

PENNSSTATE



Department of Mathematics  
Eberly College of Science

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**UNDERGRADUATE**  
**MATHEMATICS**  
**HANDBOOK**

**SUMMER 2011 – SPRING 2012**

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## Chapter 1

### Introduction

Welcome to the Mathematics Program! We hope your experience as a mathematics major is a rewarding one. Mathematics is not only a fascinating subject of great intrinsic beauty, its wide applicability to the natural and social sciences is also universally recognized. The Mathematics Program offers two degrees: the B.A. Degree and the B. S. Degree. Our curriculum emphasizes the development of analytical skills and independent thinking which is vital in an ever-changing world.

In this handbook, we give an overview of the various options available within the Mathematics Program and their course requirements. When planning your program of studies, use the check sheets in this handbook together with information available online (online advising service at <http://www.elion.psu.edu>, Undergraduate Degree Bulletin at <http://www.psu.edu/bulletins/bluebook>), and consult your academic advisor. \*For more information about anything pertaining to the Undergraduate Mathematics Program, please consult your academic advisor (if you are currently mathematics major) or the Mathematics Undergraduate Studies Director in 104 McAllister Building, (814)865-7528, [undergrad@math.psu.edu](mailto:undergrad@math.psu.edu)

### Admission and Retention

#### Entrance to the Eberly College of Science

Any student entering the college may gain entrance into the college if the following requirements have been met:

1. The student must have a 2.00 cumulative grade point average.
2. The student must have completed MATH 140 with a grade of C or better

#### Entrance to Mathematics Major

Completion of both MATH 140 and 141 with a grade of C or better in both courses and a cumulative grade point average of at least 2.0 is required for entry into the mathematics major.

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\* To make an appointment with your advisor, please call the Undergraduate Mathematics Office, (814)865-7528, or send him/her an email message. You can find his/her email address at <http://www.math.psu.edu/UG/advisors.htm>

### **Special Options within the Major**

The Department offers seven options under the B.S. Degree program. The choice of an option depends on your own interests as well as your career plans. It is an important choice because the course requirements differ greatly. These differences, for the most part, are only in the junior and senior years. This means that you can put off the choice of an option until as late as your fifth semester. If possible, this decision should not be made much later. Descriptions of the different options are given later in this handbook. You are encouraged to talk to your advisor for more information.

### **Areas of Application**

The Applied Analysis, General Mathematics, and Systems Analysis options under the B.S. Degree program require an approved sequence of courses in an area of application. In these options, you are preparing to apply mathematics to solving problems in specific areas outside mathematics. This means that you must learn both the mathematics relevant to those areas and at least enough of the area of application to be able to communicate with the experts in that area. The courses chosen must form a coherent pattern and should include one or two 400-level courses. Be sure to have your course selections approved, in writing, by your advisor.

### **Supporting Courses**

These are optional courses that students can select. You can use these courses to fulfill minor requirements in another subject. For restrictions, see Appendix B.

### **General Education**

Every student must complete 45 credits of General Education courses. The course selections are designed to provide you with a well-rounded academic experience within an integrated curriculum that allows for individual flexibility. General Education courses may be relevant to your major or to your particular interests. The Baccalaureate Degree General Education program consists of two components: (1) Skills and (2) Knowledge Domains for a total of 45 credits. The Skills component includes: Writing/Speaking (9 credits) and Quantification (6 credits). The Knowledge Domains include: Health and Physical Activity (3 credits), Natural Science (9 credits), Arts (6 credits), Humanities (6 credits), and Social and Behavioral Sciences (6 credits). For a complete listing of all approved courses in the Skills and Knowledge Domains, please refer to the website [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm).

### **Concurrent Majors**

A candidate receiving approval from the colleges involved may gain entrance to more than one major. The idea of majoring in two areas in order to broaden one's knowledge is a good one, but such a program requires ability and diligence. Anyone interested in taking on a second major should first speak with the Director of Undergraduate Studies in both of the departments concerned. The final academic record shall indicate the completion of the requirements for each major. For more information, see <http://www.psu.edu/dus/handbook/concurrent.html>. Note that students will not be allowed to complete concurrent majors in computer science or computer engineering and mathematics with the computational option. However, computer science majors can complete a concurrent major in mathematics with any option other than the computational option.

## **Minors in Other Disciplines**

Mathematics students are strongly encouraged to pursue minors in fields outside of mathematics. The interdisciplinary nature of the mathematical sciences allows for combining and integrating many different subjects within the mathematics B.A. and B.S. programs. The selection of courses for the area of application and supporting courses of the mathematics majors can be done to simultaneously fulfill the requirements for minors in other subjects. The minors listed below can be efficiently combined with a B.S. degree in mathematics.

1. Statistics
2. Economics
3. Information Science and Technology
4. Interdisciplinary Minors

For a listing of available minors, visit the web site <http://www.psu.edu/dus/handbook/minors2.html>.

## **Honors Courses and the University Scholars Program**

Several hundred of the most talented Penn State undergraduates are in the University Scholars Program. For incoming students, admission to this program takes place via a separate application reviewed by the Faculty Selection Committee. For students already here, admission to the program is determined on the basis of cumulative grade point average every semester. To graduate in the program a student must take a certain minimum number of credits in courses with an honors designation and write an Honors Thesis. More information about the Scholars Program is available at the Program Office in 10 Schreyer Honors College or at <http://www.scholars.psu.edu>. The Mathematics Department teaches honors sections of several courses. It is possible for a student not in the Scholars Program to enroll in honors sections. For more information, see the Director of Undergraduate Studies in 104 McAllister Building.

## **The Minor in Mathematics**

The minor is designed to provide students with an interest in mathematics an opportunity to study a broad range of mathematical topics. The requirements allow students a great deal of flexibility in choosing courses of interest. To earn the mathematics minor, students must take MATH 140 GQ(4) and MATH 141 GQ(4); select 6-8 credits from MATH 220 GQ(2), 230 (4), 231 (2), 232 (2), 250 (3), 251 (4), 310 (3), 311W (3), or 312 (3); and select 12 credits from 400-level MATH courses. A total of 26-28 credits is required for the minor. A grade of C or better is required for all courses in the minor. For more information on the mathematics minor, including the mathematics minor application form, please see <http://www.math.psu.edu/UG/minor.htm>.

## **Evaluation of Courses from Other Universities**

Each student who applies for courses to be transferred to Penn State is required to have a transcript sent to the Office of Admissions. When a course taken elsewhere is believed equivalent to a course given at Penn State, credit for that specific Penn State course is assigned and an entry made in the "Course Number" column of the student's transcript. If such a correspondence cannot be made, general credits (denoted "GEN" in the "Credits" column) are assigned as appropriate. The general credit designation does not imply that the credits cannot be transferred, but merely that the Office of Admissions is unable to establish the degree of overlap between a course taken elsewhere and a course offered at Penn State. The general credit designation implies that the student has the responsibility for obtaining assessments of course equivalencies "as appropriate." The determination of "appropriateness" is left to the individual colleges. For the College of Science, the policy depends on the type of course for which general credit has been assigned.

### **Cooperative Education Program**

The Cooperative Education Program gives students a chance to integrate their academics with relevant workplace experience. Students gain an understanding of how to apply their learning experience in an academic and non-academic setting. Requirements to participate in a mathematics co-op are a cumulative grade point average of 2.00 or above and prior completion of 30 credits of coursework. Note that some companies may request more stringent requirements.

For further information on The Eberly College of Science Cooperative Education Program, see <http://www.science.psu.edu/career>.

### **MASS Program**

MASS is a semester-long program that provides a comprehensive mathematical environment for a group of talented undergraduate students selected from colleges and universities across the country. The program combines advanced learning with research initiation. For more information, see <http://www.math.psu.edu/mass>.

### **Careers for Mathematics Graduates**

A mathematics degree is a useful qualification when it comes to looking for a career. This is because mathematics is used in a variety of areas of employment. For information about careers for mathematics graduates, you are strongly encouraged to visit <http://www.math.psu.edu/ug/careers.html>. You are also welcome to talk to the Director of Undergraduate Studies in 104 McAllister Building.

## Chapter 2

### Bachelor of Arts Degree in Mathematics

This degree program is intended for students whose interests outside mathematics are oriented toward the arts, humanities and social sciences. The requirements in these areas are greater than for the B. S. Degree. (See Appendix C).

Students in this degree program are strongly encouraged to select an area where mathematics is applied. These courses can be used as Supporting Courses. Areas similar to those in the B.S. Degree can be used.

The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are Supporting Courses (Appendix B of the Department Handbook).

Bachelor of Arts Check Sheet (120 credits)

<b>MAJOR REQUIREMENTS (41-42 credits)</b>	
<b>MATH 140</b> (4) ____	<b>CHOOSE 3 CREDITS BELOW:</b>
<b>MATH 141</b> (4) ____	
<b>CMPS 101</b> (3) ____ or <b>CMPS 121</b> (3) ____ or <b>CMPS 201</b> (3) ____	
<b>MATH 220</b> (2) ____	
<b>MATH 230</b> (4) ____	
<b>MATH 250</b> (3) ____ or <b>MATH 251</b> (4) ____	
<b>MATH 311W</b> (3) ____	<b>MATH</b> _____ (3) ____
<b>MATH 312</b> (3) ____	<b>MATH</b> _____ (3) ____
<b>MATH 403</b> (3) ____	
<b>MATH 435</b> (3) ____ or <b>MATH 436</b> (3) ____	

TOTAL CREDITS \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

**BACHELOR OF ARTS DEGREE**

<b>BACHELORS OF ARTS REQUIREMENTS (39-40 credits)</b>		
FOREIGN LANGUAGE (12):	BA Knowledge Domains (9 CR)	SUPPORTING COURSES (15-16)
LEVEL I: _____ (4) _____	_____ ( ) _____	_____ ( ) _____
LEVEL II: _____ (4) _____	_____ ( ) _____	_____ ( ) _____
LEVEL III: _____ (4) _____	_____ ( ) _____	_____ ( ) _____
OTHER CULTURES (3 CR):		_____ ( ) _____
_____ ( ) _____		_____ ( ) _____

TOTAL CREDITS \_\_\_\_\_

Foreign Language – Proficiency in a single foreign language equivalent to completion of three semesters of course work must be demonstrated. If fewer than 12 credits are needed to reach this level of proficiency, then choose courses from the Mathematics Department Supporting Courses List (Appendix B in the Department Handbook) to total 12 credits. Policies regarding placement in a foreign language can be found in Appendix A of the Department Handbook.

BA Knowledge Domains – Students must complete 9 credits in any one of these areas or any combination of areas. However, mathematics majors may not satisfy this requirement by taking quantification (GQ) courses. See <http://www.psu.edu/bulletins/bluebook/gened/bad.html> for details on the courses which can be used to satisfy this requirement.

Note: Other Cultures courses do not double count as US/IL courses.

Supporting Courses – A list of supporting courses appears in Appendix B in the Department Handbook.

BACHELOR OF ARTS DEGREE

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA)	SOCIAL BEHAVIORAL SCIENCE (6 CR)
ENGL 202 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
CAS 100 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
NATURAL SCIENCE (9 CR) (GN)	HUMANITIES (6 CR) (GH)	HEALTH/PHYS. ACT. (3 CR) (GHA)
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )		
_____ ( )		
WRITING ACROSS THE CURRICULUM _____	US CULTURES (3 CR) (US)	FIRST YEAR SEMINAR _____ (1) ____
	_____	
	INTERNATIONAL CULTURES (3 CR) (IL) _____	

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Arts Degree in Mathematics  
(MTHBA at University Park)**

**Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
ENGL 015 or 030 (GWS)	3	Foreign Language	4
Natural Science (GN)	3	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
First Year Seminar	1	Natural Science (GN)	4
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Foreign Language	4	CMPS 101 or CMPS 121 or CMPS 201	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	CAS 100 A, B, or C (GWS)	3
		Select 3 credits of supporting courses in consultation with academic advisor.	3
Total Credits	14	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH 411 or 412 or 417 or 419 or 421</b>	3	<b>MATH 435 or 436</b>	3
Natural Science (GN)	3	ENGL 202C (GWS) Effective Writing: Technical	3
Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3	BA Knowledge Domain	3
Other Cultures	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH 403</b>	3	<b>400-Level MATH</b> course <b>EXCEPT</b> MATH 401, 405, 406, 441, 470 or 471	3
<b>400-Level MATH</b> course <b>EXCEPT</b> MATH 401, 405, 406, 441, 470 and 471	3	BA Knowledge Domain	3
Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
BA Knowledge Domain	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Select 3 credits of supporting courses in consultation with academic advisor.	3		
Total Credits	15	Total Credits	12

**Bold** type indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: MATH 411

Spring only: MATH 412, MATH 417

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

**Notes:** A student must earn a total of 120 credits for graduation. Students who choose to use their high school foreign language experience to satisfy the foreign language requirement will need to take additional supporting courses to meet the 120 credit requirement.

### Chapter 3

#### Bachelor of Science Degree in Mathematics

There are seven options under this degree. They have in common a core of freshman and sophomore mathematics courses and university-wide general education requirements. The options are described within each section of this chapter.

#### Actuarial Mathematics Option

The goal of this option is to train people to enter the actuarial science profession. Actuaries are in great demand in the insurance industry and other related businesses. To become an actuary, it is necessary to pass one or more of the demanding examinations administered by the Society of Actuaries, a national organization. The courses required in this option are intended to prepare students for these examinations. The key mathematical areas are probability, statistics, insurance and operations research. (See Appendix D for information about the Actuarial Science Examinations.)

Actuarial Mathematics Check Sheet (120 credits)

<b>MAJOR REQUIREMENTS (26-27 CREDITS)</b>			
<b>MATH 140 (4)</b> _____	CMPSC 101 (3) _____ or CMPSC 121 (3) _____ or CMPSC 201 (3) _____	<b>MATH 230 (4)</b> _____	<b>MATH 311W (3)</b> _____
<b>MATH 141 (4)</b> _____			
<b>MATH 220 (2)</b> _____		<b>MATH 250 (3)</b> _____ or <b>MATH 251 (4)</b> _____	<b>MATH 312 (3)</b> _____

TOTAL CREDITS: \_\_\_\_\_

<b>OPTION REQUIREMENTS (54-55 credits)</b>		
INS 301 (3) _____	<b>STAT 460 (3)</b> _____	SUPPORTING COURSES (10-11) _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____
INS 410 (3) _____	CHOOSE 3 CREDITS OF	
INS 411 (3) _____	<b>400-LEVEL MATH EXCEPT:</b>	
INS 412 (3) _____	MATH 401, 405, 406, 441, 470 and 471.	
IE 425 (3) _____	<b>MATH</b> _____ (3) _____ or	
<b>MATH 414 (3)</b> _____	<b>STAT 462 (3)</b> _____	
<b>MATH 415 (3)</b> _____		
<b>MATH 416 (3)</b> _____		
<b>MATH 451 (3)</b> _____ or <b>MATH 486 (3)</b> _____		
<b>MATH 484 (3)</b> _____		

TOTAL CREDITS: \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

See Appendix D in the department Handbook for additional information on actuarial exams and VEE requirements. Supporting Courses – Actuarial students are encouraged to choose supporting courses which satisfy VEE requirements and/or minors such as statistics and economics.

ACTUARIAL MATHEMATICS OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA)	SOCIAL BEHAVIORAL SCIENCE (6 CR)
ENGL 202 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
CAS 100 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
NATURAL SCIENCE (9 CR) (GN)	HUMANITIES (6 CR) (GH)	HEALTH/PHYS. ACT. (3 CR) (GHA)
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )		
_____ ( )		
WRITING ACROSS THE CURRICULUM _____	US CULTURES (3 CR) (US)	FIRST YEAR SEMINAR _____ (1) ____
	_____	
	INTERNATIONAL CULTURES (3 CR) (IL) _____	

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –

Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Degree in Mathematics, Actuarial Mathematics Option  
(MTHBS AMATH at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
ENGL 015 or 030 (GWS)	3	<b>MATH 220 (GQ)</b>	2
Foreign Language	4	Foreign Language	4
Social and Behavioral Science (GS) ECON 102	3	Social and Behavioral Science (GS) ECON 104	3
First Year Seminar	1	Natural Science (GN)	3
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Arts (GA) or Humanities (GH)	3	CMPS 101 or CMPS 121 or CMPS 201	3
Natural Science (GN)	3	Natural Science (GN)	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Total Credits	16	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH(STAT) 414</b>	3	<b>MATH(STAT) 415</b>	3
<b>MATH 484</b>	3	<b>MATH(CMPSC) 451 or MATH 486</b>	3
INS 410	3	INS 411	3
CAS 100 A, B, or C (GWS)	3	ENGL 202C (GWS)	3
INS 301	3	Arts (GA) or Humanities (GH)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>STAT 460</b>	3	<b>MATH (STAT) 416</b>	3
INS 412	3	<b>STAT 462 or 400-Level MATH course EXCEPT MATH 401, 405, 406, 441, 470 or 471</b>	3
IE 425	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Arts (GA) or Humanities (GH)	3	Arts (GA) or Humanities (GH)	3
		Select 1-2 credits of supporting courses in consultation with academic advisor.	1-2
Total Credits	12	Total Credits	13-14

**Bold** type indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: INS 410, INS 412

Spring only: INS 411

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

Foreign Language - Proficiency in a single foreign language equivalent to completion of two semesters of course work must be demonstrated. If fewer than 8 credits are needed to reach this level of proficiency, then choose courses from the Mathematics Department Supporting Courses List (Appendix B in the Department Handbook) to total 8 credits. Policies regarding placement in a foreign language can be found in Appendix A of the Department Handbook.

**Applied Analysis Option**

The goal of this option is to train people to apply mathematics toward the solution of problems in the natural sciences and engineering. The main mathematical tools needed are real analysis, differential equations, complex analysis, and matrix theory. The requirements also include an approved sequence of courses in an area of application. (See Appendix E in the Department Handbook for suggested sequences.)

<b>MAJOR REQUIREMENTS (26-27 CREDITS)</b>			
<b>MATH 140 (4)</b> _____	CMPSC 101 (3) _____ or CMPSC 121 (3) _____ or CMPSC 201 (3) _____	<b>MATH 230 (4)</b> _____	<b>MATH 311W (3)</b> _____
<b>MATH 141 (4)</b> _____			
<b>MATH 220 (2)</b> _____		<b>MATH 250 (3)</b> _____ or <b>MATH 251 (4)</b> _____	<b>MATH 312 (3)</b> _____

TOTAL CREDITS \_\_\_\_\_

<b>OPTION REQUIREMENTS (54-55 credits)</b>		
<b>MATH 403 (3)</b> _____	CHOOSE 8 CREDITS OF NATURAL SCIENCE FROM THE FOLLOWING: (i) <b>BIOL 110 (4)</b> _____ and <b>220W (4)</b> _____ (ii) <b>CHEM 110 (3)</b> _____ and <b>CHEM 113 (1)</b> _____ (iii) <b>PHYS 211 (4)</b> and <b>PHYS 212 (4)</b> _____	SUPPORTING COURSES (8-9)  _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____
<b>MATH 421 (3)</b> _____		
<b>MATH 436 (3)</b> _____		
<b>MATH 414 (3)</b> _____		
	FOREIGN LANGUAGE(8): LEVEL I: _____ (4) _____ LEVEL II: _____ (4) _____	
CHOOSE 6 CREDITS OF: <b>MATH 411 (3)</b> _____ or <b>MATH 412 (3)</b> _____ or <b>MATH 417 (3)</b> _____	AREA OF APPLICATION (12): _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____	

TOTAL CREDITS: \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

Foreign Language - Proficiency in a single foreign language equivalent to completion of two semesters of course work must be demonstrated. If fewer than 8 credits are needed to reach this level of proficiency, then choose courses from the Mathematics Department Supporting Courses List (Appendix B in the Department Handbook) to total 8 credits. Policies regarding placement in a foreign language can be found in Appendix A of the Department Handbook.

Application Area – Choose an approved sequence of 12 credits in an area of application, have it approved by your advisor and then file a copy in 104 McAllister Building. Possible courses include engineering and the physical, earth or biological sciences. (Appendix E in the Department Handbook.)

Supporting Courses – A list of supporting courses is in Appendix B in the Department Handbook. The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are supporting courses.

APPLIED ANALYSIS OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA)	SOCIAL BEHAVIORAL SCIENCE (6 CR)
ENGL 202 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
CAS 100 (3) ____ (GWS)	_____ ( ) ____	_____ ( ) ____
NATURAL SCIENCE (9 CR) (GN)	HUMANITIES (6 CR) (GH)	HEALTH/PHYS. ACT. (3 CR) (GHA)
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )	_____ ( ) ____	_____ ( ) ____
_____ ( )		
_____ ( )		
WRITING ACROSS THE CURRICULUM _____	US CULTURES (3 CR) (US) _____	FIRST YEAR SEMINAR _____ (1) ____
	INTERNATIONAL CULTURES (3 CR) (IL) _____	

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Mathematics, Applied Analysis Option  
(MTHBS APANL at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
Natural Science (GN)	3	Natural Science (GN)	3
ENGL 15 or 30 (GWS)	3	Foreign Language	4
First Year Seminar	1	Arts (GA), Humanities (GH) or Social Science (GS)	3
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 251</b>	4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	CMPS 101 or CMPS 121 or CMPS 201	3
Natural Science (Major)	4	Natural Science (Major)	4
Total Credits	14	Total Credits	14
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH 411 or 412 or 417</b>	3	<b>MATH 411 or 412 or 417</b>	3
<b>MATH 403</b>	3	<b>MATH 436</b>	3
CAS 100 A, B or C (GWS)	3	ENGL 202C (GWS)	3
Application Course	3	Application Course	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH 421</b>	3	<b>MATH 414 or 418</b>	3
Application Course	3	Application Course	3
ARTS (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Select 3 credits of supporting courses in consultation with academic adviser	3	Natural Science (GN)	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Select 1-2 credits of supporting courses in consultation with academic advisor.	1-2
Total Credits	15	Total Credits	13-14

**Bold type** indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: Math 411, 421

Spring only: MATH 412

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

**Notes:** A student must earn a total of 120 credits for graduation. Students who choose to use their high school foreign language experience to satisfy the foreign language requirement will need to take additional supporting courses to meet the 120 credit requirement.

### Computational Mathematics Option

The goal of this option is to train people in those areas of mathematics most relevant to scientific computations. These include the mathematical tools needed for analyzing algorithms (i.e. computational procedures) as well as those mathematical problem-solving methods which can be implemented on computers. The main areas needed are numerical analysis, matrix theory, differential equations, statistics, combinatorics, and linear programming.

Computational Mathematics Check Sheet (120 credits)

MAJOR REQUIREMENTS (26-27 CREDITS)			
MATH 140 (4) _____	CMPSC 101 (3) _____ or CMPSC 121 (3) _____ or CMPSC 201 (3) _____	MATH 230 (4) _____	MATH 311W (3) _____
MATH 141 (4) _____			
MATH 220 (2) _____		MATH 250 (3) _____ or MATH 251 (4) _____	MATH 312 (3) _____

TOTAL CREDITS \_\_\_\_\_

OPTION REQUIREMENTS (54-55 credits)		
CMPSC 122 (3) _____	CHOOSE 6 CREDITS OF COMPUTATIONAL MATH BELOW:  CMPSC 468 (3) _____ or <b>MATH 310 (3) _____</b> or <b>MATH 468 (3) _____</b> or <b>MATH 485 (3) _____</b>	SUPPORTING COURSES (13-14)  _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____ _____( ) _____
CMPSC 465 (3) _____		
<b>MATH 414 (3) _____</b>		
<b>MATH 415 (3) _____</b>		
<b>MATH 455 (3) _____</b>		
<b>MATH 456 (3) _____</b>		
<b>MATH 484 (3) _____</b>		
<b>MATH 467 (3) _____</b>	FOREIGN LANGUAGE (8):  Level I: _____ (4) _____ Level II: _____ (4) _____	
CHOOSE 3 CREDITS OF:  <b>MATH 411 (3) _____</b> or <b>MATH 412 (3) _____</b> or <b>MATH 417 (3) _____</b>		

TOTAL CREDITS \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

Foreign Language – Proficiency in a single foreign language equivalent to completion of two semesters of course work must be demonstrated. If fewer than 8 credits are needed to reach this level of proficiency, then choose courses from the Mathematics Department Supporting Courses List (Appendix B in the Department Handbook) to total 8 credits. Policies regarding placement in a foreign language can be found in Appendix A of the Department Handbook.

Supporting Courses – A list of supporting courses is in Appendix B in the Department Handbook. The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are supporting courses.

COMPUTATIONAL MATHEMATICS OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	SOCIAL BEHAVIORAL SCIENCE (6 CR) (GS) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
ENGL 202 (3) ____ (GWS)		
CAS 100 (3) ____ (GWS)		
NATURAL SCIENCE (9 CR) (GN) ____ ( ) ____ ( ) ____ ( ) ____ ( ) ____ ( )	HUMANITIES (6 CR) (GH) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	HEALTH/PHYS. ACT. (3 CR) (GHA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
WRITING ACROSS THE CURRICULUM _____	US CULTURES (3 CR) (US) _____  INTERNATIONAL CULTURES (3 CR) (IL) _____	FIRST YEAR SEMINAR _____ (1) ____

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

- General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition
1. At least 36 of the last 60 credits must be earned at Penn State.
  2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Mathematics, Computational Mathematics Option  
(MTHBS CMPUT at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
Natural Science (GN)	3	Natural Science (GN)	3
ENGL 15 or 30 (GWS)	3	Foreign Language	4
First Year Seminar	1	Arts (GA), Humanities (GH) or Social Science (GS)	3
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
CMPS 121	3	CMPS 122	3
Select 3 credits of supporting courses in consultation with academic advisor	3	Natural Science (GN)	3
		Select 3 credits of supporting courses in consultation with academic advisor	3
Total Credits	13	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH (STAT) 414</b>	3	<b>MATH (STAT) 415</b>	3
<b>MATH (CMPS) 467</b>	3	<b>MATH 411 or 412 or 417</b>	3
CMPS 465	3	CMPS 468 or <b>MATH 310 or 468 or 485</b>	3
CAS 100 A, B OR C (GWS)	3	ENGL 202 C (GWS)	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH (CMPS) 455</b>	3	<b>MATH (CMPS) 456</b>	3
<b>MATH 484</b>	3	<b>CMPS 468 or MATH 310 or 468 or 485</b>	3
ARTS (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
ARTS (GA), Humanities (GH) or Social Science (GS)	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Select 3 credits of supporting courses in consultation with academic advisor.	2-3	Select 2 credits of supporting courses in consultation with academic advisor.	1-2
Total Credits	14-15	Total Credits	13-14

**Bold type** indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: MATH(CMPS) 455, MATH(CMPS) 467, MATH 485

Fall 2011, 2013, 2015, .... : MATH 468

Spring only: MATH 310, MATH(CMPS) 456

**Notes:** A student must earn a total of 120 credits for graduation. Students who choose to use their high school foreign language experience to satisfy the foreign language requirement will need to take additional supporting courses to meet the 120 credit requirement.

**General Mathematics Option**

The goal of this option is to allow students to construct, within limits, their own curricula in mathematics. The option requires at least one course at the 400 level in each of the areas of analysis, algebra, and applied mathematics. An approved sequence of an additional 12 credits in an area of application is required. The area of application may be in mathematics or in an area related to mathematics. (See Appendix E for suggested areas of application.)

General Mathematics Check Sheet (120 credits)

<b>MAJOR REQUIREMENTS (26-27 CREDITS)</b>			
<b>MATH 140 (4)</b> _____	CMPSC 101 (3) _____ or CMPSC 121 (3) _____ or CMPSC 201 (3) _____	<b>MATH 230 (4)</b> _____	<b>MATH 311W (3)</b> _____
<b>MATH 141 (4)</b> _____			
<b>MATH 220 (2)</b> _____		<b>MATH 250 (3)</b> _____ or <b>MATH 251 (4)</b> _____	<b>MATH 312 (3)</b> _____

TOTAL CREDITS \_\_\_\_\_

<b>OPTION REQUIREMENTS (54-55 credits)</b>		
<b>MATH 403 (3)</b> _____	<b>CHOOSE 6 CREDITS OF 400- LEVEL MATH EXCEPT:</b> MATH 401, 405, 406, 441, 470 and 471. <b>MATH</b> _____ (3) _____ <b>MATH</b> _____ (3) _____	<b>SUPPORTING COURSES (16-17)</b> _____ _____ _____ _____ _____ _____
<b>MATH 414 (3)</b> _____		
<b>CHOOSE 3 CREDITS OF:</b> <b>MATH 435 (3)</b> _____ or <b>MATH 436 (3)</b> _____	<b>AREA OF APPLICATION (12):</b> _____ _____ _____ _____	
<b>CHOOSE 3 CREDITS OF:</b> <b>MATH 411 (3)</b> _____ or <b>MATH 412 (3)</b> _____ or <b>MATH 417 (3)</b> _____ or <b>MATH 419 (3)</b> _____ or <b>MATH 421 (3)</b> _____		

TOTAL CREDITS \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

Application Area – Choose an approved sequence of 12 credits in an area of application, have it approved by your advisor and then file a copy in 104 McAllister Building. For possible areas of application, see Appendix F in the Department Handbook.

Supporting Courses – A list of supporting courses is in Appendix C in the Department Handbook. The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are supporting courses.

GENERAL MATHEMATICS OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	SOCIAL BEHAVIORAL SCIENCE (6 CR) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
ENGL 202 (3) ____ (GWS)		
CAS 100 (3) ____ (GWS)		
NATURAL SCIENCE (9 CR) (GN) ____ ( ) ____ ( ) ____ ( ) ____ ( ) ____ ( )	HUMANITIES (6 CR) (GH) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	HEALTH/PHYS. ACT. (3 CR) (GHA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
WRITING ACROSS THE CURRICULUM _____		
	US CULTURES (3 CR) (US) _____  INTERNATIONAL CULTURES (3 CR) (IL) _____	FIRST YEAR SEMINAR _____ (1) ____

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Mathematics, General Mathematics Option  
(MTHBS GEN at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
ENGL 015 or 030 (GWS)	3	Natural Science (GN)	3
Natural Science (GN)	3	Foreign Language	4
First Year Seminar	1	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Natural Science (GN)	3	CMPCSC 121 or CMPCSC 101 or CMPCSC 201	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
		Select 3 credits of supporting courses in consultation with academic advisor	3
Total Credits	13	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH (STAT) 414</b>	3	<b>MATH 435 or 436</b>	3
<b>MATH 411 or 412 or 417 or 419 or 421</b>	3	<b>400-Level MATH</b> course <b>EXCEPT</b> Math 401, 405, 406, 441, 470 and 471	3
Application Course	3	Application Course	3
CAS 100 A, B or C (GWS)	3	ENGL 202 C (GWS)	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH 403</b>	3	<b>400-Level MATH</b> course <b>EXCEPT</b> Math 401, 405, 406, 441, 470 and 471	3
Application Course	3	Application Course	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Select 2-3 credits of supporting courses in consultation with academic advisor.	2-3	Select 1 - 2 credits of supporting courses in consultation with academic advisor.	1-2
Total Credits	14-15	Total Credits	13-14

**Bold** type indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: MATH 411, MATH 421, MATH(CMPSC) 455, MATH 461, MATH 468, MATH 485

Spring only: MATH 412, MATH 417, MATH(CMPSC) 456, MATH 467, MATH(PHYS) 479

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

**Graduate Study Option**

The goal of this option is to prepare students for graduate study in mathematics. With this in mind, this option requires students to complete mathematics coursework in the key areas of abstract algebra, linear algebra, real analysis, complex analysis, and topology. Students can also supplement their learning by choosing additional mathematics courses in fields of interest to them.

Graduate Study Check Sheet (120 credits)

<b>MAJOR REQUIREMENTS (26-27 CREDITS)</b>			
<b>MATH 140 (4)</b> _____	CMPS 101 (3) _____ or CMPS 121 (3) _____ or CMPS 201 (3) _____	<b>MATH 230 (4)</b> _____	<b>MATH 311W (3)</b> _____
<b>MATH 141 (4)</b> _____			
<b>MATH 220 (2)</b> _____		<b>MATH 250 (3)</b> _____ or <b>MATH 251 (4)</b> _____	<b>MATH 312 (3)</b> _____

TOTAL CREDITS \_\_\_\_\_

<b>OPTION REQUIREMENTS (54-55 credits)</b>		
<b>MATH 403 (3)</b> _____	<b>CHOOSE 9 CREDITS OF 400-LEVEL MATH EXCEPT: MATH 401, 405, 406, 441, 470 and 471.</b>  <b>MATH</b> _____ <b>(3)</b> _____ <b>MATH</b> _____ <b>(3)</b> _____ <b>MATH</b> _____ <b>(3)</b> _____	<b>SUPPORTING COURSES (16-17)</b>  _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____ _____ ( ) _____
<b>MATH 404 (3)</b> _____		
<b>MATH 414 (3)</b> _____		
<b>MATH 421 (3)</b> _____		
<b>MATH 429 (3)</b> _____		
<b>MATH 435 (3)</b> _____		
<b>MATH 436 (3)</b> _____		

TOTAL CREDITS \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

Supporting Courses – A list of supporting courses is in Appendix C in the Department Handbook. The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are supporting courses.

GRADUATE STUDY OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	SOCIAL BEHAVIORAL SCIENCE (6 CR) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
ENGL 202 (3) ____ (GWS)		
CAS 100 (3) ____ (GWS)		
NATURAL SCIENCE (9 CR) (GN) ____ ( ) ____ ( ) ____ ( ) ____ ( ) ____ ( )	HUMANITIES (6 CR) (GH) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	HEALTH/PHYS. ACT. (3 CR) (GHA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
WRITING ACROSS THE CURRICULUM _____		
	US CULTURES (3 CR) (US) _____  INTERNATIONAL CULTURES (3 CR) (IL) _____	FIRST YEAR SEMINAR _____ (1) ____

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Mathematics, Graduate Study Option  
(MTHBS GRSTD at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
ENGL 015 or 030 (GWS)	3	Natural Science (GN)	3
Natural Science (GN)	3	Foreign Language	4
First Year Seminar	1	Arts (GA), Humanities (GH) or Social Science (GS)	3
Total Credits	15	Total Credits	15
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Natural Science (GN)	3	CMPS 121 or CMPS 101 or CMPS 201	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Select 3 credits of supporting courses in consultation with academic advisor	3
		Select 3 credits of supporting courses in consultation with academic advisor	3
Total Credits	13	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH 403</b>	3	<b>MATH 404</b>	3
<b>MATH 414</b>	3	<b>MATH 436</b>	3
<b>400-Level MATH course EXCEPT MATH 401, 405, 406, 441, 470 or 471</b>	3	<b>400 – Level MATH course EXCEPT MATH 401, 405, 406, 441, 470 and 471</b>	3
CAS 100 A, B or C (GWS)	3	ENGL 202 C (GWS)	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH 435</b>	3	<b>400-Level MATH course EXCEPT MATH 401, 405, 406, 441, 470 and 471</b>	3
<b>MATH 421</b>	3	<b>MATH 429</b>	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Select 3 credits of supporting courses in consultation with academic advisor.	3	Select 2 credits of supporting courses in consultation with academic advisor.	1-2
Total Credits	15	Total Credits	13-14

**Bold** type indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: MATH 411, MATH 421, MATH(CMPSC) 455, MATH 461, MATH 468, MATH 485

Spring only: MATH 412, MATH 417, MATH(CMPSC) 456, MATH 467, MATH 479

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

**Notes:** A student must earn a total of 120 credits for graduation. Students who choose to use their high school foreign language experience to satisfy the foreign language requirement will need to take additional supporting courses to meet the 120 credit requirement.

**Systems Analysis Option**

The intent of this option is to train people to apply mathematics toward the solution of problems in business, economics, and the social and behavioral sciences. The main mathematical tools needed are matrix theory, linear programming, and statistics. The requirements include an approved sequence of courses in an area of application. (See Appendix E in the Department Handbook for suggested areas of application.)

Systems Analysis Check sheet (120 credits)

<b>MAJOR REQUIREMENTS (26-27 CREDITS)</b>			
<b>MATH 140 (4)</b> _____	CMPSC 101 (3) _____ or CMPSC 121 (3) _____ or CMPSC 201 (3) _____	<b>MATH 230 (4)</b> _____	<b>MATH 311W (3)</b> _____
<b>MATH 141 (4)</b> _____			
<b>MATH 220 (2)</b> _____		<b>MATH 250 (3)</b> _____ or <b>MATH 251 (4)</b> _____	<b>MATH 312 (3)</b> _____

TOTAL CREDITS \_\_\_\_\_

<b>OPTION REQUIREMENTS (54-55 credits)</b>		
<b>MATH 414 (3)</b> _____	<b>CHOOSE 3 CREDITS OF 400-LEVEL MATH EXCEPT:</b> MATH 401, 405, 406, 441, 470 and 471.  <b>MATH</b> _____ <b>(3)</b> _____	<b>SUPPORTING COURSES (13-14)</b> _____ _____ _____ _____ _____ _____ _____
<b>MATH 415 (3)</b> _____		
<b>MATH 436 (3)</b> _____		
<b>MATH 484 (3)</b> _____		
<b>CHOOSE 6 CREDITS OF:</b>  <b>MATH 310 (3)</b> _____ or <b>MATH 451 (3)</b> _____ or <b>MATH 485 (3)</b> _____ or <b>MATH 486 (3)</b> _____	<b>AREA OF APPLICATION (12):</b> _____ _____ _____ _____	

TOTAL CREDITS \_\_\_\_\_

**Bold** type indicates courses requiring a quality grade of C or better.

Application Area – Choose an approved sequence of 12 credits in an area of application, have it approved by your advisor and then file a copy in 104 McAllister Building. Possible areas include business, economics, industrial engineering or social science (Appendix E in the Department Handbook).

Supporting Courses – A list of supporting courses is in Appendix B in the Department Handbook. The only courses in this degree which can be scheduled under the satisfactory/unsatisfactory option are supporting courses.

SYSTEMS ANALYSIS OPTION CHECK SHEET

<b>GENERAL EDUCATION (39 credits)</b>		
ENGL 15 or 30 (3) ____ (GWS)	ARTS (6 CR) (GA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	SOCIAL BEHAVIORAL SCIENCE (6 CR) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
ENGL 202 (3) ____ (GWS)		
CAS 100 (3) ____ (GWS)		
NATURAL SCIENCE (9 CR) (GN) ____ ( ) ____ ( ) ____ ( ) ____ ( ) ____ ( )	HUMANITIES (6 CR) (GH) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____	HEALTH/PHYS. ACT. (3 CR) (GHA) ____ ( ) ____ ____ ( ) ____ ____ ( ) ____
WRITING ACROSS THE CURRICULUM _____		
	US CULTURES (3 CR) (US) _____  INTERNATIONAL CULTURES (3 CR) (IL) _____	FIRST YEAR SEMINAR _____ (1) ____

TOTAL CREDITS \_\_\_\_\_

General Education Courses – A description of these requirements can be found at [http://www.psu.edu/bulletins/bluebook/general\\_education.cfm](http://www.psu.edu/bulletins/bluebook/general_education.cfm)

US Cultures and International Cultures Requirement - Students must complete a 3-credit course in United States Cultures (US) and a 3-credit course in International Cultures (IL). See <http://www.psu.edu/bulletins/bluebook/gened/gi.html> for available courses.

Note: A student may, in consultation with the advisor and the student’s college dean, develop a sequence of 9 credits in either the arts, humanities, or social or behavioral sciences by substituting 3 credits from one of the other two areas not in the student’s major field of study.

General Graduation Requirements –  
Senate Policy 83-80 Limitations on Source and Time for Credit Acquisition

1. At least 36 of the last 60 credits must be earned at Penn State.
2. At least 60 credits must be earned in last five years

**IMPORTANT: 120 CREDITS ARE NEEDED TO GRADUATE.**

**Recommended Academic Plan for Bachelor of Science Mathematics, Systems Analysis Option  
(MTHBS SYANL at University Park) Effective Summer 2011**

<b>SEMESTER 1</b>	<b>Credits</b>	<b>SEMESTER 2</b>	<b>Credits</b>
<b>MATH 140 (GQ)</b>	4	<b>MATH 141 (GQ)</b>	4
Foreign Language	4	<b>MATH 220 (GQ)</b>	2
ENGL 015 or 030 (GWS)	3	Natural Science (GN)	3
Natural Science (GN)	3	Foreign Language	4
First Year Seminar	1	Arts (GA), Humanities (GH) or Social and Behavioral Science (GS)	3
Total Credits	15	Total Credits	16
<b>SEMESTER 3</b>	<b>Credits</b>	<b>SEMESTER 4</b>	<b>Credits</b>
<b>MATH 230</b>	4	<b>MATH 250 or 251</b>	3 - 4
<b>MATH 311W</b>	3	<b>MATH 312</b>	3
Natural Science (GN)	3	CMPCSC 121 or CMPCSC 101 or CMPCSC 201	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Select 3 credits of supporting courses in consultation with academic advisor	3
		Select 3 credits of supporting courses in consultation with academic advisor	3
Total Credits	13	Total Credits	15-16
<b>SEMESTER 5</b>	<b>Credits</b>	<b>SEMESTER 6</b>	<b>Credits</b>
<b>MATH(STAT) 414</b>	3	<b>MATH(STAT) 415</b>	3
<b>MATH 310 or 485 or 486 or MATH(CMPSC) 451</b>	3	<b>MATH 436</b>	3
Application course	3	Application Course	3
CAS 100 A, B or C (GWS)	3	ENGL 202 C (GWS)	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Health and Physical Activity (GHA)	1.5	Health and Physical Activity (GHA)	1.5
Total Credits	16.5	Total Credits	16.5
<b>SEMESTER 7</b>	<b>Credits</b>	<b>SEMESTER 8</b>	<b>Credits</b>
<b>MATH 484</b>	3	<b>400-Level MATH course EXCEPT MATH 401, 405, 406, 441, 470 and 471</b>	3
<b>MATH 310 or 485 or 486 or MATH (CMPSC) 451</b>	3	Application course	3
Application course	3	Arts (GA), Humanities (GH) or Social Science (GS)	3
Arts (GA), Humanities (GH) or Social Science (GS)	3	Select 3 credits of supporting courses in consultation with academic advisor.	3
Select 1-3 credits of supporting courses in consultation with academic advisor.	1-2	Select 3 credits of supporting courses in consultation with academic advisor.	3
Total Credits	13-14	Total Credits	15

**Bold** type indicates courses requiring a quality grade of C or better.

**Scheduling patterns:**

Fall only: MATH 411, MATH 421, MATH(CMPSC) 455, MATH 461, MATH 468, MATH 485

Spring only: MATH 310, MATH 412, MATH 417, MATH(CMPSC) 456, MATH 467, MATH 479

Available during the second summer session: MATH 411, MATH(STAT) 414, MATH(CMPSC) 451

**Notes:** A student must earn a total of 120 credits for graduation. Students who choose to use their high school foreign language experience to satisfy the foreign language requirement will need to take additional supporting courses to meet the 120 credit requirement.

## **APPENDIX A – FOREIGN LANGUAGE**

All students interested in scheduling a foreign language at Penn State may choose either to continue the language they began in high school or to begin a new one. To continue with a language, students must follow the placement policy as outlined below.

### **Placement Policy**

Students who have studied a foreign language in grades 9 through 12 within four years immediately before admission to Penn State may only enroll in that language for credit based on the number of units of high school work completed.

#### Units of Study, Grades 9-12

Fewer than two

Two or three

Four or more

#### Register in

Course Level 001 (4 crs.)

Course Level 002 (4 crs.)

Course Level 003 (4 crs.)

Students may choose to audit a lower-level course but may not receive credit for it. Students who feel they are qualified for a more advanced course will be offered a diagnostic examination a few days after the beginning of each semester.

### **Non-Coursework Knowledge of Foreign Languages**

Students who have acquired knowledge of a foreign language by means other than coursework (e.g., family background, travel or study in a foreign country, participation in non-credit summer language institutes, etc.) may enroll in elementary and intermediate courses in that language only with the permission of the course coordinator or department head.

Students whose native language is something other than English may not receive credit (through coursework or examination) for elementary and intermediate courses in their native language. Enrollment in skills courses beyond intermediate level (e.g., conversation, composition) must be approved by the department head.

### **Intensive Courses**

Students may choose to enroll in intensive courses--French 111 and 112, Spanish 10 and 20, or Summer Intensive Language Institute courses. Because the objectives of these intensive courses are somewhat different, students may schedule them for full credit even if they have studied the language previously.

Questions should be addressed to the course coordinator or department head of the particular language department concerned.

## **APPENDIX B – BACHELOR of ARTS and BACHELOR of SCIENCE SUPPORTING COURSES**

Any Baccalaureate Degree course except:

ADTED 100

CAS 126

CMPSC 1, 100, 101B, 102, 110, 142, 144, 154, 164, 174, 175 AND 203

ENGL 4, 5

LL ED 5, 10

MATH 1, 2, 3, 4, 17, 18, 21, 22, 26, 34, 35, 36, 40, 41, 81, 82, 83, 87, 88 and 200

STAT 100

NOTE: Courses which substantially duplicate subject matter covered in other courses the student has taken will not count toward degree requirement, e.g.:

BIOL 11 and BIOL 12 if student has taken BIOL 110

CMPSC 360 if student has taken MATH 311W

## **APPENDIX C – BACHELOR of ARTS REQUIREMENTS**

The Bachelor of Arts degree requires 9 credits of Knowledge Domains courses. However, mathematics majors may not satisfy this requirement by taking quantification (GQ) courses. Other Cultures (3 credits) and Foreign Language (0-12 credits). For a complete listing of all approved courses in the Bachelor of Arts basic requirements, please refer to <http://www.psu.edu/ufs/scca/barequi.html>.

## **APPENDIX D – ACTUARIAL SCIENCE EXAMINATIONS**

We encourage you to visit the Society of Actuaries website at <http://www.soa.org/ccm/content>.

This site contains a full description of the actuarial examinations: topics, textbooks, schedules, locations and application forms. You can also learn more about the Society's VEE (Validation by Education Experience) program at this site.

Due to the nature of the VEE program, the following courses are highly recommended:

ECON 102; ECON 104;  
FIN 301;  
STAT 462; STAT 463

We encourage you to check the Society of Actuaries website mentioned above to confirm current VEE course requirements.

PSU's Actuarial Club web site: <http://www.clubs.psu.edu/up/actscli/>

Note that students earning the B.S. degree in mathematics with actuarial option often pursue at least one of the following minors:

Statistics: <http://www.stat.psu.edu/undergrad/minor>

Economics: <http://www.psu.edu/bulletins/bluebook/major/econmin.htm>

## APPENDIX E – APPLICATION AREAS

Your area of application should include 12 credits of course work in one discipline with the goal of being able to communicate with experts in that area. These courses should form a coherent pattern and include one or two 400-level courses. Below are examples of various areas and an introductory course associated with each area. You are not restricted to this list. Your academic advisor can assist you with your course selection.

Subject Area	Introductory Course	Minor Available	Appropriate for Math Options
Astronomy & Astrophysics	ASTRO 291 (GN)	Yes	Applied Analysis, General
Biology	BIOL 110 (GN)	Yes	Applied Analysis, General
Chemistry	CHEM 110 and CHEM 111 (GN)	Yes	Applied Analysis, General
Computer Engineering	CMPEN	No	Applied Analysis, General
Computer Science	CMPSC 121 (math major)	No	Applied Analysis, General, Systems Analysis
Economics	ECON 002 or 004 (GS)	Yes	General, Systems Analysis
Electrical Engineering	E E 210	No	Applied Analysis, General
Engineering Mechanics	EMCH 211	Yes	Applied Analysis, General
Engineering Science	E SC 313	No	Applied Analysis, General
Geosciences	GEO SC 021 (GN)	Yes	Applied Analysis, General
Information Sciences and Technology	IST 110 (GS)	Yes	General, Systems Analysis
Insurance	INS 301	Yes	General, Systems Analysis
Mechanical Engineering	M E 201	No	Applied Analysis, General
Meteorology	METEO 101 or 122 (GN)	Yes	Applied Analysis, General
Physics	PHYS 211 (GN)	Yes	Applied Analysis, General
Psychology	PSYCH 100 (GS)	Yes	General, Systems Analysis
Statistics	STAT 200	Yes	General, Systems Analysis

Some subject areas are difficult for math majors to complete because the courses have enrollment controls.

These include

Aerospace Engineering  
 Finance  
 Industrial Engineering  
 Landscape Architecture

## **APPENDIX F – ELIBIBILITY for MEMBERSHIP in PHI BETA KAPPA**

Phi Beta Kappa, the nation's oldest and most distinguished national honor society recognizing outstanding achievement in the liberal arts and sciences, was founded in 1776 at the College of William and Mary in Williamsburg, Virginia. The Pennsylvania State University Chapter (Lambda of Pennsylvania) was established in 1937.

Election to Phi Beta Kappa honors the quality and breadth of a student's undergraduate academic achievement. No formal application for Phi Beta Kappa membership is needed. The Chapter reviews student records each spring to identify candidates.

The requirements for a student to be invited into membership in Phi Beta Kappa include:

1. Candidates must have a non-professional major in the arts, humanities, social sciences, or sciences. Most majors in the College of Liberal Arts, Eberly College of Science, College of Earth and Mineral Sciences, and College of Arts and Architecture are acceptable. A few majors in the College of Communications are also considered non-professional. Majors in the College of Agricultural Sciences, Smeal College of Business Administration, College of Education, College of Engineering, and College of Health and Human Development are considered to be professional majors and are not accepted for Phi Beta Kappa membership.
2. Candidates with 90 or more credits completed must have a 3.6 cumulative GPA. Candidates with 60 to 89 credits completed must have a 3.8 GPA.
3. Candidates must have completed a minimum of 60 credits at Penn State.
4. Candidates must have completed at least one foreign language course at the second level (e.g., French 002, German 002, Japanese 002) OR must have equivalent credits granted by Penn State through examination, transfer or advanced placement OR an official of the student's College (e.g. faculty advisor, department head) must certify that the student has the required foreign language competence. The latter option may be the case when the student is a native speaker of another language.
5. Candidates must have completed all of their Penn State General Education requirements in the arts, humanities, social and behavioral sciences, natural sciences, and quantification.
6. Candidates must have at least 80 percent of their total credits in liberal arts and science courses OR at least 100 credits in total that are in liberal arts and science courses. Liberal arts and science courses include most, although not all, of the courses from the approved majors described above.

**PHI BETA KAPPA**  
*Lambda of Pennsylvania Chapter*  
**The Pennsylvania State University**  
**Dennis G. Shea, Ph.D.**  
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