories of job opportunities for mathematicians in industry may be identified:

1. Statistics

Efficient, selective collection of accurate data and correct statistical analysis of that data are essential for the successful operation of a modern business or industry. This involves design of experiments, studies of product reliability, and forecasting market trends. Only a highly trained statistician is qualified to do this.

2. Operations Research

This very rapidly growing field uses a great deal of mathematics. Calculus, linear algebra, statistics, probability, combinatorics, graph theory, optimization theory, and computer

science are all combined to form a mathematical theory of optimal decisions. A master's degree is recommended.

3. Traditional Applied Mathematics

Physical sciences and engineering have always required extensive use of mathematics and mathematicians. Practically all areas of mathematics are used, but especially "applied analysis": calculus, linear algebra, differential equations, numerical analysis and computational techniques. To get into advanced problems, at least a master's degree is required.

4. Management

The rigorous thinking, analytical skills, and problem solving experiences that the typical college mathematics major has developed may qualify him/her for a career in management. This is especially true for a student who possesses leadership abilities and has taken related courses in economics and business administration. Many Masters degree programs in business administration specifically invite applicants who have a bachelor's degree in mathematics.

5. Computer Mathematics

Almost every industry makes extensive use of computers, and needs people who can communicate correctly and efficiently with a computer. Anyone who expects to work as a mathematician in industry should have significant computer experience. For a student with only a bachelor's degree, this area of employment is one of the more readily available.

C. Mathematicians in Government Agencies

Federal, state and urban governments employ many mathematically trained people. At the beginning levels of employment, the mathematical work may be primarily computational. All of the categories of mathematical work listed under "Careers in Industry" apply equally to government work. In addition to government agencies which are involved in scientific and engineering work, there are agencies devoted to human services. The human service agencies make extensive use of statistics and operations research. Several "intelligence" agencies actively recruit mathematics graduates.

The major difference between employment in industry and government is the employment structure. One generally enters government service through civil service examinations. Salaries and advancement procedures follow nationwide or statewide regulations. This creates both job security and some inflexibility. As the employee is promoted through the ranks, his/her responsibilities tend to become more administrative.

D. The Actuarial Profession

An actuary is a specialized mathematician working in one of the various areas of insurance and pensions. The success or failure of an insurance company is dependent upon its actuaries, who use sophisticated mathematical probability theory and statistics to determine premium rates and commit their companies to long-term financial obligations. They must take into account the risk being underwritten, the changing patterns of public needs, the need for fair and competitive prices, and the financial well-being of their company.

An actuary belongs to an organized profession, which has its own advancement structure. Professional status is achieved by becoming a member of the Society of Actuaries or the Casualty Actuary Society. Membership and promotion in either society is through a series of nine examinations. The first exam is typically taken during the junior or senior year of college. Before applying for a position as an actuary (entry level), one should pass at least one of these exams. Anyone who passes these exams is commonly in demand by employers. Once employed, the actuary receives on-the-job education, which allows him/her to prepare for the remaining exams.

E. Teaching Mathematics

A very large number of mathematicians have traditionally been employed in the teaching profession, and this is likely to remain true in the foreseeable future. This profession is a very broad one, with a great diversity of positions and work loads.

1. Teaching in a Secondary School (Senior High, Junior High, or Middle School)

Teaching mathematics can be an exciting and rewarding career. Over the years Millersville University has developed an outstanding reputation throughout its service area and beyond for its strong program of preparing secondary school mathematics teachers. Our graduates hold responsible positions in many senior high, junior high, and middle schools located over a wide region. Because of the excellence of our mathematics education program, our graduates compete quite successfully everywhere openings exist.

2. Teaching in a Two-Year College

The essential criterion for employment as a teacher in a two-year college is a Master's degree in mathematics or mathematics education. In many community colleges, the mathematics courses are largely remedial--for students who need to learn (or relearn) elementary mathematics before going on to college-level courses. Because of the wide variety of student backgrounds and abilities, many experimental, individualized and non-traditional teaching techniques are often used. This may be one of the most fascinating aspects of the job. Teaching loads tend to be lighter than in secondary schools but heavier than in four-year colleges.

3. Teaching at a College or University

The university faculty position is the traditional goal of the mathematician who wishes to pursue creative research in pure mathematics and of many who pursue research in applied mathematics. A professor at a major research-oriented university spends roughly half of his/her time in tasks related to teaching and the other half in mathematical research. The Ph.D. degree is mandatory. It is not advisable for a student to pursue this goal unless he/she is very talented and exceptionally dedicated. Although there has been a steady decline of American students seeking the Ph.D. degree in mathematics, there has been increasing competition from foreign Ph.D.'s seeking to fill a fairly steady number of job vacancies. While the long-term projections remain positive, recent financial crises at both state and private colleges and universities have led to some uncertainty for those pursuing this career option. Again, long-term projections are optimistic and talented students should be encouraged to consider this path.

Additionally, students with a commitment to teaching who have earned a Bachelor’s and/or Master’s degree in mathematics education can also seek the Ph.D. degree in mathematics education with a potential goal to teach at the university level; persons with such degrees are currently in great demand. Such professors often work extensively with the training of future and current teachers in the local school systems.

The smaller university or four-year college faculty positions are similar to the research university positions, except that the teaching load is heavier, there is less time available for carrying on research, and there are fewer higher-level courses available to teach. A faculty member at a college or university is able to participate in a stimulating intellectual, cultural and social milieu.

F. Mathematics in Medicine

The field of medicine is increasingly relying on support from mathematics, statistics, and computer science. Current medical research requires staff and consultants who can employ the latest mathematical, statistical, and computer techniques in studying and analyzing behavior of the human organism, both normal and pathological. Mathematics and computer science are also important in the study and reorganization of health delivery systems.

G. Careers Outside Mathematics

It is a mistake to think that a college major in mathematics must be followed by a career of "doing" mathematics. There are many professional opportunities open to graduates who wish to use their mathematical preparation as a springboard to another field. The legal profession is a post-graduate field, and a major in mathematics can serve quite well as preparation. Business Administration or Economics are other areas where a mathematics graduate may find a career. His/her experiences with quantitative thinking and problem solving may prove invaluable in a managerial position involving mathematically based decision making. Naturally, it is advisable for students who contemplate future employment in business administration to take as many courses in economics, business and computer science as possible. At present, the Master's degree in Business Administration (M.B.A.) is a very popular degree. Many highly respected M.B.A. programs actually state in their advertising literature that a bachelor's degree in mathematics is a desirable preparation for their program. Banking and urban planning are other areas where a graduate, especially one with computer knowledge, may find a rewarding career.

III. MATHEMATICS DEGREE PROGRAMS AT M. U.

BACHELOR'S DEGREE PROGRAMS:

The Department of Mathematics at Millersville University offers the following bachelor's degree programs:

(1) Bachelor of Arts (B.A.) in Mathematics

(2) Bachelor of Science (B.S.) in Mathematics

(3) Bachelor of Science in Education (B.S.Ed.) (Mathematics major; Secondary Education)

Both the B.A. and B.S. degree programs allow considerable freedom of choice, within the major and without. The B.S.Ed. program in mathematics, however, has less latitude because one entire year is devoted to field placements and student teaching. These programs are described in detail in the next few pages.

ELECTIVES:

Students should be aware of the importance of choosing their electives wisely. Those who are preparing for a career in applied mathematics are advised to develop some interest and knowledge in one or more "related areas", which will make them attractive to an employer. Knowledge of computer science is very important for those seeking a career in applied mathematics. Students planning to continue on to Master's and Doctoral programs must be especially careful to take electives that will prepare them for the rigors of graduate study.

SECOND MAJORS:

With careful planning and hard work, an energetic student can graduate from M.U. with two majors. A student wishing to "double major" is advised to consult the university catalog for the regulations to be followed, and to obtain a special "double major" form from the registrar's office. However, only one degree is granted: either a B.A. or a B.S., but not both.

MINORS:

Students are encouraged to develop an area of interest outside their major. An excellent way to do this is to minor in another subject.

In fact, the Mathematics Department welcomes students from other majors to elect either a minor in Mathematics or a minor in Statistics. These minors are described in section VIII of this handbook.

IV. THE B.A. DEGREE IN MATHEMATICS

The B.A. degree program in mathematics is a flexible curriculum designed to accommodate the widest possible range of career objectives. It is structured according to the traditional liberal arts approach to college education.

In addition to the "general education" requirements common to all B.A. programs at Millersville (see the University catalog, or the appropriate "curriculum record form") this program requires the student to take:

A. Required Core Courses **25-26 s.h.**

MATH 161 - Calculus I	4 s.h.
(or MATH 163 - Honors Calculus I	5 s.h.)
MATH 211 - Calculus II	4 s.h.
MATH 310 - Intro. to Mathematical Proof	3 s.h.
MATH 311 - Calculus III	4 s.h.
MATH 322 - Linear Algebra I	4 s.h.
MATH 345 - Abstract Algebra I	3 s.h.
MATH 464 - Real Analysis I	3 s.h.

B. MATH Electives **18 s.h.**

- A minimum of 6 additional courses (18 s.h.) chosen from among those listed below.
- These 6 courses must include:

  (i) **At least one** of MATH 335, MATH 365

  and

  (ii) **At least one** of Math 422, MATH 435, MATH 445, MATH 465, or MATH 467; others may be substituted by departmental permission.

MATH 335 - Mathematical Statistics I	3 s.h.
MATH 353 - Survey of Geometry	3 s.h.
MATH 355 - Transformational Geometry	3 s.h.
MATH 365 - Ordinary Differential Equations	3 s.h.
MATH 370 - Operations Research	3 s.h.
MATH 375 - Numerical Analysis	3 s.h.
MATH 393 - Number Theory	3 s.h.
MATH 395 - Introduction to Combinatorics	3 s.h.
MATH 422 - Linear Algebra II	3 s.h.
MATH 435 - Mathematical Statistics II	3 s.h.
MATH 445 - Abstract Algebra II	3 s.h.
MATH 457 - Elementary Differential Geometry	3 s.h.
MATH 465 - Real Analysis II	3 s.h.
MATH 467 - Partial Differential Equations	3 s.h.
MATH 471 - Mathematical Modeling	3 s.h.
MATH 472 - Financial Mathematics	3 s.h.

MATH 483 - Point-set Topology	3 s.h.
MATH 4_8 - Topics in _____	1-3 s.h.
MATH 535 - Statistical Methods I	3 s.h.
MATH 536 - Statistical Methods II	3 s.h.
MATH 566 - Complex Variables	3 s.h.
MATH 592 – Graph Theory	3 s.h.

(Selected 500-level courses may be substituted for the above with the approval of the department.)

C. Required Related Courses **13-20 s.h.**

1. The second semester of a Foreign Language. 3-6 s.h.

2. CSCI 161 - Introduction to Computing I 4 s.h.

3. One of the following options: 6-10 s.h.

   a. Two courses (at least 3 credits each) chosen from the departments of Biology, Chemistry, Computer Science, Earth Sciences and Physics, which count toward the major in that department, or PHIL 312.

or

   b. Three courses (at least 3 credits each) from a single department, chosen from courses counting toward the major in that department.

Note: Sample four-year plans of study for students in this program are found on the next two pages.

SAMPLE FOUR YEAR PLAN OF STUDY

THE BACHELOR OF ARTS IN MATHEMATICS

FIRST SEMESTER

MATH 161 Calculus I	4
CSCI 161 Intro to Comp I	4
ENGL 110 Composition	3
UNIV 103 (Math majors section)	3
Total s.h.	14

SECOND SEMESTER

MATH 211 Calculus II	4
COMM 100 Fund of Speech	3
Hum./Fine Arts #1	3
Social Sciences #1	3
WELL 175	3
Total s.h.	16

THIRD SEMESTER

MATH 311 Calculus III	4
MATH 310 Intro to Math Proof	3
Foreign Language	3
Social Sciences #2	3
Sciences #2	3
Total s.h.	16

FOURTH SEMESTER

MATH 322 Linear Algebra I	4
Hum./Fine Arts #3	3
Foreign Language	3
Sciences #3 (LAB)	4
Total s.h.	14

FIFTH SEMESTER

MATH 335 Math Stat I	
(**OR** MATH 365 Ord Diff Eq)	3
MATH Elective	3
Social Sciences #3	3
Elective (Diversity)	3
Elective*	3
Total s.h.	15

SIXTH SEMESTER

Advanced Writing	3
MATH 345 Abstract Algebra I	3
MATH Elective	3
Elective	3
Elective*	3
Total s.h.	15

SEVENTH SEMESTER

MATH 464 Real Analysis I	3
MATH Elective	3
Perspectives	3
Elective*	3
Elective	3
Total s.h.	15

EIGHTH SEMESTER

MATH Elective	3
MATH Elective (422, 435, 445, 465 or 467)	3
Elective	3
Elective	3
Elective	3
Total s.h.	15

Total S.H. = 120 (minimum)

* Note that 2-3 Electives are needed to fulfill the Required Related Courses. See Section C.3.

BACHELOR OF ARTS IN MATHEMATICS

SAMPLE FOUR-YEAR PLAN OF STUDY
FOR STUDENTS STARTING WITH MATH 160

FIRST SEMESTER

MATH 160 Precalculus	4
CSCI 161 Intro to Comp I	4
ENGL 110 Composition	3
UNIV 103 (Math majors section)	3
Total s.h.	14

SECOND SEMESTER

MATH 161 Calculus I	4
COMM 100 Fund of Speech	3
WELL 175	3
Social Sciences #1	3
Sciences #1	3
Total s.h.	16

THIRD SEMESTER

MATH 211 Calculus II	4
Hum/Fine Arts #1	3
Foreign Language	3
Social Sciences #2	3
Elective	3
Total s.h.	16

FOURTH SEMESTER

MATH 311 Calculus III	4
MATH 310 Intro. Math Proof	3
Foreign Language	3
Social Sciences #3	3
Elective	3
Total s.h.	16

FIFTH SEMESTER

MATH 322 Linear Algebra I	4
MATH 335 Math Stat I (**OR** MATH 365 Ord Diff Eq)	3
Sciences (LAB) #2	5
Elective*	3
Total s.h.	15

SIXTH SEMESTER

MATH 345 Abstract Algebra I	3
MATH Elective	3
Advanced Writing	3
Sciences #3	3
Elective	4
Total s.h.	16

SEVENTH SEMESTER

MATH 464 Real Analysis I	3
MATH Elective	3
Perspectives	3
Elective (Diversity)	3
Elective*	3
Total s.h.	15

EIGHTH SEMESTER

MATH Elective	3
MATH Elective	3
MATH Elective (422, 435, 445, 465 or 467)	3
Elective*	3
Total s.h.	12

Total S.H. = 120 (minimum)

* Note that 2-3 Electives are needed to fulfill the Required Related Courses. See Section C.3.

V. THE B.S. DEGREE IN MATHEMATICS

The B.S. degree program differs from the B.A. degree program in that it is specifically application-oriented. It requires greater concentration in mathematical analysis and science, and thus it is somewhat less flexible than the B.A. program. At the same time there is no foreign language requirement for the B.S. degree.

In addition to the "general education" requirements common to all B.S. programs at Millersville (see the University catalog, or the appropriate "curriculum record form") this program requires the student to take:

A. Required Core Courses **34-35 s.h.**

MATH 161 - Calculus I	4 s.h.
(or MATH 163 - Honors Calculus I	5 s.h.)
MATH 211 - Calculus II	4 s.h.
MATH 310 - Intro. to Mathematical Proof	3 s.h.
MATH 311 - Calculus III	4 s.h.
MATH 322 - Linear Algebra I	4 s.h.
MATH 335 - Mathematical Statistics I	3 s.h.
MATH 345 - Abstract Algebra I	3 s.h.
MATH 365 - Ordinary Differential Equations	3 s.h.
MATH 375 - Numerical Analysis	3 s.h.
MATH 464 - Real Analysis I	3 s.h.

B. Math Electives **9 s.h.**

Any three courses (9 s.h. minimum) chosen from among:

MATH 353 - Survey of Geometry	3 s.h.
MATH 355 - Transformational Geometry	3 s.h.
MATH 370 - Operations Research	3 s.h.
MATH 393 - Number Theory	3 s.h.
MATH 395 - Introduction to Combinatorics	3 s.h.
MATH 422 - Linear Algebra II	3 s.h.
MATH 435 - Mathematical Statistics II	3 s.h.
MATH 445 - Abstract Algebra II	3 s.h.
MATH 457 - Elementary Differential Geometry	3 s.h.
MATH 465 - Real Analysis II	3 s.h.
MATH 467 - Partial Differential Equations	3 s.h.
MATH 471 - Mathematical Modeling	3 s.h.
MATH 472 – Financial Mathematics	3 s.h.
MATH 483 - Point Set Topology	3 s.h.
MATH 4_8 - Topics in _____	1-3 s.h.
MATH 535 - Statistical Methods I	3 s.h.
MATH 536 - Statistical Methods II	3 s.h.
MATH 566 - Complex Variables	3 s.h.
MATH 592 – Graph Theory	3 s.h.

(Selected 500-level courses may be substituted for the above with the approval of the department.)

These 3 courses must include:

At least one of MATH 422, MATH 435, MATH 445, MATH 465, or MATH 467; (others may be substituted by departmental permission).

C. Required Related Courses **18-22 s.h.**

1. CSCI 161 - Intro. to Computing I 4 s.h.

2. PHYS 231 - General Physics I 5 s.h.

3. One of the following options: 9-13 s.h.

   a. Three courses (at least 3 credits each) chosen from the departments of Biology, Chemistry, Computer Science, Earth Sciences and Physics, which count toward the major in that department and **to include at least one of**: BIOL 375, CSCI 162, ESCI 340, ESCI 341, ESCI 342, or PHYS 232.

or

   b. Four courses (at least 3 credits each) chosen from a single department, which count toward the major in that department.

For descriptions of these courses, and their prerequisites, consult the university catalog.

Note: Sample four-year plans of study for students in this program are found on the next two pages.

SAMPLE FOUR YEAR PLAN OF STUDY

THE BACHELOR OF SCIENCE IN MATHEMATICS

FIRST SEMESTER		SECOND SEMESTER	
MATH 161 Calculus I	4	MATH 211 Calculus II	4
CSCI 161 Intro to Comp I	4	COMM 100 Fund of Speech	3
ENGL 110 Composition	3	Social Sciences #1	3
UNIV 103 (Math majors section)	3	Humanities/Fine Arts #1	3
		WELL 175	3
Total s.h.	14	Total s.h.	16

THIRD SEMESTER		FOURTH SEMESTER	
MATH 311 Calculus III	4	MATH 322 Linear Algebra I	4
PHYS 231 General Physics I	5	MATH 365 Ord Diff Eq	3
MATH 310 Intro to Math Proof	3	Sciences #3**	4
Humanities/Fine Arts #2	3	Social Sciences #2	3
Total s.h.	15	Total s.h.	14

FIFTH SEMESTER		SIXTH SEMESTER	
MATH 335 Math Stat I	3	MATH 345 Abstract Algebra I	3
Advanced Writing	3	Humanities/Fine Arts #3	3
MATH 375 Numerical Analysis	3	Perspectives	3
Social Sciences #3	3	Open Elective	3
Elective	4	Elective	3
Total s.h.	16	Total s.h.	15

SEVENTH SEMESTER		EIGHTH SEMESTER	
MATH 464 Real Analysis I	3	MATH Elective	3
MATH Elective	3	MATH Elective	
Elective (Diversity)	3	(422, 435, 445, 465 or 467)	3
Elective*	3	Elective	3
Elective*	3	Elective*	3
		Elective*	3
Total s.h.	15	Total s.h.	15

Total S.H. = 120 (minimum)

* Note that 3-4 Electives are needed to fulfill the Required Related Courses. See Section C.3.

BACHELOR OF SCIENCE IN MATHEMATICS

SAMPLE FOUR-YEAR PLAN OF STUDY
FOR STUDENTS STARTING WITH MATH 160

FIRST SEMESTER	
MATH 160 Precalculus	4
CSCI 161 Intro to Comp I	4
ENGL 110 Composition	3
UNIV 103 (Math majors section)	3
Total s.h.	14

SECOND SEMESTER	
MATH 161 Calculus I	4
COMM 100 Fund of Speech	3
Humanities/Fine Arts #1	3
WELL 175	3
Sciences #2**	3
Total s.h.	16

THIRD SEMESTER	
MATH 211 Calculus II	4
Open Elective	3
Humanities/Fine Arts #2	3
Social Sciences #1	3
Elective	3
Total s.h.	16

FOURTH SEMESTER	
MATH 311 Calculus III	4
MATH 310 Intro. Math Proof	3
Humanities/Fine Arts #3	3
Social Sciences #2	3
Elective	3
Total s.h.	16

FIFTH SEMESTER	
MATH 322 Linear Algebra I	4
MATH 335 Math Stat I	3
PHYS 231 General Physics I	5
Social Sciences #3	3
Total s.h.	15

SIXTH SEMESTER	
MATH 345 Abstract Algebra I	3
MATH 365 Ord Diff Eq	3
Perspectives	3
Elective*	4
Elective*	3
Total s.h.	16

SEVENTH SEMESTER	
MATH 375 Numerical Analysis	3
MATH Elective	3
Advanced Writing	3
Elective (Diversity)	3
Elective*	3
Total s.h.	15

EIGHTH SEMESTER	
MATH 464 Real Analysis I	3
MATH Elective	3
MATH Elective	3
Elective*	3
Total s.h.	12

Total S.H. = 120 (minimum)

* Note that 3-4 Electives are needed to fulfill the Required Related Courses. See Section C.3.
** Note that either 1 additional Physics course or 2 Natural Science courses will be needed to complete the Science block.

VI. THE B.S. DEGREE IN EDUCATION (MATHEMATICS)

The B.S.E. is the degree program for prospective teachers of mathematics in secondary schools.

The Mathematics Education curriculum at Millersville is structured to enable students to discover early in the college experience whether or not the teaching profession is appropriate. Students are first exposed to middle and senior high school students during their "Foundations Block" experience. Students typically enroll in this block of two education courses during their sophomore or junior year. Following this, they will have a one-semester mathematics teaching-methods course that places them in secondary school classrooms for four to five mini-teaching experiences. The program is capped off in the senior year by a full semester of actual classroom teaching as a student-teacher.

After earning the B.S.E. degree in mathematics with the required overall 3.0 grade point average, satisfying required background clearances (Act 34/114/151) and passing the Praxis I and Praxis II content exam, you will receive a provisional certificate to teach mathematics in any secondary school in Pennsylvania. That certification becomes permanent after three years of successful teaching and after earning 24 additional college credits.

In addition to the general education and professional requirements common to all B.S.E. programs at Millersville (see the university catalog, or the appropriate "curriculum record form") this program requires the student to take:

A. Required Core Courses **37-40 s.h.**

MATH 161 - Calculus I	4 s.h.
(or MATH 163 - Honors Calculus I - 5 s.h.)	
MATH 211 - Calculus II	4 s.h.
MATH 301 – History of Mathematics	3 s.h.
MATH 310 - Intro. to Mathematical Proof	3 s.h.
MATH 311 - Calculus III	4 s.h.
MATH 322 - Linear Algebra I	4 s.h.
MATH 333 - Intro. to Probability and Statistics	4 s.h.
or { MATH 335 - Mathematical Statistics I - 3 s.h., and MATH 435 - Mathematical Statistics II - 3 s.h.	
MATH 345 - Abstract Algebra I	3 s.h.
MATH 353 - Survey of Geometry	3 s.h.
(or MATH 355 - Transformational Geometry 3 s.h.)	
MATH 464 - Real Analysis I	3 s.h.
* MATH 405 - Teaching of Mathematics in the Secondary School	5 s.h.

* Students in this program must meet special prerequisites and APS status for MATH 405 and student teaching (see C.5-6. of "Departmental Policy" on page 37).

B. MATH Electives **6 s.h.**

Any two courses not taken in the required core, chosen from among:

MATH 353 - Survey of Geometry	3 s.h.
MATH 355 - Transformational Geometry	3 s.h.
MATH 365 - Ordinary Differential Equations	3 s.h.
MATH 370 - Operations Research	3 s.h.
MATH 375 - Numerical Analysis	3 s.h.
MATH 393 - Number Theory	3 s.h.
MATH 395 - Introduction to Combinatorics	3 s.h.
MATH 422 - Linear Algebra II	3 s.h.
MATH 435 - Mathematical Statistics II	3 s.h.
MATH 445 - Abstract Algebra II	3 s.h.
MATH 457 - Elementary Differential Geometry	3 s.h.
MATH 465 - Real Analysis II	3 s.h.
MATH 467 - Partial Differential Equations	3 s.h.
MATH 471 - Mathematical Modeling	3 s.h.
MATH 472 – Financial Mathematics	3 s.h.
MATH 483 - Point-set Topology	3 s.h.
MATH 4_8 - Topics in _____	1-3 s.h.
MATH 535 - Statistical Methods I	3 s.h.
MATH 536 - Statistical Methods II	3 s.h.
MATH 566 - Complex Variables	3 s.h.
MATH 592 – Graph Theory	3 s.h.

(Selected 500-level courses may be substituted for the above with the approval of the department.)

C. Required Related Courses **11-14 s.h.**

1.	CSCI 161 - Introduction to Computing I	4 s.h.
2.	CSCI 140 – Discrete Structures	4 s.h.

D. Professional Education Courses **32 s.h.**

Foundations Bloc

EDFN 211 – Foundations of Modern Education(D)	3 s.h.
EDFN 241 – Psych. Foundations of Teaching	3 s.h.

Professional Bloc

MATH 405 - Teaching of Mathematics in the Secondary School	5 s.h.
EDSE 321 – Issues in Secondary Education	3 s.h.
SPED 346 – Inclusive Settings	3 s.h.
EDSE 340 – Literacy for Diverse Classes	3 s.h

Student Teaching Bloc

EDMA 461 – Student Teaching	9 s.h
SPED 471 - Differentiating Instr. in St. Teaching	3 s.h.

Note 1: In order to graduate in 4 years, students in the B.S.E. program must complete all their academic coursework in 6 semesters. The seventh and eighth semesters are spent in Professional Bloc and full-time student teaching experiences. (If necessary, although not advised, students may be able to take one 3-credit class during Professional Bloc.) Consequently, students in this program must carefully plan their program of study in consultation with their advisor. Although not required, students may find it helpful to take one or two courses during a summer or winter session.

Note 2: B.S.E. students are required to submit and maintain samples of work for their content portfolios. These submissions must be up to date prior to entry into MATH 405.

Note 3: Prior to ANY/ALL field placements, students must have all three background checks (FBI Finger-print, Child Abuse Clearance, Criminal Background Check) and a negative TB test – all within the last year.

Note 4: In addition to other requirements, all BSE majors must successfully complete a course in English Literature.

Note 5: Sample four-year plans of study for students in this program are found on the next two pages.

ADVISING; SAMPLE FOUR YEAR PLAN OF STUDY
BSE (MATHEMATICS); Starting MATH 161

FIRST SEMESTER		SECOND SEMESTER	
MATH 161 Calc I	4	MATH 211 Calc II	4
CSCI 161 Intro to Comp I (RR/G2)	4	COMM 100 Fund of Speech	3
ENGL 110 Composition	3	Hum/Fine Arts #1 (G1, ENG/PHIL)	3
WELL 175: Wellness	3	CSCI 140 (RR)	4
UNIV 103 (Math majors section)	3	[BIOL 100 (Lab/G2)]	3
Total s.h.	17	Total s.h.	17

THIRD SEMESTER		FOURTH SEMESTER	
MATH 310 Proof (W)	3	MATH 333: Prob/Stat	4
MATH 311 Calc 3	4	MATH 322: Linear Algebra	4
EDFN 211 Found of Mod Ed (D)	3	Social Sciences #3 (G3)	3
EDFN 241 Psych Found Tchg	3	ENGL Literature (G1)	3
Social Sciences #2 (G3)	3		
Total s.h.	16	Total s.h.	14

FIFTH SEMESTER		SIXTH SEMESTER	
MATH 353/355 Geometry	3	MATH 464 Real Analysis	3
MATH 345: Abstract Algebra	3	MATH Elective	3
Advanced Writing	3	MATH Elective	3
Social Sciences #1 (G3)	3	[BIOL 204, 207, 256 (G2/W)**]	3
MATH 301 (P)	3	Hum/Fine Arts #3 (G1, PHIL 211 or 312 suggested)	3
Total s.h.	15	Total s.h.	15

SEVENTH SEMESTER		EIGHTH SEMESTER	
MATH 405 Tchg Math/Sec Sch	5	EDMA 461 Student Teaching	9
EDSE 321 Issues in Secondary Ed	3	EDSE 471 Diff. Instruction	3
SPED 346: Inclusive Settings	3		
EDSE 340: Literacy for Diverse Classes	3		
XXXX XXX	3*		
Total s.h.	14/17	Total s.h.	12

Total S.H. = 120 (minimum)

NOTE: [designates suggested options]

* An additional 3-credit course can be scheduled during the 7th semester if needed, but it is NOT recommended.

****** ALL Clearance AND TB tests MUST now be updated EVERY year for ANY Field Placement semester**

****** PAPA 1; prior to Seventh Semester (preferably earlier); PRAXIS 2; prior to Eighth Semester (preferably prior to Seventh semester, but must have completed MATH 353/355 and 345)**

ADVISING; SAMPLE FOUR YEAR PLAN OF STUDY
BSE (MATHEMATICS); Starting MATH 160

FIRST SEMESTER		SECOND SEMESTER	
MATH 160 Pre-Calculus	4	MATH 161 Calc I	4
CSCI 161 Intro to Comp I (RR/G2)	4	COMM 100 Fund of Speech	3
ENGL 110 Composition	3	Hum/Fine Arts #2 (G1: ENG/PHIL)	3
UNIV 103 (Math majors section)	3	CSCI 140 (RR)	4
WELL 175	3	[BIOL 100 (Lab/G2)]	3
Total s.h.	17	Total s.h.	17

THIRD SEMESTER		FOURTH SEMESTER	
MATH 211 Calc II	4	MATH 310 Proof (W)	3
ENGL Literature (G1)	3	MATH 311 Calc 3	4
EDFN 211 Found of Mod Ed (D)	3	Advanced Writing	3
EDFN 241 Psych Found Tchg	3	Social Sciences #3 (G3)	3
Social Sciences #2 (G3)	3	Hum/Fine Arts #3 (G1, PHIL 211 or 312 suggested)	3
Total s.h.	16	Total s.h.	16

FIFTH SEMESTER		SIXTH SEMESTER	
MATH 333: Prob/Stat	4	MATH 353/355 Geometry	3
MATH 322: Linear Algebra	4	MATH 345: Abstract Algebra	3
		MATH Elective	3
Social Sciences #1 (G3)	3	[BIOL 204, 207, 256 (G2/W)**]	3
MATH Elective	3	MATH 301 (P)	3
Total s.h.	14	Total s.h.	15

SEVENTH SEMESTER		EIGHTH SEMESTER	
MATH 405 Tchg Math/Sec Sch	5	EDMA 461 Student Teaching	9
EDSE 321 Issues in Secondary Ed	3	EDSE 471 Differentiated. Instr.	3
SPED 346: Inclusive Settings	3		
EDSE 340: Literacy for Diverse Classes	3		
MATH 464: Real Analysis	3		
Total s.h.	17	Total s.h.	12

Total S.H. = 124 (minimum)

NOTE: [designates suggested options]

****** ALL Clearance AND TB tests MUST now be updated EVERY year for ANY Field Placement semester**

****** PAPA 1: prior to 7th semester (preferably earlier); PRAXIS 2: before 8th semester (preferably earlier, but you must have completed MATH 333, 353/355 and 345).**

THREE SPECIALTY OPTIONS:

ACTUARIAL SCIENCE
APPLIED MATHEMATICS
STATISTICS

A. The Actuarial Science Option

The Actuarial Science option is designed to prepare students for a career as an actuary. Students successfully completing the option will be prepared to take the first examination administered by the Society of Actuaries. Students enrolled in any of the B.A., B.S. or B.S.E. programs may complete the Actuarial Science Option by including the following courses among the courses taken to fulfill their major.

1. Required Courses

MATH 319 - Calculus and Actuarial Sci Probl Solv Sem	1 s.h.
MATH 335 - Mathematical Statistics I	3 s.h.
MATH 375 - Numerical Analysis	3 s.h.
MATH 435 - Mathematical Statistics II	3 s.h.
MATH 535 - Statistical Methods I	3 s.h.

2. Required Related Courses

ECON 101 – Principles of Macroeconomics	3 s.h.
ECON 102 - Principles of Microeconomics	3 s.h.

3. Recommended Courses

MATH 422 - Linear Algebra II	3 s.h.
MATH 536 - Statistical Methods II	3 s.h.
* BUAD 161 – Introduction to Financial Accounting	3 s.h.
* BUAD 162 – Introduction to Managerial Accounting	3 s.h.

*Note that the courses BUAD 161, 162 do not count in the general education curriculum. Therefore, students are recommended to take theses courses only if their schedules will permit them.

Note: A sample four-year plan of study for students in this program is found on page 26.

B. The Applied Mathematics Option

The Applied Mathematics option is designed to give students a focus in those areas of mathematics used most often in applications. The program is designed to prepare students for jobs applying mathematics to other fields or for graduate study in mathematics. Students enrolled in the B.S. program may complete the Applied Mathematics Option by including the following courses among the courses taken to fulfill their major.

1. Required MATH courses

MATH 335* - Mathematical Statistics I	3 s.h.
MATH 365* - Ordinary Differential Equations	3 s.h.
MATH 375* - Numerical Analysis	3 s.h.
MATH 467 - Partial Differential Equations	3 s.h.

and one of:

MATH 370 – Operations Research	3 s.h.
MATH 471 - Mathematical Modeling	3 s.h.
MATH 478 – Topics in Applied Mathematics	3 s.h.

2. Required Related Courses

PHYS 231* - Physics I with Calculus	5 s.h.

and one of:

PHYS 232 - Physics II with Calculus	5 s.h.
ESCI 341 - Atmospheric Thermodynamics	3 s.h.
ESCI 342 - Atmospheric Dynamics I	3 s.h.

3. Recommended Courses

CSCI 406 - Topics in Computer Science (FORTRAN programming)	1-3 s.h.
PHYS 311 - Mechanics I	3 s.h.
PHYS 312 - Mechanics II	3 s.h.

* These courses are already required for students in the B.S. program.

Note: A sample four-year plan of study for students in this program is found on page 27.

C. The Statistics Option

The Statistics option is intended to prepare students for work as statisticians as well as for graduate study in statistics. Students enrolled in any of the B.A., B.S. or B.S.E. programs may complete the Statistics Option by including the following courses among the courses taken to fulfill their major.

1. Required Courses

MATH 335 - Mathematical Statistics I	3 s.h.
MATH 435 - Mathematical Statistics II	3 s.h.
MATH 535 - Statistical Methods I	3 s.h.
MATH 536 - Statistical Methods II	3 s.h.
MATH 537 - Stat Problem Solving Sem	1 s.h.

2. Recommended Courses

MATH 422 - Linear Algebra II	3 s.h.
MATH 370 - Operations Research	3 s.h.
MATH 375 - Numerical Analysis	3 s.h.

Note: A sample four-year plan of study for students in this program is found on page 28.

SAMPLE FOUR YEAR PLAN OF STUDY
THE BACHELOR OF SCIENCE IN MATHEMATICS
ACTUARIAL SCIENCE OPTION

FIRST SEMESTER		SECOND SEMESTER	
MATH 161 Calculus I	4	MATH 211 Calculus II	4
ENGL 110 Composition	3	COMM 100 Fund of Speech	3
CSCI 161 Intro to Comp I	4	WELL 175	3
UNIV 103 (Math majors section)	3	Social Sciences #1	3
		Humanities/Fine Arts #1	3
Total s.h.	14	Total s.h.	16

THIRD SEMESTER		FOURTH SEMESTER	
MATH 311 Calculus III	4	MATH 322 Linear Algebra I	4
PHYS 231 General Physics I	5	MATH 365 Ord Diff Eq	3
MATH 310 Intro to Math Proof	3	Elective	3
ECON 101 Macroeconomics	3	ECON 102 Microeconomics	3
Total s.h.	15	Total s.h.	13

FIFTH SEMESTER		SIXTH SEMESTER	
		Advanced Writing	3
MATH 335 Math Statistics I	3	MATH 435 Math Stats II	3
Humanities/Fine Arts #2	3	MATH 345 Abstract Alg I	3
Sciences #3**	3	MATH 319 Calc/Act Sci Sem	1
Elective	3	Cultural Diversity/Community	3
BUAD 161 (recommended)	3	BUAD 162 (recommended)	3
Total s.h.	15	Total s.h.	16

SEVENTH SEMESTER		EIGHTH SEMESTER	
MATH 535 Stat Methods I	3	MATH 464 Real Analysis I	3
MATH 375 Numerical Analysis	3	MATH Elective	3
Perspectives	3	Elective*	3
Humanities/Fine Arts #4	3	Elective*	3
Elective*	3	Gen Ed. Elective	3
Total s.h.	15	Total s.h.	15

Total S.H. = 120 (minimum)

* Note that 3-4 Electives are needed to fulfill the Required Related Courses. See Section C.3., page 15.
** Note that either 1 additional Physics course or 2 Natural Science courses will be needed to complete the Science block.

SAMPLE FOUR YEAR PLAN OF STUDY
THE BACHELOR OF SCIENCE IN MATHEMATICS
APPLIED MATHEMATICS OPTION

FIRST SEMESTER	
MATH 161 Calculus I	4
CSCI 161 Intro to Comp I	4
ENGL 110 Composition	3
UNIV 103 (Math majors section)	3
Total s.h.	14

SECOND SEMESTER	
MATH 211 Calculus II	4
COMM 100 Fund of Speech	3
WELL 175	3
Social Sciences #1	3
Humanities/Fine Arts #1	3
Total s.h.	16

THIRD SEMESTER	
MATH 311 Calculus III	4
PHYS 231 General Physics I	5
MATH 310 Intro to Math Proof	3
Social Sciences #2	3
Total s.h.	15

FOURTH SEMESTER	
MATH 322 Linear Algebra I	4
MATH 365 Ord Diff Eq	3
PHYS 232 General Physics II (sug)	5
Social Sciences #3	3
Total s.h.	15

FIFTH SEMESTER	
MATH 335 Math Stats I	3
MATH 375 Numerical Analysis	3
Humanities/Fine Arts #2	3
Open Elective	3
Gen Educ Elective	3
Total s.h.	15

SIXTH SEMESTER	
Advanced Writing	3
MATH 467 Partial Diff Eq	3
MATH 345 Abstract Alg I	3
Cultural Diversity/Community	3
Elective*	3
Total s.h.	15

SEVENTH SEMESTER	
MATH 478 Topics in Appl Math	3
MATH Elective	3
Perspectives	3
Humanities/Fine Arts #3	3
Elective*	3
Total s.h.	15

EIGHTH SEMESTER	
MATH 464 Real Analysis	3
MATH 471 Math Modeling	3
Elective*	3
Elective*	3
Elective	3
Total s.h.	15

Total S.H. = 120 (minimum)

* Note that 3-4 Electives are needed to fulfill the Required Related Courses. See Section C.3., page 15.

SAMPLE FOUR YEAR PLAN OF STUDY
BACHELOR OF SCIENCE IN MATHEMATICS
STATISTICS OPTION

FIRST SEMESTER		SECOND SEMESTER	
MATH 161 Calculus I	4	MATH 211 Calculus II	4
CSCI 161 Intro to Comp I	4	COMM 100 Fund of Speech	3
ENGL 110 Composition	3	WELL 175	3
UNIV 103 (Math majors section)	3	Social Sciences #1	3
		Humanities/Fine Arts #1	3
Total s.h.	14	Total s.h.	16

THIRD SEMESTER		FOURTH SEMESTER	
MATH 311 Calculus III	4	MATH 322 Linear Algebra I	4
PHYS 231 General Physics I	5	MATH 365 Ord Diff Eq	3
MATH 310 Intro to Math Proof	3	Elective	3
Social Sciences #2	3	Social Sciences #3	3
Total s.h.	15	Total s.h.	13

FIFTH SEMESTER		SIXTH SEMESTER	
MATH 335 Math Stat I	3	Advanced Writing	3
MATH 375 Numerical Analysis	3	MATH 435 Math Stats II	3
Humanities/Fine Arts #2	3	MATH 345 Abstract Alg I	3
Social Sciences #3	3	Cultural Diversity/Community	3
Elective	4	Elective*	3
Total s.h.	16	Total s.h.	15

SEVENTH SEMESTER		EIGHTH SEMESTER	
MATH 535 Stat Methods I	3	MATH 536 Stat Methods II	3
MATH Elective	3	MATH 464 Real Analysis I	3
Perspectives	3	MATH 537 Stat Prob Solv Sem	1
Humanities/Fine Arts #3	3	Gen Educ Elective	3
Elective*	3	Elective*	3
		Elective*	3
Total s.h.	15	Total s.h.	16

Total S.H. = 120 (minimum)

* Note that 3-4 Electives are needed to fulfill the Required Related Courses. See Section C.3., page 15.

VIII. THE MINORS IN MATHEMATICS AND STATISTICS

Students who are majoring in a subject other than mathematics may elect to minor in either mathematics or statistics.

A. The Minor in Mathematics

The mathematics minor requires successful completion of the following courses:

1. Required Mathematics Courses **16-17 s.h.**

MATH 161 - Calculus I	4 s.h
(or MATH 163 - Honors Calculus I	5 s.h.)
MATH 211 - Calculus II	4 s.h.
MATH 311 - Calculus III	4 s.h.
MATH 322 - Linear Algebra	4 s.h.

2. Mathematics Electives **6 s.h.**

Any two mathematics courses of 3 s.h. or 4 s.h. numbered 310 or above.

TOTAL **22-23 s.h.**

B. The Minor in Statistics

1. Required Mathematics Courses **12-13 s.h.**

MATH 161 - Calculus I	4 s.h
(or MATH 163 - Honors Calculus I	5 s.h.)
MATH 211 - Calculus II	4 s.h.
MATH 311 - Calculus III	4 s.h.

2. Core Statistics Courses **4-6 s.h.**

Either:

a. MATH 335 - Mathematical Statistics I - 3 s.h., and
MATH 435 - Mathematical Statistics II - 3 s.h.

or

b. MATH 333 - Intro to Prob and Stat 4 s.h.

3. Applied Statistics Courses **7 s.h.**

a. MATH 535 - Statistical Methods I 3 s.h.

b. MATH 536 - Statistical Methods II - 3 s.h., or
MATH 438 - Topics in Statistics - 3 s.h.

c. MATH 537 - Stat Prob Solv Seminar 1 s.h.

C. POLICIES GOVERNING MINORS

1. Admission into the Mathematics or Statistics minor is upon approval of the Department of Mathematics chairperson. A "C-" or better in Math 161 and all Math courses already taken which count toward a Math minor is required for admission.

2. A student with a mathematics minor taking any Math course required as a prerequisite for a later Math course must earn a grade of "C-" or better in that course before being admitted to the later course for which it is a prerequisite.

3. A student with a mathematics or statistics minor must have a quality point average of at least 2.00, computed over all Millersville courses required for the minor.

4. At least half the minor requirements must be completed at Millersville.

5. No course required for the minor may be taken Pass-Fail.

IX. THE COOPERATIVE EDUCATION PROGRAM

The Cooperative Education Program is a non-traditional college curriculum combining on-campus studies with off-campus job experiences. It is a cooperative venture in which the student, the employer, and Millersville University *cooperate*--working hand-in-hand sharing resources and knowledge. See the 2011-2012 university catalog for details, pages 42, and 115.

After successfully completing at least the freshman year, the cooperative education student is employed in a full-time or part-time paid position closely aligned with his or her major areas of career interest. This position is held for one semester (or up to eight months including a summer), after which the student returns to Millersville University for a normal semester of academic coursework. The student may continue some pattern of alternating his/her semesters (including summers) between working at his/her position of employment and studying toward his/her degree at MU. Students who complete the program earn academic credits for their job experiences.

Students wishing to enter this program (or simply learn more about it) should contact Dr. James Fenwick, the Cooperative Education Coordinator in the Department of Mathematics. The coordinator screens candidates, helps arrange employment, and counsels the students. A co-op supervisor from the department is then appointed to evaluate the on-the-job experience and the student's performance.

The Cooperative Education office on campus works closely with the student in co-op placement and provides valuable advice in resume preparation and job interviewing.

The department believes that this program provides students with an excellent opportunity to gain a career awareness, along with a greater understanding of the practical applications of their academic studies. Through work experiences in an area related to their field of study, this program enables students to develop self-confidence and maturity. Another attractive feature of this program is that it provides students with an opportunity to finance a part of the cost of his/her own education.

X. ADVICE IN PLANNING YOUR PROGRAM

There are many courses available for you to take at Millersville. You need to decide which of them to take and when to take them in order to fulfill degree requirements and to reach your career and personal goals.

A. Frequency of Course Offerings

As you progress through your program, you will find that some courses are not offered every semester, and indeed some are offered only once every several years. Careful advance planning is recommended to assure that you will get all the courses you want.

Although the department does not follow any schedule of course offerings precisely (due to changing course demands and resources), what follows is a **rough** guideline. Certainly do not expect courses to be offered any more frequently than in the following guide; however, in addition to Calculus I, II, and III, some upper level courses have been offered each summer. To be absolutely certain, you should check with your faculty advisor.

ROTATION OF UPPER LEVEL MATH COURSE OFFERINGS

FALL	SPRING
MATH 310 – Intro to Math Proof	MATH 310 – Intro to Math Proof
MATH 333 – Intro Prob/Stat	MATH 333 – Intro Prob/Stat
MATH 322 – Linear Algebra	MATH 322 – Linear Algebra
MATH 345 – Abstract Algebra I	MATH 345 – Abstract Algebra I
MATH 365 – Ord Diff Eq	MATH 365 – Ord Diff Eqns
MATH 405 – Teaching of Math	MATH 405 – Teaching of Math
MATH 464 – Real Analysis I	MATH 464 – Real Analysis I
MATH 335 – Math Stats I	MATH 355 – Transform Geometry
MATH 353 – Survey of Geometry	MATH 435 – Math Stats II
MATH 375 – Num Analysis	MATH 467 – Partial Diff Eqns
MATH 535 – Stat Methods I	MATH 537 – Stat Prob Solv
	MATH 319 – Calc & Act Sci Seminar

One of:	**Two of:**
MATH 422 – Linear Algebra II	MATH 393 – Number Theory
MATH 395 – Combinatorics	MATH 471 – Math Modeling
	MATH 536 – Stat Methods II

The following courses are offered as the demand and resources permit:

MATH 370 – Operations Research
MATH 438 – Topics in Statistics
MATH 445 – Abstract Algebra II
MATH 457 – Differential Geometry
MATH 465 – Real Analysis II
MATH 472 – Financial Mathematics
MATH 483 – Topology

B. Courses Recommended for Graduate Study

Students planning to enter a master's degree or doctoral degree program in pure or applied mathematics or statistics need to pursue a strong undergraduate degree program. Such students often seek advice in selecting courses that will be especially helpful in preparing them for the rigors of graduate study. There are several courses that may be regarded as containing standard graduate-prep material. These courses should not be overlooked by anyone considering graduate school:

MATH 335 - Mathematical Statistics I
MATH 422 - Linear Algebra II
MATH 365 - Ordinary Differential Equations
MATH 393 - Number Theory
MATH 435 - Mathematics Statistics II
MATH 445 - Abstract Algebra II
MATH 465 - Real Analysis II
MATH 566 - Complex Variables

C. Recommended Computer Science Courses

It is required for students majoring in mathematics to acquire some knowledge of computer science as well. For most post baccalaureate endeavors knowledge of computer science is necessary. If you are interested in follow-up courses to CSCI 161 (required of all math majors) we recommend the following:

CSCI 162 - Introduction to Computing II
CSCI 240 - Computational Models
CSCI 362 - Data Structures
CSCI 440 - Theory of Computation

D. Advanced Placement Credit

1. Advanced Placement in Calculus

Students who elect calculus in high school are strongly encouraged to take the Advanced Placement Exam of the College Entrance Examination Board. There are two different exams: the AB test and the BC test. The BC test covers more material than the AB test. Each exam is scored 1, 2, 3, 4, or 5. Current policy of the Department of Mathematics at MU is as follows:

IN ALL CASES WHERE A CALCULUS ADVANCED PLACEMENT SCORE OF 3, 4, OR 5 IS OFFICIALLY REPORTED, THE STUDENT WILL BE OFFERED COLLEGE CREDIT. THE RECORDING OF SUCH CREDIT IN THE REGISTRAR'S OFFICE IS SUBJECT TO THE STUDENT'S ACCEPTANCE OF THE CREDITS. NO OFFERS OF CREDIT ARE MADE FOR REPORTED SCORES LESS THAN 3. COLLEGE CREDIT SHALL BE OFFERED AS FOLLOWS:

a. **For a reported score of 3 on the AB test**: 4 semester hours credit for MATH 151 (Calculus for the Management, Life and Social Sciences) with a grade of "P" (pass).

b. **For a reported score of 4 or 5 on the AB test or a 3 on the BC test**: 4 semester hours credit for MATH 161 (Calculus I) with a grade of "P" (pass).

c. **For a reported score of 4 or 5 on the BC test**: 4 semester hours credit for MATH 161 (Calculus I) and 4 semester hours credit for MATH 211 (Calculus II), with a grade of "P".

d. The student has the right to reject part or all of any credit offer and begin his/her calculus sequence with any calculus course at or below the highest recommended one.

e. In all cases, the student is encouraged to discuss his/her situation with the department chair or assistant chair before a final decision is made.

2. Advanced Placement in Statistics

Students who elect AP Statistics in high school may take the Advanced Placement Exam of the College Entrance Examination Board. Each exam is scored 1, 2, 3, 4, or 5. Current policy of the Department of Mathematics at MU is as follows:

FOR AN AP STATISTICS SCORE OF 3, 4, OR 5 THAT IS OFFICIALLY REPORTED, THE STUDENT WILL BE OFFERED COLLEGE CREDIT. THE RECORDING OF SUCH CREDIT IN THE REGISTRAR'S OFFICE IS SUBJECT TO THE STUDENT'S ACCEPTANCE OF THE CREDITS. NO OFFERS OF CREDIT ARE MADE FOR REPORTED SCORES LESS THAN 3. COLLEGE CREDIT SHALL BE OFFERED AS FOLLOWS:

a. Credit for MATH 130 will be offered to those scoring a 3 on the AP Statistics Exam.

b. Credit for MATH 130 or Math 235 (depending upon their major) will be offered to those scoring a 4 on the AP Statistics Exam.

c. Credit for MATH 235 will be offered to those scoring a 5 on the AP Statistics Exam.

d. These courses are not part of the required or elective courses in the curriculum for a bachelor's degree in mathematics. The credits do count toward the 120 credits required for graduation.

3. MATH 160 (Precalculus) vs. MATH 161 (Calculus I) Placement

The Precalculus course (MATH 160) is offered for students whose mathematics background is not sufficiently strong to enable them to succeed in Calculus I (MATH 161). MATH 160 covers topics in which beginning calculus students are often deficient: elementary functions, theory of equations, inequalities, trigonometry, and analytic geometry. This course may not be counted toward the major in mathematics, but does count as an elective toward graduation.

University policy requires each student, regardless of major, to have his/her mathematics competency evaluated before being permitted to register for either MATH 160 (Elementary Functions) or MATH 161 (Calculus I). For most new, entering students, this will be done during the orientation process through a Mathematics Placement Test (MPT). The MPT tests knowledge of algebra, trigonometry and elementary functions.

Because of weak backgrounds in precalculus mathematics, some students who may have completed high school calculus will be required to take MATH 160 before continuing on to calculus.

If a student feels that he/she has been placed improperly into a particular mathematics course, he/she is encouraged to discuss the matter with the Mathematics Placement Coordinator (Dr. Delray Schultz) in the Mathematics Department.

E. Individualized Study

Within the departmental major programs several types of individualized study experiences are available to seriously motivated students in unusual circumstances. These include:

1. Courses by Examination

Subject to approval by the Registrar's Office and by the department offering the course, any course in which the student would normally be permitted to enroll, and has not already received a grade, may be challenged "by examination."

2. Courses by Arrangement

Subject to approval by the department chairperson and the school dean, a faculty member may agree to provide an established course to a student on an individual basis, if the course is not being offered in a given semester in which the student needs that course.

3. Independent Study

This is a project-oriented experience designed to allow a student to extend and deepen his/her knowledge in an area of keen interest, through a program of study which is not available through an established course. It involves supervision by a faculty member competent in that area of study.

F. Departmental Honors Program

The purpose of the Mathematics Departmental Honors program is to provide advanced undergraduate students with a research experience in statistics, pure or applied mathematics or mathematics education.

The minimum eligibility requirements to participate in the departmental honors program are: completion of Math 310, 322, 311 and one mathematics major course at the 300 level or higher, a Millersville QPA of 3.00 or higher, a Millersville Math QPA of 3.35 or higher and the recommendation of a mathematics faculty member who is willing to be the project supervisor and thesis advisor.

Types of acceptable projects include:

a. original research in an area of statistics, pure or applied mathematics or mathematics education;

b. creative exposition of material from one of the above four areas not covered in a regular Math Department course offering;

c. creative mathematical modeling for the solution of a real-world problem of substantial complexity.

Additional information is available in the current university catalog, **Departmental Honors Program**, page 40. Specific guidelines and additional details are given in the Mathematics Departmental Honors Program Policy Statement which is available from the departmental office. Students wishing to participate must meet departmental criteria and follow formal application procedures. Further information may be obtained from your faculty advisor and the department chairperson.

G. Deviations from Policy

Ordinarily a student will not be permitted to deviate from any of the policies set forth in this handbook or the university catalog. In those unusual circumstances in which a deviation may seem justified, the student must not presume that it will be allowed. In all matters regarding deviation from departmental policy, permission must come from departmental action.

Any student who, after serious consultation with his/her faculty advisor, feels justified in requesting a deviation must submit a letter to the Department Chairperson setting forth his/her request along with a detailed justification. After consulting with appropriate faculty and administration, the Department Chairperson will respond in writing.

XI. DEPARTMENTAL POLICIES ON THE EVALUATION OF MAJORS

A. POLICIES FOR ADMISSION TO THE MAJOR

1. New students (freshmen and transfers) are admitted to the mathematics major by the Office of Admissions upon admission to the University.

2. Admission to the Mathematics major from other majors (or from the "undeclared" major) is upon approval of the chairperson of the Department of Mathematics. A "C-" or better in Math 161 and all Math courses already taken which count toward a Math major is required for admission.

3. Non-degree and continuing education students are admitted to the mathematics major by the Office of Admissions, subject to approval by the chairperson of the Department of Mathematics.

B: POLICIES FOR RETENTION IN THE MAJOR

1. University requirements for retention.

2. A mathematics major taking any Math course required as a prerequisite for a later Math course must earn a grade of "C-" or better in that course before taking the later course for which it is a prerequisite.

   A student is only allowed to attempt a course 3 times. A student who drops a course during the Drop Period will have no record of the dropped course on his/her transcript, nor does the course count as an official attempt at the course. After the Drop Period has passed, a student may withdraw from a class until the end of the 10^{th} week of class. A withdrawal is recorded as a grade of "W" on a student's transcript, and counts as an attempt at the course. See page 46 in the undergraduate catalog for further details.

3. Each semester the Department of Mathematics will review the progress of each major according to the following criteria:

   a. A major must have a minimum QPA of 2.00 computed over all Millersville mathematics major courses taken to date;

   b. Except in unusual circumstances, a mathematics major must be enrolled each semester in at least one mathematics major course.

   A major not meeting these criteria will be placed on "**probation in the major**."

4. A mathematics major may take a mathematics course a maximum of two times without penalty. A student taking a course a third time will be placed on probation-in-the-major for the semester. A student who does not earn a satisfactory grade on the third attempt will be dropped from the major.

5. A student who is placed on probation-in-the-major will be informed of that fact by letter. The letter will stipulate what the student must do to be removed from probation, and a timetable for achieving it. If the student is not successful in meeting these stipulations, the student may be removed from the major.

6. A student who has been placed on probation-in-the-major or removed from the major may appeal in writing to the chairperson of the department for reconsideration.

C. POLICIES FOR COMPLETION OF THE MAJOR

1. A student must meet all university and departmental curricular requirements.

2. A mathematics major must have a QPA of at least 2.00 computed over all Millersville mathematics courses required for the major.

3. At least half the course requirements in the major department must be met at Millersville.

4. No course required for the major may be taken Pass-Fail.

5. No student will be admitted to MATH 405 who has not achieved a grade of "C-" or better in each of MATH 161, 211, 310, 333 (or 335/435), 322, 311, 345, and 353 (or 355). In addition, B.S.E. students are required to submit and maintain samples of work for their content portfolios. These submissions must be up to date prior to entry into MATH 405.

6. Prior to student teaching, each student in the B.S.E. program is subject to a departmental review. No student will be allowed to student teach who has not first earned a "C-" or better in MATH 405.

D. RECOGNITION OF STUDENT ACHIEVEMENT

The department maintains a **CHAIRMAN'S LIST** and a **DEPARTMENTAL HONORS LIST** to recognize students who are doing outstanding academic work. These lists are compiled at the close of each semester, and are displayed prominently in Wickersham Hall.

The **Chairman's List** consists of all mathematics majors who have taken at least four courses in the department and who have maintained a cumulative grade point average of 3.60 or better in their math courses.

The **Departmental Honors List** consists of all mathematics majors who have been recommended by their professor for outstanding achievement that semester in a particular course. This is understood to be a more selective criterion than that of receiving a grade of "A". It is recognition for a truly superior accomplishment, and is awarded at the discretion of the professor.

Students who earn the distinction of being included in either of these lists are notified by the department in an official letter of recognition. The student's advisor also receives a copy of this letter, for inclusion in his/her file.

Since 1995, the department has hosted an annual Awards Banquet to recognize students achieving meritorious performance in mathematics. The banquet is held each April.

XII. STUDENT INVOLVEMENT

A. Tutoring

The Mathematics Department offers tutorial services to any student needing assistance in certain basic areas. This program employs qualified students as tutors. **The need for good mathematics tutors is especially high.** Working as a student tutor is an excellent opportunity to gain experience, deepen one's own understanding of basic mathematical concepts and techniques, and earn a little money--all within a meaningful, non-traditional context.

B. Computer Consulting

The Information Technology Department employs qualified students as consultants working in the various computer laboratories across campus, to help users with hardware and software problems. For further information, contact the Information Technology office.

C. Student Assistants

The department employs several students to work in various capacities such as:

1. Clerical office work
2. Assisting professors with large-group courses, by conducting help-sessions, and by assisting in class.

D. Weekly Mathematics Colloquia

The Mathematics Departments of Millersville University and neighboring Franklin & Marshall College sponsor a weekly series of hour-long talks on a wide range of mathematical topics. The list of speakers and their topics is posted in Wickersham Hall and the departmental web page. Speakers include Millersville and Franklin & Marshall faculty (from both in and outside of the Mathematics Departments) as well as mathematicians from other colleges and universities. Many of the talks are accessible to undergraduate students.

E. Math Club (Mu Kappa Mu)

1. What is Mu Kappa Mu (MKM)?

   MKM is a student organization planned and coordinated by the mathematics students and faculty. Activities are scheduled according to the level of student interest and supported by several members of the mathematics faculty.

2. The purpose of MKM is to:

   a. Encourage **mathematical scholarship** through recreational problem solving, dialogue with mathematics students and faculty, and mathematical input via films, seminars and special lectures. Establishing a student chapter of MAA (the Mathematical Association of America) and/or NCTM (National Council of Teachers of Mathematics) and affiliation with Pi Mu Epsilon (the National Math Honor Society) are eventual goals.

b. Gain knowledge of **mathematical career options** by sponsoring visits by practicing professionals and sharing information gained through individual research.

c. Build **social relationships** by meeting regularly with mathematics students and faculty and by structuring social/recreational activities.

d. Provide mathematically related **services** by staffing tutorials and assisting with administration of the annual High School Math Contest.

F. Department Socials

The department sponsors several social events each year, such as picnics, recreation, and banquets. They provide excellent opportunities for students and staff to "mix" informally. In addition, the Math Club has sponsored book sales, T-shirt sales, field trips, and other activities.

G. Mathematics Educators at Millersville University (MEMU)

MEMU was created to foster student interest and participation in teaching mathematics (K-12) as a career option. MEMU meets monthly during the Fall and Spring semesters to discuss relevant issues in teaching and learning mathematics, to plan and facilitate a math fair for 2nd – 5th graders at a local elementary school, and to coordinate efforts to participate in local (e.g., Math Competition, MathCounts) and statewide (e.g., Pennsylvania Council of Teachers of Mathematics Annual Conference) activities related to future mathematics teachers

XIII. SUGGESTIONS FOR STUDENTS PREPARING FOR GRADUATE SCHOOL IN MATHEMATICS AND STATISTICS

There is continuing demand for persons who hold graduate degrees in the mathematical sciences, especially in statistics and other applied areas. The need for college and university professors of mathematics and statistics will continue to be high for the foreseeable future. At the same time, government, business and industry all rely on statisticians for a nearly unlimited range of research support and on applied mathematicians for the mathematical solution of problems arising in engineering and other areas.

Graduate schools are competing for students, so your prospects for scholarships, assistantships, and fellowships are very good. If you demonstrate superior mathematical ability as an undergraduate, you may reasonably expect to pursue graduate study at minimal cost. Cost should not be a factor in your decision to pursue graduate study in mathematics.

Letters of recommendation written by your professors who can speak to your mathematical ability carry much weight when applying for admission to graduate schools. Professors who know you personally and for whom you were an "A" student will write strong letters on your behalf. A senior independent study project under a professor's direction provides one of the best settings for this to happen.

Finally, your success in graduate school depends upon the mathematical foundation you lay while at Millersville University. While you will find some courses more enjoyable than others, all courses are important and should be taken seriously. Abstract algebra, Linear Algebra, Real Analysis, and Mathematical Statistics are each offered in a two semester sequence. The second semester of these sequences is designed with the prospect of graduate study in mind. Whenever possible, and in consultation with your advisor, try to complete both semesters of these two-semester offerings. A list of specific recommended courses is found in section X.B.

XIV. CATALOG DESCRIPTIONS OF MATHEMATICS COURSES FOR MAJORS

MATH 160 – Precalculus (4 s.h.)

Prerequisites: High School Algebra I and II, Geometry and Trigonometry or equivalent.

Designed for persons intending to continue into Calculus, who are not adequately prepared to begin their mathematics sequence with Calculus I (MATH 161). Covers topics in which beginning calculus students are often deficient: elementary functions, curve sketching, theory of equation, inequalities, trigonometry and analytic geometry. Math placement testing/evaluation before registration is required. This course does not count toward a major in mathematics.

MATH 161 - Calculus I (4 s.h.)

Prerequisites: C- or better in MATH 160, or Math Placement Testing/Evaluation.

Introduces the concepts and techniques of Calculus, beginning with limits. Major emphasis is on the theory and applications of continuity, derivatives, anti-derivatives and the definite integral. Includes introductory calculus of trigonometric, inverse trigonometric, exponential and logarithmic functions; L'Hopital's Rule.

MATH 163 - Honors Calculus I (5 s.h.)

Prerequisite: Permission of department.

A more in-depth and enriched introduction to the concepts and techniques of elementary calculus than that provided in MATH 161.

MATH 211 - Calculus II (4 s.h.)

Prerequisite: C- or better in MATH 161 or 163.

Continuation of MATH 161. Techniques of integration, applications of the definite integral, improper integrals, parametric equations, polar coordinates, infinite sequences and infinite series.

MATH 301 - History of Mathematics (Perspectives) (3 s.h.)

Prerequisite: C- or better in MATH 161, or 163.

The progression of mathematical concepts, in the context of the thought and civilization of the time, from the Babylonians to the 20th Century. Focus on the contributions of the Hellenic and Alexandrian Greeks as a point of departure for the evolution of geometry, number theory, analysis and logic. Proofs of some of the great theorems. **This course counts for Perspectives credit only and not toward a major in mathematics.**

MATH 310 - Introduction to Mathematical Proof (3 s.h.)

Prerequisite: C- or better in MATH 211.

Emphasizes mathematical reasoning and communication of mathematical ideas, both orally and in writing. Symbolic logic. Techniques of mathematical proof. Algebra of sets, binary relations and functions. Infinite sets, both countable and uncountable. (This course counts as a Writing (W) course in the General Education curriculum).

MATH 311 - Calculus III (4 s.h.)

Prerequisite: C- or better in MATH 211.

Continuation of MATH 211. Vector calculus, functions of several real variables, partial differentiation, implicit functions, multiple integrals, line and surface integrals, and applications.

MATH 312 – Software for Multivariable Calculus (1 s.h.)

Prerequisite or Corequisite: C- or better in MATH 311.

This course will introduce students to a computer algebra system and programming language of use in understanding multivariable calculus. Assuming no prior experience with this software, the students will learn how to evaluate algebraic expressions, plot functions, and perform many operations common in calculus such as integration and differentiation. Students will develop skills with this software that are useful for the visualization and manipulation of multivariable and vector-valued functions.

MATH 319 - Calculus and Actuarial Science Problem Solving Seminar (1 s.h.)

Prerequisite: C- or better in MATH 311.

An extension and synthesis of the calculus sequence that provides students with the problem solving skills emphasized in such examinations as the Society of Actuaries Exam 100, the Graduate Record Exam, and the Advanced Placement Calculus Exams. Does not count as an upper division elective for the mathematics major or minor.

MATH 322 - Linear Algebra (4 s.h.)

Prerequisite or Corequisite: C- or better in MATH 311 (MATH 310 recommended).

A rigorous introduction to linear algebra. Includes systems of linear equations, matrix algebra, determinants, vector spaces, inner product spaces, geometry in R^n, linear transformations, orthogonal transformations; eigentheory, and diagonalization.

MATH 333 - Introduction to Probability and Statistics (4 s.h.)

Prerequisite: C- or better in MATH 311.

Designed for mathematics education majors. A rigorous one-semester study of probability, distribution theory and the basics of statistical inference. Includes probability, expectation, discrete and continuous distributions, descriptive statistics and both estimation and hypothesis testing for one and two-sample problems. No credit for both MATH 333 and 235 or for both MATH 333 and MATH 335.

MATH 335 - Mathematics Statistics I (3 s.h.)

Prerequisite: C- or better in MATH 311.

Probability, random variables and probability distributions, mathematical expectation, special probability distributions and probability densities. MATH 335 may be considered as an introductory course in probability theory.

MATH 345 - Abstract Algebra I (3 s.h.)

Prerequisite: C- or better in MATH 310 and 322.

Groups, rings, fields, and integral domains. Emphasis on the structure of algebra.

MATH 353 - Survey of Geometry (3 s.h.)

Prerequisites: C- or better in MATH 310 and 322, or permission.

Various examples of axiom systems, brief exposition of Euclidean geometry using Hilbert's axioms. Growth and development of geometry, non-Euclidean geometries and projective geometry. Elementary projective geometry from both the synthetic and analytic point of view.

MATH 355 - Transformational Geometry (3 s.h.)

Prerequisite: C- or better in MATH 310 and 322, or permission.

The study of geometry from a transformational point of view. The group of affine transformations, with the subgroups of similarities and motions, is studied with investigation of invariant properties. Some exposure to transformations in the complex plane.

MATH 365 - Ordinary Differential Equations (3 s.h.)

Prerequisite C- or better in MATH 311.

First order differential equations, linear first and second order initial value problems, power series solutions, and applications. Also includes at least one of the following topics: special functions of mathematical physics, Laplace transforms, systems of first order equations.

MATH 370 - Operations Research (3 s.h.)

Prerequisites: C- or better in MATH 322 and one of MATH 235, 333 or 335.

Principles of model building; examples from linear optimization, network analysis, dynamic programming, probabilistic decision theory, Markov chains, queuing theory, simulation and inventory models. Applications and theory will be examined.

MATH 375 - Numerical Analysis (3 s.h.)

Prerequisites: CSCI 161, and C- or better in MATH 311 and 322.

Numerical methods for solving systems of linear equations, solving nonlinear equations, integration, interpolation, approximation, and least squares curve fitting. Error theory.

MATH 393 - Number Theory (3 s.h.)

Prerequisite: C- or better in MATH 310.

The study of the properties of integers with respect to the fundamental operations. Primary emphasis on the logical derivations of these properties. Includes induction, divisibility, congruences, theorems of Fermat and Euler, continued fractions, and quadratic reciprocity.

MATH 395 - Introduction to Combinatorics (3 s.h.)

Prerequisite: C- or better in MATH 322.

Mathematical foundation for the concepts and techniques used in combinatorics. Topics include recurrence relations, finite differences, generating functions, pigeonhole principle, special sequences of integers (such as Fibonacci, Sterling, and Bell sequences), principle of inclusion and exclusion, and an introduction to the theory of graphs. Applications will be indicated.

MATH 405 - Teaching of Mathematics in the Secondary School (5 s.h.)

Prerequisites: C- or better in MATH 345, MATH 353 (or 355), and MATH 333 (or 335/435).

Place and function of mathematics in secondary education; evaluation and improvement of instruction; current trends in objectives, methods, and subject matter of junior and senior high school mathematics. A considerable portion of class time is devoted to teaching mathematics to secondary school students.
NOTE: This course is taken simultaneously with EDSE 321, and **should be taken the semester immediately proceeding the student teaching semester.**

MATH 422 - Linear Algebra II (3 s.h.)

Prerequisite: C- or better in MATH 322.

A continuation of MATH 322. Topics include further theory of linear transformations and their matrix representations: invariant subspaces, equivalent and similar matrices, canonical forms. The vector space L(V,W). Orthogonal transformations and isometries; analysis of Euclidean motions in R^3. Least squares approximation and theory of generalized inverses. Bilinear and quadratic forms and their matrix representations; applications to conic sections in R^2 and quadric surfaces in R^3. Complex vector spaces.

MATH 435 - Mathematical Statistics II (3 s.h.)

Prerequisite: C- or better in MATH 335.

A continuation of Mathematical Statistics I. Functions of random variables, sampling distributions, point estimation, interval estimation, hypothesis testing theory and applications.

MATH 445 - Abstract Algebra II (3 s.h.)

Prerequisite: C- or better in MATH 345.

Continuation of MATH 345. Introduction to field theory, rings of polynomials, and introduction to Galois theory.

MATH 457 - Elementary Differential Geometry (3 s.h.)

Prerequisites: C- or better in MATH 310, 311, and 322.

Frenet frames; curvature and torsion of curves in 3-space. Calculus of vector fields; geodesics and curvature of surfaces in 3-space. Surface area and volume. The Euler characteristic of a surface and the Gauss-Bonnet theorem. Rigid motions and isometries. Riemannian metrics, parallelism, non-Euclidean geometries and applications.

MATH 464 - Real Analysis I (3 s.h.)

Prerequisites: C- or better in MATH 310, 311, 322 and 345.

Rigorous development of the concepts and methods of calculus. The real number system and its topology; theory of limits and continuity; differentiable functions and their properties; the Riemann integral.

MATH 465 - Real Analysis II (3 s.h.)

Prerequisite: C- or better in MATH 464.

Continuation of MATH 464. Topics chosen from the following: convergence and uniform convergence of infinite sequences and series of functions; topology of Euclidean n-space R^n; differential calculus of functions $R^n \to R$ and $R^n \to R^m$; extreme values; implicit and inverse function theorems; Riemann integration in R^n; metric spaces; function spaces; Riemann-Stieltjes integration.

MATH 467 - Partial Differential Equations (3 s.h.)

Prerequisite: C- or better in MATH 365.

Fourier series and the method of separation of variables; the wave equation, heat equation and Laplace's equation; d'Alembert's formula. Maximum principles, energy integrals and uniqueness. Sturn-Liouville problems and eigenfunction expansions.

MATH 471 - Mathematical Modeling (3 s.h.)

Prerequisite: C- or better in MATH 365.

Applications of mathematics to real-world problems drawn from industry, research laboratories, the physical sciences and engineering, and the scientific literature. May include parameter estimation, curve-fitting, elementary probability, optimization, computer programming and ordinary and partial differential equations.

MATH 472 --- Financial Mathematics (3 s.h.)

Prerequisite: C- or better in MATH 311 Note: Some background in elementary statistics is recommended.

The mathematical analysis of investment emphasizing the time value of money, rates of return for investment cash-flow sequences, utility functions, stochastic processes, mean--variance analysis, portfolio selection, hedging strategies, the capital assets pricing model, and the Black-Scholes theory of options. This course will also introduce some of the topics covered on the Course 2 and Course 3 actuarial exams jointly administered by the Society of Actuaries. A brief overview of relevant topics from probability and statistics is included in the course.

MATH 483 - Point-set Topology (3 s.h.)

Prerequisite: C- or better in MATH 464 or permission.

Foundation course for extensive study in modern higher analysis and topology, and related areas. Infinite set theory, metric spaces, topological spaces, separation properties, continuous mappings, homeomorphisms, convergence theory, product spaces, quotient spaces, connectedness, compactness, function spaces, applications.

MATH 535 - Statistical Methods I (3 s.h.)

Prerequisite: C- or better in MATH 333 or 335.

A survey of statistical methods currently used in research, education, behavioral science and biomedical application. Various experimental designs are discussed regarding advantages, disadvantages, sampling problems, analysis and conclusions. Regression and correlation analysis, analysis of variance and nonparametric approaches are included.

MATH 536 - Statistical Methods II (3 s.h.)

Prerequisite: C- or better in MATH 535 or permission.

A continuation and extension of the statistical methods introduced in MATH 535 (Statistical Methods I). Coverage includes advanced topics in regression analysis, analysis of variance, experimental design, nonparametric statistics, categorical data analysis and censored data.

MATH 537 - Statistical Problem Solving Seminar (1 s.h.)

Prerequisite: C- or better in MATH 535.

This is a capstone course, designed to serve as an outcome assessment for the for mathematics majors enrolled in the Actuarial Science/Statistics option. The course will involve problem solving, data analysis and statistical consulting. Materials for the course will be drawn from real-world problems encountered by local industry and the experience of the course instructor. Reading materials will be assigned from the literature related to statistical consulting. Students will work both individually and in teams.

MATH 566 - Complex Variables (3 s.h.)

Prerequisites: C- or better in MATH 311 and 322.

A study of functions of a complex variable, complete enough to contain and illustrate the essential features of the subject. Applications are indicated.

MATH 592 – Graph Theory (3 s.h.)

Prerequisites: C- or better in MATH 322.

A study of finite graphs, multigraphs, digraphs, and networks from theoretical, practical and historical perspectives. Specific topics will include isomorphisms, graph invariants, planarity and nonplanarity, traversability, colorings, flows, matchings and optimization algorithms.

XV. FACULTY & STAFF OF THE DEPARTMENT OF MATHEMATICS

The Department of Mathematics is housed in Wickersham Hall, which fronts the picturesque campus lake. This building houses virtually all the mathematics courses, the Departmental Office and offices of the faculty of this department, various computer user facilities, and the departmental study/seminar room.

FULL-TIME FACULTY (2011-2012)
(offices, phone extensions and e-mail addresses)

SCHULTZ, DELRAY J. **(Department Chair)** (W-208A-1, x7314)
Statistics, Applied Statistics, Biostatistics Delray.Schultz@millersville.edu

BUCHANAN, J. ROBERT (W-216-1, x7305)
Applied Mathematics, Differential Equations, Robert.Buchanan@millersville.edu
Mathematical Finance

CARDWELL, ANTONIA E. (W-206B-1, x7306)
Functional Analysis, Operator Theory Antonia.Cardwell@millersville.edu

CATEPILLÁN, XIMENA P. (W-211C-1, x7307)
Analysis, Operator Theory Ximena.Catepillan@millersville.edu

FENWICK, JAMES W. (W-109B-1, x7309)
Statistics, Applied Statistics James.Fenwick@millersville.edu

HAN, ZHIGANG (W-216-1, x7310)
Geometry, Topology Zhigang.Han@millersville.edu

HEITMAN, NOEL (W-214B-1, x7311)
Applied Mathematics, Numerical Analysis Noel.Heitman@millersville.edu
Computational Fluid Dynamics

IKENAGA, BRUCE M. (W-105B-1, x7312)
Algebra, Group Cohomology Bruce.Ikenaga@millersville.edu

MA, BAOLING (W-207C-1, x4263)
Applied Mathematics, Differential Equations Baoling.Ma@millersville.edu

MOSS, ERIN R. (W-214C-1, x5903)
Math Education Erin.Moss@millersville.edu

ROBINSON, KEVIN S. (W-110-1, x7313)
Statistics, Applied Statistics Kevin.Robinson@millersville.edu

SHAO, ZHOUDE (W-211B-1, x7315)
Applied Mathematics, Dynamical Systems Zhoude.Shao@millersville.edu

TAYLOR, CYNTHIA (W102-1, x7317)
Mathematics Education Cynthia.Taylor@millersville.edu

UMBLE, RONALD N. (W-203-1, x7318)
Algebraic Topology, Rational Homotopy Theory Ronald.Umble@millersville.edu

WASHINGTON, H. TYRONE (W-202-1-1, x7319)
Mathematics Education

WHITE, JANET A. **(Assistant Department Chair)** (W-208B-1, x7320)
Mathematics Education, Technology, Secondary Methods Janet.White@millersville.edu

WISMER, MICHAEL G. (W-109C-1, x7321)
Mathematics Education, Curriculum & Instruction Michael.Wismer@millersville.edu
Middle School Mathematics Methods

ZHAN, MINGQUAN (W-206C-1, x7122)
Discrete Mathematics, Graph Theory Mingquan.Zhan@millersville.edu

PERMANENT PART-TIME FACULTY

GARBER, DIANA (W-109-A1, x5267)
Diana.Garber@millersville.edu

SECRETARY

CODY, KATHRYN (W-208, x7668)
Kathy.Cody@millersville.edu