

# HANDBOOK IN MATHEMATICS

## FOR MAJORS AND MINORS

Department of Mathematics  
Norwich University  
Northfield, Vermont  
Academic Year 2015-2016



# NORWICH

## UNIVERSITY™

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# I. Introduction.

Welcome to Norwich University, and congratulations on your decision to seek a major or minor in Mathematics. We at Norwich believe we have an outstanding program for students seeking a major or minor in Mathematics. The range of offerings ranks as high as those of most small universities in the nation, and encompasses all fields of Mathematics including such applied areas as statistics, computer science, cryptology, operations research, engineering mathematics and the more theoretical areas of abstract algebra, number theory and topology. The Mathematics classrooms and the offices of the faculty are all located in a newly renovated Math/Sciences building, along with a departmental library and student conference room equipped with computers that can access the university network and the internet. Faculty members are readily accessible, and students are encouraged to visit with faculty for help and counsel. The Math community at Norwich, including the faculty, the students majoring or minoring in Mathematics, and others interested in Mathematics, is a closely knit group, committed to helping each other and participating in activities outside the classroom. Students work on their problem solving skills to take the national Putnam examinations, play an active role in the Math Club, attend Mathematics conferences and give presentations of their work, and take trips to explore opportunities of employment and interview mathematicians about career choices.

Mathematics has been called the “Queen of the Sciences”, because mathematics plays such an important role in all the sciences, engineering, business, insurance, economics and computer science, to name a few. Students who major in these math-related disciplines find that a strong foundation in mathematics improves their chances of acceptance to quality graduate programs, and opens the doors to promotions to more interesting positions in their careers. In fact, if you (or a friend) are interested in a career in a technical area, but haven't yet come to a final decision, you would do well to follow the Math major program. It will prepare you for other courses that require a good foundation in Mathematics. Many Law schools are also interested in Mathematics majors, because of their training in logic. The four year program for our Mathematics majors also has great flexibility that includes a number of free electives, allowing you to choose any courses that are of interest to you, such as obtaining a strong minor in another discipline where you can apply your mathematics skills.

During the first week of your Freshman year, you will be assigned to one of the faculty in the Mathematics Department who will be your academic advisor. Your academic advisor will help you select your courses and help you in your transition from high school to college. College is very different from high school, and your advisor is the best resource for helping you with such things as time management, strategies for studying, library usage, knowing what your professors expect from you, and policies and regulations of the University.

## II. The Curriculum.

The major in Mathematics leads to a Bachelor of Science (B.S.) degree. At Norwich, the basic difference between a B.S. degree and a Bachelor of Arts (B.A.) degree is that the B.S. degree places more emphasis on the sciences, while the B.A. degree requires a language. Certainly, you can take a foreign language as part of your B.S. program. The curriculum in Mathematics has the kind of built-in flexibility that allows you to explore other areas in your education, like taking a language, because of the numerous electives available to you.

First, every student who begins at Norwich takes a placement exam in Mathematics to determine which Math course to take first. If your score is satisfactory, you will begin with the Calculus sequence. Otherwise, you may need to start out with a pre-calculus course. Your advisor will work with you to get you off to the right start.

The curriculum maps, as we call them, are in Section VII. These three maps outline the schedule of courses you will take during your four years as a Mathematics major. You can select the Curriculum leading to the BS in Mathematics, the BS with Actuarial Concentration, or the BS that meets the requirements for Teacher Licensure. The University catalog describes the content of these courses, as well as all the other courses in Mathematics which you can select for math electives. In your Freshman year, you will start with MA 121 and MA 122, the first two courses in the calculus sequence. Classes meet four times a week, and these courses will introduce you to the limit concept, a topic that sort of separates analysis from other branches in Mathematics. You will learn how to take derivatives and integrals of the fundamental functions, like polynomials, trigonometric functions, exponential and log functions, and see how they are applied to real-world problems. You will also take MA 241 in the Spring semester, where you will learn some computer programming and apply it to a number of problem solving strategies. With these programming skills, you can write some code to let the computer do all the tedious calculations of a math problem, and investigate some “what-if” scenarios to attain a better understanding of some underlying concepts. In your Sophomore year, you will continue with the calculus by taking MA 223, followed by differential equations, MA 224, where you will see numerous applications of the calculus in modeling physical systems, and predicting the motion of objects in three dimensions. In MA 306, you will see an introduction to logic and techniques of proof, and learn about new algebraic systems. Your background from MA 241 will also be put to use here as you learn more about applications in various areas of computer science. MA 310 is Linear Algebra, one of the most important topics in all areas of Mathematics. As with your calculus courses, you will be joined by students from engineering and the sciences in this course as you learn how to deal with problems involving many variables, using vector spaces and matrices. By the Spring semester of your Sophomore year, you will have been exposed to a lot of Mathematics, and you will be working on problems that may go for pages. In literature, novelists and poets hone their skills by writing every day. The same skills are needed in writing good Mathematics so the reader can clearly understand a mathematical result that you may have worked so hard to achieve. The course MA 250 on Communication in Mathematics will show you how mathematicians do library searches and prepare manuscripts for publication.

The Junior year marks a transition for students majoring in Mathematics at most universities. You have been exposed to many topics and developed skills in writing mathematics. MA303-304, Advanced Calculus, places more emphasis on reading and composing proofs of the theorems you studied during your first two years in the calculus sequence. MA309, Algebraic Structures, will expose you to a variety of different kinds of algebraic systems. You will see how a rich mathematical structure can be created from only a few axioms, and learn how to logically derive new results from given assumptions. With these courses, you are moving toward maturity as a mathematician. Also, one subject that pervades almost every technical field is Statistics, and MA311, Statistical Methodology, will introduce you to the foundations and applications of this very important area. You will learn how to design experiments, collect the appropriate data, and use the mathematics of statistics to form conclusions with a certain level of probability. During this Junior year, you will probably be communicating with your professors more than you did during the earlier years. They will be helping you with your assignments, and preparing you to be a better mathematician. Remember, they want to see you succeed, so take advantage of their availability and professional experiences.

Welcome to the Senior year. This is where you get to choose among a number of the upper level courses in Mathematics that are of interest to you, and prepare you for further study in graduate school. You will be required to take MA 411, Senior Seminar, the capstone course for the Math major. This seminar will integrate reading, writing, critical thinking, and speaking in an area of Mathematics that is of interest to you. You will get to work with one of the faculty in the Math department on a subject not usually covered in any of the courses offered by the department. Once you and your professor have agreed on a topic, you will use the library, journals and other resources to prepare a final paper, which you will present to the public, usually at the end of the semester. A final copy of your seminar work will be provided for the Chair of the Math department to keep on file. This will be a busy and exciting year for you, as you begin thinking about career choices, employment opportunities and graduate school. Your professors will be excellent sources of information for you as you decide on your next step into the future, so feel free to seek their advice.

### **III. Resources on the Internet.**

Learn more about Mathematics at Norwich, the faculty, professional societies in Mathematics, careers, and more by going to the site below. See the menu on the left to learn more about the Curriculum, Mathematics Minor, Teacher Licensure, and Math Placement Testing.

<http://programs.norwich.edu/mathscience/mathematics/>

## IV. ACTIVITIES, WORK STUDY AND TUTORING.

The students majoring and minoring in Mathematics often participate in activities that will improve their math skills or present their work at conferences. Here are some of the activities.

**A. The Putnam Examinations:** Students from colleges and universities throughout the nation can test their problem-solving skills by taking this day long exam on the first Saturday of each December. Here at Norwich you and others get to meet weekly with a faculty member who provides typical exam questions to work on for practice in preparation for the exam. Whether you take the exams or not, these weekly sessions are great ways to get better acquainted with other math majors and minors and learn how others attack interesting problems and present their solutions.

**B. The Problem Solving Competition:** This activity is designed to support a mathematics problem solving activity conducted and judged locally on the Norwich campus. Over 600 colleges and universities participate in this competition, and the top problem solver from Norwich can attend the U.S. National Collegiate Mathematics Competition, which was held in California for 2007.

**C. The MAA Team Competition:** You might want to join a team from Norwich to participate in a team problem solving competition offered by the Northeast section of the Mathematical Association of America in the Fall semester.

**D. The Integration Bee:** Each Spring semester, the Math Department sponsors a contest for students who have learned the techniques of integration in calculus. Students who can work through enough integrations successfully win some very inviting prizes.

**E. Presenting your work at conferences:** You may have been working with one of the faculty on an undergraduate research project, or completed a paper for your senior seminar. You have an opportunity to present your work to other students and faculty from other institutions at meetings that are held by the Mathematical Association of America during the Fall semester or in the summer, or at a series of student presentations at the Hudson River Undergraduate Mathematics Conference.

**F. Tutoring:** One of the best ways to learn Mathematics comes when you have to explain it to someone else. After you have taken a few math courses, you may be eligible to serve as a paid tutor to help other students with their homework and preparation for exams. The Learning Support Center provides work study funds to eligible students who would receive income for tutoring.

## V. GRADUATION REQUIREMENTS.

As you progress through the semesters, you will need to be sure that all the requirements for graduation are being met, and there are many of them. Your advisor will help you with this, but ultimately, the responsibility is yours. The Curriculum Map for the Math major has been copied from the University catalog, and appears in Section VII, followed by the list of all courses offered by the Math Department in Section VIII, showing the content of each math course, credit hours and prerequisites. A Math Major Check List is also provided in Section IX, which you should update at the end of each semester.

Every student must also satisfy the General Education Requirements, which is in Section X. As you follow the Curriculum Map, you will need to select some courses to be sure that the general education requirements are also being satisfied. To find out more about courses offered in other departments, you can access the University catalog through the Registrar's Web site at <http://www.norwich.edu/registrar/>. You can also access the Academic Regulations at this Web site. The Academic Regulations cover the academic rules and regulations for the University, such as degree credits for graduation, grade point average, criteria for academic progress, academic honors, classroom procedures, transfer of credit for courses taken at another institution, grievance procedures, and much more.

## VI. A Reading List.

In addition to your textbooks in Mathematics, there are a number of classic books about Mathematics and mathematicians. The articles in this list will broaden your knowledge of the history of mathematicians and how their work changed society and advanced science. This is just a brief list, and your advisor may suggest other works for you to read. These books are in the Kreitzberg Library on the third floor. The older history books were mostly about European mathematics. More recent texts include mathematics history from Africa and Asia, especially China. Also, the more recent books include the works of many women mathematicians.

### A. Articles from *Men of Mathematics*, by E. T. Bell

Zeno, Eudoxus, Archimedes	Descartes
Fermat	Pascal
Newton	Leibnitz
The Bernoulli	Euler
Gauss	Cauchy
Abel	Galois
Boole	Kronecker
Riemann	Kummer, Dedekind
Poincare	Cantor

## B. Articles from *The World of Mathematics*, by James R. Newman

This is a large 4 volume work with loads of interesting articles. Here are some of them.

### Volume One:

The Nature of Mathematics	The Great Mathematicians
Archimedes	Greek Mathematics
Isaac Newton	Newton, The Man
Srinivasa Ramanujan	My Mental Development (Bertrand Russell)
The Sand Reckoner	Counting
Calculating Prodigies	The Ability of Birds to Count
The Queen of Mathematics	Definition of Number
The Seven Bridges of Konigsberg	

### Volume Two:

Mathematics of Motion	The Soap Bubble
On Being the Right Size	Concerning Probability
Chance	The Meaning of Probability

### Volume Three:

The Vice of Gambling and the Virtue of Insurance (G. B. Shaw)	
Infinity	Paradox Lost and Paradox Regained
New Names for Old	

### Volume Four:

A Mathematician's Apology	Mathematical Creation
Young Archimedes	Meaning of Numbers
The Locus of Mathematical Reality	Assorted Paradoxes
What the Tortoise Said to Achilles and Other Riddles	
Flatland	Pastimes of Past and Present Times

## C. BOOKS:

*Number*, Tobias Danzig

*Mathematics and the Imagination*, Edward Kasner and James R. Newman

*Mathematics Queen and Servant of Science*, E. T. Bell

*Excursions in Number Theory*, Ogilvy and Anderson

*An Introduction to the History of Mathematics*, Howard Eves

*A Mathematician's Apology*, G. H. Hardy

*What is Mathematics*, R. Courant and H. Robbins

*Discovering Mathematics*, A. Gardiner

*In Mathematical Circles*, Howard Eves

*The Most Beautiful Mathematical Formulas*, L. Salem, F. Testard, C. Salem

*In Code, A Young Woman's Mathematical Journey*, Sarah Flannery

*The Code-Breakers; History of Secret Communication*, David Kahn

*The Code Book*, Simon Singh



## VII. Curriculum Maps: Department of Mathematics

Department Chair: Professor Poodiack; Professors: True, LaVarnway, Frey; Associate Professors: Timoszyk, McQuillan, Olsen, Olson; Assistant Professors: Latulippe,C, Latulippe,J, Kramer Lecturers: Mathai, Herman, Ku; Adjuncts: Rogers, Gambler, Musty, Grindle

The Mathematics Department offers a four-year program leading to the Bachelor of Science degree in Mathematics. The courses offered are intended to (1) prepare mathematics majors for graduate work in mathematics or careers in computer science, engineering, industry, business, actuary science, or teaching; (2) support the curricula in all disciplines, and (3) supply the students with the mathematics courses necessary to qualify for teacher licensure.

Courses required of the mathematics major are listed in the following pages. Mathematics majors must obtain grades of “C” or better in at least three of the four courses MA121, MA122, MA223, MA224 and in at least six math courses at the 300-400 level, other than MA360. Courses listed in the third year and fourth year of the program as math electives are taken at the 300-400 level.

For a minor in mathematics students must complete six courses of 3 or more credits in mathematics (MA) above the level of MA121 (at least three at the 300-400 level) with a grade of “C” or better. Students are invited to design their own programs so as to blend these courses with their academic majors, with the advice of the Mathematics Department.

Students interested in licensure as a secondary (or middle school) math teacher should declare Education as a minor early in their program of study. These students should work with their academic advisor and an advisor from the Education Program to develop schedules of courses meeting the degree requirements for a B.S. In Mathematics and including the course requirements of the Teacher Licensure Program. See the curriculum map in this section.

### B.S. in Mathematics

#### First Year

	Credits		Credits
MA121 Calculus I	4	MA122 Calculus II	4
EN101 Comp. & Lit.	3	EN102 Comp. & Lit.	3
Lab Science Elective	4	Lab Science Elective	4
Elective	3	MA241 Mathematical	
		Computation and Modeling	3
	<b>14</b>		<b>14</b>

## Second Year

	Credits		Credits
MA223 Calculus III	4	MA224 Diff. Equations	4
MA306 Discrete Math	3	MA310 Linear Algebra	3
EN201 World Lit.	3	EN202 World Lit.	3
*General Education Elective	3	*General Education Elective	3
PS211 Univ. Physics I	4	PS212 Univ. Physics II	4
		MA250 Communications in Mathematics	1
	<b>17</b>		<b>18</b>

## Third Year

	Credits		Credits
§MA303 or 309	3	MA Elective	3
MA311 Statistical Methodology	3	MA Elective	3
*General Education Elective	3	*General Education Elective	3
Elective	3	Elective	3
Elective	3	**MA304 or MA312	3
	<b>15</b>		<b>15</b>

## Fourth Year

	Credits		Credits
§MA303 or 309	3	MA Elective	3
MA411 Senior Seminar	3	MA Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
	<b>15</b>		<b>15</b>

\*The four required general education electives are

1. a course in History (except HI209).
2. a Social Science Elective.
3. a course in Ethics, either PH 303 or PH 350.
4. a Humanities Elective.

§MA303 and MA309 alternate as fall semester courses; both courses are required. For years these courses are offered, see Course Descriptions.

\*\*MA304 and MA312 alternate as spring semester courses; one of the two courses is required.

## B.S. in Mathematics - Actuarial Concentration

### First Year

	Credits		Credits
MA121 Calculus I	4	MA122 Calculus II	4
EN101 Comp. & Lit.	3	EN102 Comp. & Lit.	3
Lab Science Elective	4	Lab Science Elective	4
*General Education Elective	3	MA241 Mathematical Computation and Modeling	3
<b>14</b>		<b>14</b>	

### Second Year

	Credits		Credits
MA223 Calculus III	4	MA224 Diff. Equations	4
MA306 Discrete Math	3	MA310 Linear Algebra	3
EN201 World Lit.	3	EN202 World Lit.	3
EC201 Macro Economics	3	EC202 Micro Economics	3
PS211 Univ. Physics I	4	PS212 Univ. Physics II	4
<b>17</b>		MA250 Communications in Mathematics	1
		<b>18</b>	

### Third Year

	Credits		Credits
§MA303 or 309	3	MA 312 Statistical Methods	3
MA311 Statistical Methodology	3	MA Elective	3
MA212 Finite Mathematics	3	*General Education Elective	3
*General Education Elective	3	Elective	3
Elective	3	MA Elective	3
<b>15</b>		<b>15</b>	

### Fourth Year

	Credits		Credits
§MA303 or 309	3	MA 321 Financial Math	3
MA411 Senior Seminar	3	MA Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
<b>15</b>		<b>15</b>	

§MA303 and MA309 alternate as fall semester courses; both courses are required.

\*The three required general education electives are:

1. a course in History (except HI209).
2. a course in Ethics, either PH 303 or PH 350.
3. a Humanities Elective.

The required courses for the Actuarial Concentration are (to be completed with grade C or better): EC201, EC202, MA212, MA311, MA312, MA321.

A grade of B- or better is required in EC201, EC202, MA311, and MA 312 to meet the Society of Actuaries Validation by Educational Experience Requirement.

## B.S. in Mathematics - Teacher Licensure

### meeting requirements for Teacher Licensure as a grades 7-12 mathematics teacher

#### First Year

	Credits		Credits
MA121 Calculus I	4	MA122 Calculus II	4
EN101 Comp. & Lit.	3	EN102 Comp. & Lit.	3
Lab Science Elective	4	Lab Science Elective	4
PY211 Intro to Psych.	3	MA241 Mathematical	
ED104 Found. of Ed.	3	Computation and Modeling	3
		ED104 Found. of Ed.	3
	<b>17</b>		<b>17</b>

#### Second Year

	Credits		Credits
MA223 Calculus III	4	MA224 Diff. Equations	4
MA306 Discrete Math	3	MA310 Linear Algebra	3
EN201 World Lit.	3	EN202 World Lit. II	3
ED234 Learn Strat.	4	*PY220 Dev. Psych.	3
PS211 Univ. Physics I	4	PS212 Univ. Physics II	4
		MA250 Communications in	
		Mathematics	1
	<b>18</b>		<b>18</b>

#### Third Year

	Credits		Credits
§MA303 or 309	3	MA 304 or 312	3
MA311 Statistical Methodology	3	MA Elective	3
MA Elective	3	MA Elective	3
*Elective(HI, PH or MA 360)	3	*HU Elective, if program	
		includes MA360	3
PY324 Adolescent Psychology	3-4	**MA304 or MA312	3
		ED363 Reading and Writing	
		in a Content Area	4
		ED 315 Special Needs Child	3
	<b>15-16</b>		<b>19</b>

## Fourth Year

	Credits		Credits
§MA303 or 309	3	ED 425 student Teaching	12
MA411 Senior Seminar	3		
MA Elective	3		
*Elective(HI, PH or MA360)	3		
*HU Elective	3		
ED368 Curriculum & Methods	4		
	<b>19</b>		<b>12</b>

\*The following required general education electives must all be satisfied

1. a course in History (except HI209).
2. a Social Science Elective.
3. a course in Ethics, either PH 303 or PH 350.
4. a Humanities Elective.

§MA303 and MA309 alternate as fall semester courses; both courses are required. For years these courses are offered, see Course Descriptions.

\*\*MA304 and MA312 alternate as spring semester courses; one of the two courses is required.

## VIII. Description of Courses

### Mathematics (MA)

\*Students will not be granted more than 12 degree credits in Mathematics courses below 200.

#### **005. Preparatory Mathematics**

**3 Credits**

A comprehensive review of the fundamentals of arithmetic and a presentation of the basic algebraic skills and concepts. Topics include basic arithmetic with signed numbers, proportions, percent, geometry, linear equations and graphing of linear equations. Applications are included throughout the course. Students assigned to MA005 must satisfactorily complete it before enrolling in any other mathematics course. If required, MA005 must be completed by the end of the first year of study. This course will not meet any degree requirements and cannot be used as an elective. 3 lecture hours.

#### **\*101. Mathematics: A Liberal Art**

**3 Credits**

An investigation of mathematical concepts and methods with emphasis given to their impact on current and ancient problems. Topics include logic, counting problems, probability, geometry and mathematics of finance. Emphasis is on techniques of problem solving. Prerequisite: Satisfactory completion of MA 005 or equivalent as determined by departmental placement testing. Not open for the first time to a student with a grade of "C" or higher in MA107, or with credit for any mathematics course requiring MA107 as a prerequisite. Offered fall semesters.

#### **\*102. Mathematics: A Liberal Art**

**3 Credits**

An investigation of mathematical concepts and methods with emphasis given to their impact on current and ancient problems. Topics include mathematics of voting systems, basic graph theory including Euler circuits and the traveling salesman problem, the mathematics of population growth, statistics, and basic game theory. Emphasis is on techniques of problem solving. Prerequisite: Satisfactory completion of MA 005 or equivalent as determined by departmental placement testing. Not open for the first time to a student with a grade of "C" or higher in MA107, or with credit for any mathematics course requiring MA107 as a prerequisite. Offered spring semesters.

#### **\*103. College Algebra I**

**3 Credits**

A comprehensive study of algebraic topics, this course provides a strong foundation for subsequent mathematics-based courses. Topics include introduction to functions, polynomials, factoring, inequalities, systems of linear equations with two variables, integer exponents, and linear, quadratic, radical, and rational equations. Prerequisite: Grade of "C" or better in MA005 or equivalent as determined by departmental placement testing. Not open for the first time to students who have received degree credit in any math course except MA101, MA102. This course does not fulfill the General Education requirement in mathematics. 3 lecture hours.

#### **\*107. Precalculus Mathematics**

**4 Credits**

A course on topics in precalculus mathematics involving algebra and trigonometry designed to prepare students to progress into introductory calculus. It is a rapid development of elementary topics in algebra to linear, quadratic, logarithmic, and exponential functions, followed by an analytical treatment of

trigonometry. Prerequisite: Grade of "C" or better in MA103 or equivalent as determined by departmental placement testing. Not open for the first time to students with credit in any course requiring MA107 as a prerequisite.

**\*108. Applied Calculus**

**4 Credits**

A course on topics in analytical geometry progressing to differential and integral calculus. Presentation of a wide variety of practical application to technology, business, and science. Not open for the first time to a student with credit in MA121 or any course requiring MA108 as a prerequisite. Prerequisite: MA107 or equivalent as determined by departmental placement testing. Not more than one of MA108 or MA121 may count as degree credit.

**\*121. Calculus I**

**4 Credits**

An introduction to plane analytic geometry and to differential and integral calculus. Prerequisite: grade of "C" or better in MA107 or equivalent as determined by departmental placement testing. Not more than one of MA108 or MA121 may count as degree credit.

**\*122. Calculus II**

**4 Credits**

A continuation of MA121. Transcendental functions, methods of integration, vectors, polar coordinates, indeterminate forms, L'Hôpital's Rule, improper integrals, infinite sequences and series. Prerequisite: MA121 or "C" or better in MA108 and permission of the department.

**160. Mathematics for Elementary School Teachers I 3 Credits**

This course will address an advanced perspective of topics in algebra and the real number system as they relate to the teaching and learning of mathematics. Course structure involves an emphasis on problem solving and communications; making, following and assessing mathematical argument and developing an array of mathematical strategies and understandings which can be extended across K-6 mathematics. This course is open to education majors. Prerequisite: Satisfactory completion of MA005 or equivalent as determined by the department placement testing. Offered fall semesters of even years. 3 lecture hours. This course does not meet the General Education Math requirements.

**161. Mathematics for Elementary School Teachers II 3 Credits**

This course will address an advanced perspective of topics in geometry, measurement, statistics, data analysis, and probability as they relate to the teaching and learning of mathematics. algebra and the real number system as they relate to the teaching and learning of mathematics. Course structure involves an emphasis on problem solving and communications; making, following and assessing mathematical argument and developing an array of mathematical strategies and understandings which can be extended across K-6 mathematics. Prerequisite: Grade of "C" or better in MA160. Offered spring semesters of odd years. 3 lecture hours.

**199. Mathematics Test Course**

**4 Credits**

This course is designed for Nursing majors only.

**212. Finite Mathematics****3 Credits**

This course includes linear algebra with applications to systems of equations, linear programming, math of finance, sets, combinatorial analysis, and probability theory. Prerequisite: MA107 or equivalent as determined by department placement testing. Offered spring semesters.

**220. Geometry in Action****3 Credits****223. Calculus III****4 Credits**

A course that continues MA122. Multiple integration, solid analytic geometry, partial differentiation, two- and three-dimensional vector analysis. Prerequisite: MA122. Offered fall semesters.

**224. Differential Equations****4 Credits**

Ordinary differential equations are developed as models of physical phenomena. Differential equations are investigated by finding exact solutions and using computer software to determine the solution to linear and non-linear problems. Solution techniques include operator methods, Laplace transforms, and numerical methods. Prerequisite: MA122. Offered spring semesters.

**232. Elementary Statistics****3 Credits**

A course that covers the study of frequency distributions, averages and standard deviations, normal curve, probability, decision-making, sampling techniques, testing hypotheses, chi-square, students-t and F-distributions, correlation and linear regression. This course is valuable for those who plan to enter teaching. Prerequisite: A college level mathematics course or equivalent as determined by departmental placement testing. Not open to students with credit in MA311.

**235. Clinical Mathematical Methods****3 Credits**

A course investigating mathematics concepts and methods used in the health care settings. This course will cover the essential math for medication calculations, the continued development of statistical techniques utilized in scientific research, and the mathematics of population dynamics and epidemiological studies. Case studies will be used where appropriate. Emphasis will be on critical thinking and logic of math in a health care environment and in health care research and administration. This is a mathematics course for Nursing Majors. Prerequisite: MA232. Offered fall semester. 3 lecture hours and 1 laboratory hour.

**240. Introduction to Number Theory and Cryptology** **3 Credits**

An introduction to fundamental topics in number theory, including the real number system, prime numbers, modular arithmetic, the Euclidean Algorithm, Fermat's Theorem, Euler's Theorem, Euler's Phi function. Topics will be applied to Caesar and affine ciphers and the Chinese Remainder Theorem. Prerequisite: MA107 and knowledge of a programming language or permission of instructor. Offered fall semesters.

**241. Mathematical Computation and Modeling** **3 Credits**

A course designed to introduce effective problem solving strategies and modeling techniques to find solutions to complex and often ill-defined problems. Introductory material chosen from common



experiences encompassing many academic disciplines. Emphasis is placed on the development of mathematical models and computation on a variety of computing platforms and programming environments. Prerequisite: MA108 or MA 121 or permission of instructor. Offered spring semesters.

**250. Communication in Mathematics** **1 Credit**

This course illustrates the organization of the mathematical literature, the efficient search of the literature and a formal introduction to writing mathematics. Prerequisite: Sophomore Mathematics Major or permission of instructor.

**303. Advanced Calculus I** **3 Credits**

A course that provides an extension of concepts of basic calculus to functions of several variables to include limits, continuity, differentiation, and Riemann integration. Treatment of selected topics not included in the basic calculus series as a foundation for more advanced courses in analysis and applied mathematics is also included. Prerequisite: MA223 and either MA306 or permission of the instructor. Offered Fall semesters of even numbered years. 3 lecture hours.

**304. Advanced Calculus II** **3 Credits**

A course that continues with the content of MA303, including limits, continuity, differentiation, and Riemann integration. Treatment of selected topics not included in the basic calculus series as a foundation for more advanced courses in analysis and applied mathematics is also included. Prerequisite: MA303. Offered Spring semesters of odd numbered years.

**306. Discrete Mathematics** **3 Credits**

A course in logic, sets, techniques of proof, relations and functions, directed and undirected graphs, algebraic systems, Boolean algebra, and emphasis on applications in various areas of computer science. Prerequisite: MA108 or MA 121 and knowledge of computer programming. Offered fall semesters.

**308. Modern Geometry** **3 Credits**

A course in modern geometries that includes foundations of Euclidean geometry and the development of non-Euclidean geometries. Recommended for prospective teachers. Prerequisite: MA108 or MA121. Offered Spring 2010 and every third year.

**309. Algebraic Structures** **3 Credits**

A course on groups, rings, fields, morphisms, vector spaces; special topics selected from group theory, algebraic number theory, field theory, Galois theory. Prerequisite: MA306 or permission of the instructor. Offered fall semester of odd numbered years.

**310. Linear Algebra** **3 Credits**

A theoretical course on such topics as matrices, determinants, linear equations, vector spaces, bases and dimensions, linear transformations, eigenvalues, and eigenvectors. Prerequisite: MA223 or permission of the instructor. Offered spring semesters.

**311. Statistical Methodology I****3 Credits**

A course designed to provide a firm foundation for the employment of statistical methodology in engineering and the sciences. Examples drawn from the technical fields will be used throughout. The course will cover probability, continuous and discrete statistical distributions, estimation, tests of hypotheses, and sample regression. As time permits, other topics may be examined based on the interests of the students. Prerequisite: MA223. Offered fall semesters.

**312. Statistical Methodology II****3 Credits**

A continuation of MA311. Continued development of statistical techniques utilized in scientific and engineering research. Topics to be covered include regression, multiple regression, analysis of variance, experimental design, statistical quality control, and reliability analysis. Prerequisite: MA311. Offered Spring semester of even numbered years.

**318. Cryptology****3 Credits**

A course that covers fundamental mathematical concepts from modern algebra, number theory, and other areas of mathematics. Provides a foundation for the understanding of classical encryption systems. Modern encryption methods. Emphasis on the mathematical underpinnings germane to cryptology. Prepares students for advanced study of modern cryptography. Experience implementing encryption, decryption and cryptanalytic methods on a variety of systems. Prerequisite: MA240 and knowledge of a programming language or permission of instructor. Offered spring semesters.

**321. Financial Mathematics****3 Credits**

A course designed to extend the student's understanding of the fundamental concepts of financial mathematics and application of these concepts in calculating present and accumulated values for various streams of cash flows as a basis for future use in reserving, valuation, pricing, asset/liability management, investment income, capital budgeting and valuing contingent cash flows. The student will also be given an introduction to financial instruments, including derivatives, and the concept of no-arbitrage as it relates to financial mathematics. Prerequisite: MA121 or MA108 and MA212.

**360. Teaching Mathematics at the Elementary - Middle School Level****3 Credits**

A course in the content, methods, and materials for the teaching of elementary and middle school mathematics. Prerequisite: MA161.

**370. Introduction to Operations Research 3 Credits**

A course that concentrates on the fundamental concepts and techniques necessary to enable an individual to obtain "optimal" solutions to problems in business, economics, engineering, and the physical and behavioral sciences. Topics include linear programming, network analysis, dynamic programming. Prerequisites: MA212 or MA223. Offered Spring semesters of odd numbered years.

**380. Theory of Computation****3 Credits**

This course introduces the theory of computability, including important results from the study of automata and formal languages. Includes introductory material about the theory of directed graphs and

trees. A discussion of automata and their relationship to regular, context free and context-sensitive languages. General theories of computability, including Turing machines, and recursive functions. Further topics include decidability undecidability and computational complexity. Prerequisite: MA306. Offered Spring semesters of even numbered years.

### **390. Numerical Linear Algebra and Analysis 3 Credits**

Numerical techniques for solving problems in linear algebra and analysis. Topics to be studied include integration, interpolation, function approximation, solutions of systems of equations, locating eigenvalues. Attention will be paid to the theoretical aspects of the techniques, with particular emphasis on estimation of errors and on convergence properties of iterative techniques. Prerequisites: MA241, MA224. Offered Spring 2009 and every third year.

### **405. Complex Analysis 3 Credits**

A course in complex numbers, analytic functions, differentiation, and integration of complex functions, Taylor and Laurent series, evaluation of improper real integrals. Prerequisites: MA223 and either MA306 or permission of the instructor. Offered Spring 2011 and every third year.

### **407. Vector Analysis 3 Credits**

A course that analyzes scalar and vector fields. Topics included are Newtonian kinematics and Kepler's Law of Planetary Motion, gradient, divergence, curl, theorems of Green, Stokes, Gauss, curvilinear coordinates. Prerequisite: MA223. Offered Fall 2009 and every third year.

### **411. Senior Seminars 3 Credits**

Advanced study designed to develop student competence in working independently and to afford students an opportunity to pursue topics not otherwise offered by the department. Prerequisite: senior standing in mathematics or permission of the instructor. This is the capstone course for the Mathematics Major.

### **412. Senior Seminars 3 Credits**

Advanced study designed to enhance student competence in working independently and to afford students an opportunity to pursue topics not otherwise offered by the department. Topics may extend research performed in MA411 or be a topic independent of MA411. Prerequisite: MA411.

### **421. Number Theory 3 Credits**

A course in the properties of integers, prime numbers, congruences, Diophantine equations, quadratic reciprocity. Prerequisite: MA306 or permission of the instructor. Offered Spring 2011 and every third year.

\*Students will not be granted more than 12 credits in Mathematics courses below 200.

# IX. Mathematics Course CheckList

**Name:** \_\_\_\_\_ **Corps?** \_\_\_\_\_ **Class Year:** \_\_\_\_\_

COURSE	Passed S/Y	Transfer/Credit	COURSE	Passed S/Y	Transfer/Credit
<b>First Year</b>					
MA121 Calculus I			MA122 Calculus II		
EN101 Comp. & Lit.			EN102 Comp. & Lit.		
Lab Science Elective			Lab Science Elective		
Elective			MA241 Math Comp and Modeling		
<b>Second Year</b>					
MA223 Calculus III			MA224 Diff. Equations		
MA306 Discrete Math			MA310 Linear Algebra		
EN201 World Lit.			EN202 World Lit.		
*General Education Elective			*General Education Elective		
PS211 Univ. Physics I			PS212 Univ. Physics II		
			MA250 Communications in Math		
<b>Third Year</b>					
**MA303 or 309			MA Elective		
MA311			MA Elective		
*General Education Elective			*General Education Elective		
Elective			Elective		
Elective			**MA304 or MA312		
<b>Fourth Year</b>					
**MA303 or 309			MA Elective		
MA411			MA Elective		
Elective			Elective		
Elective			Elective		
Elective			Elective		

\* One course in history and a second in either Psychology, Sociology, Economics, or Political Science is required.  
 One course in Ethics, either PH 303 or PH 360 is required.  
 One additional course in English, Modern Language, or Fine Arts (Exclusive of EN 101, 102, 201, 202, 112, 203)  
 \*\* MA 303 and MA 309 alternate as Fall semester courses.

## X. General Education Goals

Norwich University General Education Goals are designed to provide students with the intellectual tools to experience, explore and master new topics throughout a period of life-long learning. To this end, at least a third of the credits in every major must be dedicated to basic literacy in English, mathematics, humanities, social sciences, and science outside the area of major concentration. Students majoring in both liberal arts and professional programs must demonstrate the following competencies to meet graduation requirements:

- 1) Students must be able to write and speak with clarity and precision, read and listen with comprehension, and analyze, synthesize, and critically evaluate information. This objective will be met beginning with EN101 and EN102, be reinforced by reading and writing throughout the curriculum, and culminate in a capstone course in each major. Wherever written work is required, part of the grade must be used to evaluate clarity and precision, and to reinforce the writing mechanics learned in EN101 and EN102.
- 2) Students will achieve an understanding of mathematical and quantitative reasoning and its place in today's world. They should understand how to construct mathematical models as a means of formulating problems and be able to apply appropriate logical, quantitative, and technological methods to solve problems. All students must complete two mathematics courses, exclusive of MA005 Preparatory Mathematics, MA103 College Algebra I and MA160 Mathematics for Elementary School Teachers I.
- 3) Students will possess a knowledge of and appreciation for the variety of human expression found in cultures and civilizations of the United States and the world. This will be achieved by requiring all students to take one course in history, one course in literature and one course in arts and humanities.
- 4) Students will gain a basic level of literacy in current scientific knowledge and theories and develop an appreciation for the natural world, in part through classroom and hands-on laboratory experiences by completing two courses in laboratory science. This will expose students to the scientific method and provide the critical thinking skills, necessary to make intelligent, well informed decisions.
- 5) Students will possess an understanding of the institutions and processes that are characteristic of human societies. This will be accomplished beginning with a course in psychology, sociology, economics or political science.
- 6) Students must be able to think critically and make ethical decisions. Critical thinking begins with integration of course work from all general education areas and culminates in the capstone course in each major. Ethical decision-making begins with adherence to the honor code. Students must be able to recognize ethical issues and articulate ethical decisions. This will be achieved in a course that includes the requirement that students deal with ethical ambiguities and articulate ethical decisions.
- 7) Students are encouraged to develop leadership skills through participation in leadership classes and activities.

### **Specific courses that fulfill the General Education Requirements**

**English Requirement:** EN102, EN108 or equivalent must be completed by the end of the sophomore year.

**Mathematics Requirement:** Complete two 100 level or above MA courses (MA005, 103, and 160 do NOT count).  
MA005 Preparatory Mathematics (Must be completed by the end of the first year if required.)  
One hundred level Math courses must be finished by the end of the second year.

**History Requirement:** Complete one history course (HI) Any History course except HI209.

**Literature Requirement:** (Bachelor of Arts candidates have more restrictive literature requirements.)  
Complete one Literature course from:

English courses: EN201, 202, 210, 220, 225, 226, 227, 228,240, 244,245, 250, 251, 270, 320-399, 420, 450.  
French courses: FR 321, 322, 327, 328,350, 415, 421.  
German courses: GR 322, 324, 326,350, 415, 421.  
Spanish courses: SP 321,322,327,328,350, 415, 421.

Arts and Humanities Requirement: Complete one of the following

English courses above EN206 ( except 240, 241, 242)

Music courses: MU101,271

All Philosophy courses (PH)

All modern language courses (Chinese, French, German, Spanish) numbered 112 and above

All Fine Arts courses (FA)

All Studio Arts courses (SA)

Communication courses: CM109,261,335,436

Social Science Requirement: Complete one of the following

Psychology courses (PY)

Sociology courses (SO)

Economics courses (EC)

Political Science courses (PO)

Ethics Requirement: Complete one of the following (AP436,CM436,EG450,EG043,EN450,NS422,PH303,PH322, PH323, PH324,PH350,PY360,SM439,SSDA400)

Science (with Laboratory) Requirement: Complete two Lab Science courses from BI,CH,GL, or PS.

Capstone Requirement: Complete one Capstone course (as indicated in Major requirements)

# Academic Calendar for 2015-2016

## Fall 2015

Aug. 31, Monday	Classes start
Sept. 1, Tuesday	Convocation (afternoon)
Sept. 7, Monday	Labor Day – No Classes
Sept. 8, Tuesday	Drop/add period ends
Oct. 19, Monday	Mid-semester grades due at noon
Oct. 27, Tuesday	Friday AM labs (7:00 p.m.) – at instructor’s discretion
Oct. 28, Wednesday	Friday PM labs (7:00 p.m.) – at instructor’s discretion
Oct. 30, Friday	Mid-semester break – no classes
Oct. 30, Friday	Last day to withdraw from a course with a grade of “W”
Nov. 11, Wednesday	Veterans Day
Nov. 21, Saturday	Thanksgiving vacation begins
Nov. 30, Monday	Classes resume
Dec. 15, Tuesday	Friday schedule of classes followed
Dec. 16, Wednesday	Reading Day – No extracurricular activities to be scheduled
Dec. 17, Thursday	Semester examinations (through Tuesday, 22 Dec.)
Dec. 22, Wednesday	Mid-year vacation begins

## Spring 2015

Jan. 18, Monday	Classes start
Jan. 25, Monday	Drop/add period ends
March 7, Monday	Mid-semester grades due at noon
March 12, Saturday	Spring semester break begins
March 21, Monday	Classes resume
March 26, Friday	Last day to withdraw from a course with a grade of “W”
May 7, Saturday	Reading Day — No extracurricular activities to be scheduled
May 8, Sunday	Semester examinations (through Friday, 13 May)
May 14, Saturday	Commencement
May 15, Sunday	Commissioning