2017-2018

HANDBOOK FOR MAJORS AND MINORS

Department of Mathematics and Statistics
University of Vermont

Contents

I. INTRODUCTION

We would like to congratulate you on your acceptance to the University of Vermont and on your decision to consider mathematics or statistics as your major. The Department of Mathematics & Statistics is pleased to welcome you to the University and invites you to join the mathematical community of UVM. All of us are aware of the growing importance of the mathematical sciences in our technological society and many of our courses are designed to explore the role of mathematics and statistics in today's world. We are looking forward with excitement and enthusiasm to sharing classroom experiences which reveal the contributions of mathematics and statistics to society.

A major in mathematics or statistics represents one of the most flexible and valuable options available at UVM. The degree requirements are encompassing but not restrictive, providing ample opportunity for students to explore other areas of interest. Furthermore, individuals trained in the mathematical sciences have many opportunities to use their knowledge. Mathematics and statistics majors are equally well-prepared for jobs in business, industry, government, or teaching and for advanced study in graduate school. For example, UVM mathematics and statistics graduates are often employed in the computer, information, and communications industries, in engineering, in the insurance business, in government agencies, and in a variety of other occupations. Many attend graduate school in the mathematical sciences, business, the physical sciences, social sciences, medicine, dentistry, or law.

ORIENTATION

The Department Office and many faculty offices are housed in the Henry Marcus Lord House at 16 Colchester Avenue on the north edge of the main campus, opposite Ira Allen Chapel and the Campus Center Theater. Other departmental buildings are Mansfield House and 12 Colchester Avenue (the Pearl House). Most mathematics and statistics classes are held in Votey Hall, Perkins Building, Waterman Building, Torrey Hall, and Lafayette Hall. Other important buildings are the Billings Student Center, the Bailey-Howe Library and Hills Building, where some Statistics faculty participate in the College of Medicine Biometry Facility and in the College of Agriculture and Life Sciences Statistical Services Unit. The College of Engineering and Mathematical Sciences (CEMS) computing facilities are located in Votey Hall. The Mathematics & Statistics Department offers a major in (1) the College of Engineering and Mathematical Sciences (leading to a B.S. degree in mathematics); and (2) the College of Arts and Sciences (CAS) (leading to a B.A. degree in mathematics). Between 20 and 50 undergraduate degrees are typically awarded each year in mathematics and statistics. There are about 30 full-time faculty members in the Department, several part-time instructors and from 25 to 35 graduate students. A full-time faculty member will be assigned as your advisor to assist you in choosing courses suited to your goals and interests. You are encouraged to see your advisor often – and regard this person as a valuable and essential resource.

WHO MAJORS OR MINORS IN MATHEMATICS

Certainly mathematics majors share a common interest in mathematics, but their other academic interests may vary significantly.   The applications of mathematics intersect nearly every other discipline on campus, so the "other" interests of mathematics majors and minors vary greatly.   This diversity enhances involvement in the university community and offers broad job opportunities upon graduation.   More than any other major or minor at UVM, a mathematics major or minor makes you an attractive employee in many fields.   If you find mathematics interesting and wish to study it further, regardless of your career plans, you are encouraged to consider majoring or minoring in mathematics.

The mathematics curriculum for both Math major and minor is quite flexible. It is designed to provide a sound basic training in the mathematical sciences, which allows you to experience the broad sweep of mathematical ideas and techniques, to utilize the computer in mathematics, and to develop an area of special interest in the mathematical sciences.   Many majors at UVM are well on their way to having a minor in Mathematics while fulfilling their major requirement.   For example, Students who major in Engineering and Computer Science are usually just a couple of 100-level Math courses away from a Math minor at the end of their sophomore year.

Mathematics majors a n d m i n o r s gain lasting skills in computational ability and logical reasoning.   Statistics majors gain lasting skills in obtaining information and interpreting data for decision making.   Those seeking useful and marketable life skills should certainly consider these majors.

WHO MAJORS IN STATISTICS

Students receiving a B. S. in the College of Engineering and Mathematical Sciences may elect statistics as their major. In addition, students receiving a B. A. degree in the College of Arts and Sciences may concentrate in statistics as a part of their mathematics major.   Statistics is a mathematical science extensively used in a wide variety of fields.   Indeed, every discipline that gathers and interprets data uses statistical concepts and procedures to understand the information implicit in their data base. Statisticians become involved in efforts to solve real world problems by designing surveys and experimental plans, constructing and interpreting descriptive statistics, developing and applying statistical inference procedures, and developing and investigating random models or computer simulations.   To investigate new statistical procedures requires knowledge of mathematics and computing as well as statistical theory.   To apply concepts and procedures effectively also calls for an understanding of the field of application.

The curriculum is designed for students who plan to enter business, industry, or government as statisticians; to become professional actuaries; or to continue to graduate school in statistics and biostatistics or another field where a quantitative ability can

prove valuable (business, operations research, public health, psychology, etc.). The courses and curricula are administered through the Statistics Program Steering Committee, which includes faculty from Statistics, the College of Medicine Biometry Facility, Psychology, Natural Resources, and the Agricultural Experiment Station. Students are encouraged to undertake special projects to gain experience in data analysis, design, and statistical computing. Also, experience can be gained with local industry and other organizations for those interested in such areas as quality control, industrial statistics, survey and market research, or forecasting.

II. GETTING STARTED

As you embark upon a major in mathematics or statistics, you should keep in mind the important principle that there is no substitute for thoughtful planning. As Louis Pasteur once wrote, "fortune favors the prepared mind." In the current context, that adage translates into a long-range schedule of courses, planned by you and your advisor, that takes into account your background, experience, preferences, and expectations in selecting mathematics or statistics as a major. Of course, such a schedule will undoubtedly change as time passes, as you gain experience in the major, and as your exposure to different areas of the mathematical or statistical landscape shapes your vision for the future. Nonetheless, it is important to have a plan and to start out with a focused approach.

In the pages that follow we will discuss some of the typical questions that may arise in deciding what courses to take, and we will provide information that may be helpful in making those decisions. **Please remember that this written material is informational, and is not a substitute for personalized course planning with your advisor.** The section below on advising will discuss in more detail the relationship between you and your advisor. For now, suffice it to say that the goal of advising is to ensure that you have an enriching and beneficial educational experience. Your advisor is a person you can count on for information and guidance at any time.

WHERE TO BEGIN: CALCULUS

The calculus sequence consists of three courses, Math 21, 22, and 121, taken in this order. While Math 21 would be taken by most students in their first semester at UVM, other students, depending upon their secondary school background in mathematics, may choose to bypass this course. If you have not taken calculus in high school, then quite likely you will start calculus with the first course in the sequence, Math 21. However, if you have been exposed to calculus in high school, where to start in the sequence will depend substantially on the quality and quantity of your high school calculus. You and your advisor, together, should review your previous calculus experience in order to make that decision.

There are no blanket recommendations that can be made here, but several considerations that will go into your decision can be discussed. First, you will have the results of the mathematics readiness test to use as a guide. The course placement recommendation is based upon your score on this test, but you may, after consulting with your advisor, begin with a different course if you feel that your test score is not an accurate measure of your mathematical background. However, you should discuss your decision with the instructor in the course to let him or her know of your situation. Finally, note that if you did well in a substantial calculus course in high school that is comparable to our Math 21, we would probably advise you to go directly to Math 22, but this decision should be carefully thought out. On the one hand, we do not want you to be bored sitting through a course in which you already know the material; on the other, we do not want you to have major gaps in your calculus background. The collective judgment of you and your advisor will resolve this issue.

THE FIRST TWO YEARS

In roughly your first two years, you can make a strong start in the major by completing the calculus sequence (Math 21, 22, 121), Computer Programming I (CS 21), Fundamentals of Mathematics (Math 52), and the linear algebra/matrix theory course (Math 124). These courses, which are foundational for the major, introduce fundamental conceptual ideas, methods, and techniques that are important throughout mathematics and statistics, as well as applications. Note that CS 21, Math 52, and Math 124 are normally taken in that order, and CS 21 is only required for the BS Degree.

As just noted, one of the primary curricular goals in the first two years is to give you the mathematical skills, techniques, and methods that form the backbone of mathematical usage and applications. Another goal, less tangible but equally important, is to help you begin to acquire a quality of mind that one refers to as "mathematical maturity. " Thus, for example, we hope that you will learn to reason from the particular to the general and vice versa, to ask yourself why mathematical processes work as they do, to think about when procedures apply in new circumstances or how techniques and definitions can be altered to cover a wider set of problems, and to catalogue problems and cross-reference ideas. These achievements represent your first step in the transition from practice to theory.

CALCULUS AND LINEAR ALGEBRA

Your classmates in the calculus sequence, and to a lesser extent linear algebra, will include those majoring in engineering, computer science, and the physical sciences, as well as mathematics and statistics. In view of this diversity, the emphasis in this portion of the core curriculum is more on breadth of coverage than on depth of understanding. In particular, you will be exposed to a variety of topics and be expected to develop various technical and computational skills related to these topics. For example, in calculus you will be evaluated on your ability to

compute and use derivatives and definite integrals, and in linear algebra on finding the inverse or determinant or eigenvalues of a matrix. Occasionally you will work at "problem solving", applying the concepts that have been learned to solve a word problem. In these courses, you will also be engaged in conceptual learning that involves definitions, hypotheses, counterexamples, and the like. In the calculus sequence you will be asked primarily to use theorems rather than prove them; while in linear algebra understanding and creating proofs will play a larger role.

MATH 52 AND OTHER TRANSITIONAL COURSES

The intent of Math 52 is to introduce deductive mathematical reasoning and proof techniques, and thereby provide a transition from the more computational mathematics courses in the calculus sequence to upper level courses in which precise mathematical arguments are required. Math 52 also plays another important role in the mathematics and statistics core curriculum by emphasizing writing of mathematics.

In addition to Math 52, which is required for the major, there are elective courses that may also assist you in the transition to rigorous mathematical reasoning. One such course is Basic Combinatorial Theory (Math 173). This course emphasizes problem solving techniques in the broad area of "counting problems." Students find that the problem solving training from this course is extremely valuable in subsequent classes. Another such course is Elementary Number Theory (Math 255), in which familiar properties of the integers provide the base on which beautiful relationships with geometry, algebra, and analysis are developed. Foundations of Geometry (Math 260) is also a course that can help to bridge the gap between the lower level courses and the more rigorous upper level courses. Axioms and proofs are presented in a context in which the basic concepts are familiar and easy to visualize. Please consult the course descriptions in this handbook for more information on these courses.

UPPER LEVEL COURSES

With your background from Math 52, 124, and perhaps other transitional courses, you should be prepared for the theoretical side of mathematics developed in upper level courses. You are encouraged to take appropriate upper level courses as soon as possible. In these upper level courses, you will be required to assimilate a substantial number of new mathematical concepts in the relatively short time frame of one semester, and in some courses you will be learning to compose proofs. In time and with diligence, you will achieve understanding and a satisfying sense of accomplishment. Many support structures and learning aids are available (see Section V below) to help you make this transition to proof-based mathematics; the most important of these is time spent individually or in small groups with your instructor during office hours. Especially in courses in which you are exposed to new and deep ideas, it is important to do the homework on a regular basis, to not fall behind in the class, to arrange study groups with classmates, and to get help in a

timely fashion whenever you have questions. Remember that your instructor and your advisor are your allies and want you to succeed!

STATISTICS IN THE FIRST TWO YEARS

As a first year student you can take Discrete Probability Models (Stat 51). Calculus is not used, and the emphasis is on the important types of reasoning used with probability models. Various statistical applications of probability will also be discussed.

In order to gain an early exposure to statistics you can take Basic Statistical Methods (Stat 141) or Applied Probability (Stat 151) after your first calculus course. Stat 141 introduces the fundamental concepts of statistical reasoning (statistical measures, confidence limits, hypothesis testing, correlation, study designs, etc.), with a smaller coverage of probability concepts. Stat 151 can be taken after Math 22 and covers the fundamentals of probability models for discrete and continuous data, with some coverage of statistical inference. Stat 141 and 151 may be taken in any order, but most students are advised to take 141 before 151. If you have waited until your junior or senior year to try a statistics course, then you can take Statistical Methods I (Stat 211) as an introductory course. The emphasis here is on statistical reasoning rather than on probability models.

If you are considering becoming a statistics major, it is a good idea to take Stat 141 in your sophomore year, and perhaps Stat 151 as well if your schedule permits, so that you will have plenty of options for other statistics courses in your junior and senior years. Note that as mathematics major you can minor in statistics. See the information sheet that precedes the Index.

DISTRIBUTION REQUIREMENTS

During your first two years, whether you are working on a Bachelor of Science degree through the College of Engineering and Mathematical Sciences or a Bachelor of Arts degree through the College of Arts and Sciences, you should begin fulfilling your distribution requirements. Together with your advisor, you should plan to include among your distribution requirements those courses that relate closely to your mathematical and career interests (see Sections III and IV below). In selecting courses to meet distribution requirements, we have two other general pieces of advice: take a variety of courses and take courses that interest you! Because mathematics and physics are historically intertwined, because seeing mathematics in context can enhance your understanding, and because an understanding of general physics will enrich your experience in upper-division courses, you should also consider taking some physical science courses. Similarly, because of the close relationship between mathematics and computing already cited above, if you have any inclination towards computers, we urge you to take as

many computer science courses as possible. Careers in industry and teaching will benefit greatly from a foundation in the physical sciences and a facility in computing.

III. REQUIREMENTS AND RECOMMENDATIONS

AREAS OF INTEREST IN MATHEMATICS AND STATISTICS

There are many options open to you within the mathematics and statistics major. The first decision is whether to select the major within the College of Arts and Sciences or within the College of Engineering and Mathematical Sciences. You may have already made this decision based on your preference for a Bachelor of Arts degree or a Bachelor of Science degree, and the type of education that each connotes. As you would expect, the basic difference between the two options does, in fact, reflect the philosophies of the two colleges. The B.A. degree, granted by the College of Arts and Sciences, embodies a broad liberal arts education and a high degree of flexibility that can lead to a double major, while the B.S. degree, granted by the College of Engineering and Mathematical Sciences, indicates a strong focus on science and technology.

In this section of the handbook, you will find the requirements of each degree described in detail. Transferring from one college to another is possible. Talk with your advisor if you feel such a change may be right for you.

Many personal goals are compatible with both types of mathematics majors. For example, either major provides excellent preparation for a career in teaching, academics, or medicine. Since these careers interest so many students, special advice is provided here on how to approach them.

Teaching of Mathematics: The centrality of mathematics in a technological world requires high quality mathematics teaching in our schools. The Department of Mathematics & Statistics and the College of Education and Social Services (CESS) cooperate closely in the area of mathematics education. A student seeking a career as a mathematics teacher in a middle or secondary school should take a rich array of mathematics courses chosen from Math 141, 161, 173, 230, 237, 255, 260, 273, Stat 151 and Stat 211. Consult the Coordinator of Secondary School Education in the College of Education and Social Services for admission to the Secondary Education Program in CESS and for courses required for certification.

Pregraduate Training: If you intend to pursue an advanced degree in the mathematical sciences, you are urged to obtain a solid foundation in mathematics by including as many of the courses of particular importance as possible (These courses are marked with an asterisk in the Areas of Special Interest later in this section). Furthermore Math 242 and/or Math 252 are highly recommended since many graduate schools require them. You should also consider enrolling in the junior-senior seminar

(Math 283) and writing an honors thesis (Math 293 or Stat 293). Most graduate schools require GRE (Graduate Record Examinations) results, so you should plan to take these in your senior year.

Premedical Training: The mathematics major provides excellent credentials for a student who plans to apply to medical school. It is suggested that the student follow the recommendations for a special interest in Allied Fields (2), (3), or (8) given below. During your first or second year, you should review catalogues of those institutions that interest you.

In addition, you should contact the Office of Career Services during your junior year regarding the specifics of the medical school application process. To specialize more exclusively in statistics consider the following Premedical Concentration in Statistics.

Premedical Concentration in Statistics: Each student electing the Premedical Concentration in Statistics must fulfill the general requirements for the statistics major. In addition, the premedical concentration should include a minimum of two years of chemistry with laboratory (Chemistry 31, 32 or 35, 36, and 141, 142), at least one year of physics with laboratory (Physics 31 with Math 21 and Physics 42 with Math 22), and at least one year of biology with laboratory (Biology 1, 2). Exposure to medical research problems will be provided through supervised experiences in the College of Medicine Biometry Facility.

THE COLLEGE OF ENGINEERING AND MATHEMATICAL SCIENCES

The College of Engineering and Mathematical Sciences offers programs in several areas of the mathematical sciences and their applications. The curriculum leads to the Bachelor of Science degree in mathematics. The Statistics Program offers a major in statistics within this degree.

Basic Requirements

Mathematics: Math 21, 22, 121, 52, 124, 241, 251 and CS 21.

With the approval of the student's advisor(s) and the Math Department Chair, Computer Science majors may count CS 64 instead of Math 52 towards a major in Mathematics.

Statistics: Math 21, 22, 121, 124, CS 21; one of Stat 141,143, or 211; Stat 151 or 251; Stat 201; Stat 221 or 227; Stat 241 or 261; and Stat 281 or 293.

Additional Requirements

In addition to the Basic Requirements, candidates for the degree of Bachelor of Science in mathematics must complete the following requirements A, B, C, and D.

A. Major Courses

Mathematics: A minimum of 21 additional hours in mathematics, statistics, or computer science courses numbered 100 or above. At least 12 hours must be in courses numbered 200 or above and no more than 12 hours may be chosen from computer science.

Statistics: An additional six credit hours of statistics, so that the total credits earned in statistics is at least 24 hours. A minimum of two additional hours in mathematics, statistics, or computer science courses numbered 100 or above, so that a total of at least 45 credits in the basic and major courses is earned. A total of 18 credit hours in the combined basic curriculum and major courses must be taken at the 200 level and no more than 12 hours can be taken in computer science.

B. Allied Field Courses

Allied Field Courses include the following:

Twenty-four hours selected from the following Allied Fields:

1. Physical Sciences	7. Business Administration
2. Biological Sciences	8. Psychology
3. Medical Sciences	9. Economics
4. Engineering	10. Environmental Sciences & Studies
5. Computer Science (26 or higher)	11. Natural Resources
6. Agricultural Sciences	

Each student, in consultation with his or her advisor, must plan a sequence of Allied Field courses consistent with his or her professional and personal goals. A student interested in pursuing intensive studies in an area not specifically listed is encouraged to plan a program with his or her advisor and submit it to the appropriate departmental committee for review and approval. Allied Field Course requirements are as follows:

Mathematics: Twenty-four hours selected from the above list of Allied Fields. Of these 24 hours, at least six hours must be in courses numbered 100 or above, and at least six hours must be taken in fields (1) to (5). Courses used to satisfy requirement A above may not be used to satisfy this requirement.

Statistics: Twenty-four hours selected from the above list of Allied Fields, including at least one laboratory experience in science or engineering. Of these 24 hours, at least six hours must be in courses numbered 100 or above, and at least six hours must be taken in fields (1) to (5). Courses used to satisfy requirement A above may not be used

to satisfy this requirement.

C. Humanities and Social Science Courses (Courses used in B may not be used here.)

English 1, and 21 hours of courses selected from categories I, II, and III listed below. These 21 hours must be distributed over at least two categories, and at least six hours must be taken in each of the two categories chosen. Statistics majors must include Speech 11.

I. Language and Literature

Chinese	Classics	English	French	German
General	Russian	Spanish	Hebrew	Greek
Italian	Linguistics	World Literature		

II. Fine Arts, Philosophy and Religion

Art	Film	Music	Philosophy
Religion	Speech	Theatre	

III. Social Science

ALANA U.S. Ethnic Studies	Anthropology	Area & International Studies
Communication Sciences	Economics	Geography
History	Political Science	Psychology
Sociology	Vermont Studies	Women's Studies

D. Total Hours

A minimum of 120 semester hours is required. First year students must include two courses approved by the College of Arts and Sciences as meeting the "Race Relations and Ethnic Diversity in the United States" requirement.

Double Major: Students may earn a double major in mathematics and statistics by meeting the requirements of the statistics major and earning an additional 15 credits in mathematics, including Math 52 and two of Math 230, 237, 241 or 251.

E. Grades

No more than three grades of D, D+ or D- in the 200/300 level Mathematics and Statistics courses used to satisfy the "Core Curriculum" and "Major Courses" requirements will be acceptable.

AREAS OF INTEREST WITHIN THE MATHEMATICS AND STATISTICS MAJOR

Because of the enormous range of mathematics, courses are grouped in areas of interest to assist you in planning your Mathematics and Statistics program. Because mathematics also has an inner unity, there is a great deal of overlap among these

areas. Selecting courses from different areas helps you achieve breadth in the major, while focusing several courses in the same area assures a depth of concentration in the major. Courses of particular importance in an area are marked with an asterisk. Furthermore, students earning a mathematics major can minor in statistics by earning an additional 15 statistics credits. See "Minor in Statistics" for details.

Recommendations for Major Courses

In consultation with your advisor, you should choose an area of interest within the mathematics major and plan a coherent program that addresses your interests. This area might be one of those listed below, or it might be one you suggest. If you are interested in one of the areas listed, you would typically take at least three courses in that area, including all of the courses marked with an asterisk. In addition, you should take courses from at least two other areas. Because of its centrality in mathematics, you should make sure that you take at least two courses listed under classical mathematics.

In following these recommendations, a course listed in more than one area is meant to be counted only once.

1. *Classical Mathematics*. Classical mathematics, also called pure mathematics, is the study of the major developments of mathematical thought. Many of these topics are central to any course of mathematical study. Classical mathematics includes analysis, abstract algebra, number theory, combinatorics, graph theory, geometry, topology, measure theory, and the theory of complex variables. Current research interests of the faculty include graph theory, combinatorial design theory, algebraic number theory, group theory, and harmonic analysis. Courses in this area include: Math 141, 151, 173, 236, 240, 241*, 242, 251*, 252, 255, 257, 260, 264, 273, 331, 353.

2. *Applied Mathematics*. Applied mathematics involves the use of mathematical methods to investigate problems originating in the physical, biological, and social sciences, and engineering. Mathematical modeling, coupled with the development of mathematical and computational solution techniques, illuminates mechanisms which govern the problem and allows predictions to be made about the actual physical situation. Current research interests of the faculty include biomedical mathematics, nonlinear dynamics, complex networks, complex systems, fluid mechanics and hydrodynamic stability, asymptotics, singular perturbation theory, and weather prediction. Courses in this area include: Math 230*, 235, 236, 237*, 240, 266, 268, 272, 273, 274, 300, 303, 330, 337.

3. *Computational Mathematics*. Computational mathematics involves the development of new computational techniques and the innovative modification and application of existing computational strategies to new contexts. Intensive computation is central to the solution of many problems in areas such as applied

mathematics, number theory, engineering, and the physical, biological and natural sciences. In these areas, mathematics provides a formulation for the rules governing the systems under study. Computational mathematics provides useful methods for making comprehensive predictions about these systems.

Many physical problems can be simulated on computers, with computational experiments complementing physical experiments so that expensive and dangerous procedures are minimized. Computational mathematics provides the methods and, in some cases, a valuable conceptual framework for these simulations.

Computational mathematics is often interdisciplinary in nature since the source of the problems under study is often outside mathematics. Algorithm development and implementation form a bridge between underlying mathematical results and the solutions of related physical problem. In the process of forming this bridge, ideas and insight are produced in addition to the numerical results. In recent decades, "pure" mathematics has also become a large user of computation, with the computation being used to test cases and suggest patterns in the pursuit of mathematical results. Courses in this area include: Math 173, 230, 237*, 274, 337, and Stat 201.

4. *Theory of Computing***.** The mathematical theory of computing deals with the mathematical underpinnings which allow effective use of the computer as a tool in problem solving. Aspects of the theory of computing include: designing parallel computing strategies (graph theory), analyzing strengths and effectiveness of competing algorithms (analysis of algorithms), examining conditions which ensure that a problem can be solved by computational means (automata theory and computability), and rigorous analysis of run times (complexity theory). Courses in this area include: Math 173, 223, 224*, 243, 273, 325, Computer Science 346, 353.

5. *Mathematics of Management.* Mathematics of management involves the use of mathematics in making the kinds of decisions that occur in such area as business, government, medicine and the military. The following examples illustrate some typical problems that occur.
- a bank manager must determine the number of tellers that should be utilized during the noon hour;
- a manager of a trucking firm must decide on a transportation schedule that minimizes cost and meets demand requirements;
- a city manager must determine the set of one-way streets which allows the maximum traffic flow.

When such a situation requiring a decision arises, pertinent information is investigated, quantified if possible, and formulated into a mathematical structure, commonly known as a mathematical model. This model might take the form of a differential equation, a system of linear equations, or a set of logical statements. After the problem is translated into a mathematical framework, an attempt is made to find a solution. If successful, the information from the mathematical solution is utilized in choosing the appropriate course of action. The mathematics used in these types of problems is drawn from several areas including: calculus,

linear algebra, probability, statistics, differential equations, combinatorics, and graph theory. Furthermore, mathematical models can frequently be generalized so that the same model can be used in many seemingly different situations. On the other hand, new models are developed daily as new and unique problems arise. Courses in this area include:

Math 173, 221*, 222, 230, 236, 273
Stat 141 or 211, Stat 151 or Math 207, Stat 224, 241, 253.

6. *Actuarial Mathematics*. Actuaries use quantitative skills to address a variety of problems within business environments, such as managing risks that have financial consequences. Some responsibilities may include, but are not limited to: designing retirement programs for large organizations, assessing the impact of various causes on the mortality experience of insured populations, estimating benefit costs associated with labor contracts, determining fair premiums, and assisting companies with investment decisions. Actuaries are proficient in statistics and mathematics, and additionally are interested in business, legal, and political issues. The majority of actuaries work for life, health, and casualty insurance companies. Opportunities also exist with consulting firms, universities, and government agencies such as the Social Security Administration. Actuaries enjoy a high degree of responsibility and visibility and are compensated accordingly.

Two professional organizations, The Society of Actuaries (SOA) and the Casualty Actuarial Society (CAS), sponsor qualifying examinations and certify actuaries in the United States and Canada. A unique feature of the actuarial profession is that formal training is typically completed "on-the-job" after graduation. Most employers of actuaries support and encourage advancement to Associateship and Fellowship in one of the Societies. Many of these organizations will sustain trainees by providing examination support, materials, study time, review classes, and examination raises or bonuses.

If you are planning an actuarial career, you can prepare for and complete some associateship level examinations prior to graduation. Several departmental course offerings serve as preparation for the examinations:

General Preparation:
    Math 21, 22, 121, 124, 173
    Stat (141 or 211) 151, 221, 183 (Stat for Business), 295 (Time Series Analysis)
Exam P – Probability:
    Stat 151, 251, (241 or 261)
Exam FM – Financial Mathematics:
    Math 183 (Fundamentals of Financial Mathematics)
Exam M – Actuarial Models:
    Stat 229, 251, Math 222
Exam C – Construction and Evaluation of Actuarial Models:
    Stat 237, 251, 261, 295 (Bayesian Statistics)

In order to enhance career opportunities, courses in accounting, business

management, finance, economics, computer science, speech and writing are also recommended.

All entry level positions require a B.S. degree in mathematics or statistics or B.A. degree with substantial coursework in mathematics and statistics. Many also require a minimum GPA of 3.0 and successful completion of one or two of the actuarial examinations. Summer intern programs are sometimes available for qualified junior level students.

7. *Probability and Statistical Theory.* Probabilistic reasoning is often a critical component of practical mathematical analysis or risk analysis and can usefully extend classical deterministic analysis to include models with random components. It also provides a basis for statistical theory, which is concerned with how inference can be drawn from real data in any of the social or physical sciences. It opens the door to the theory of statistical methods for the interpretation of scientific and technological data. Courses in this area include: Math 222, 241, 242, (Stat 151 or Math 207)*, Stat 241*, 252a, 252b, 261, 262, 270.

Recommendations for Allied Field Courses

If you select the ***Mathematics*** option you should also discuss Allied Field courses with your advisor and then choose those courses that complement your mathematical interests. For the mathematical interests listed below, you should take at least six hours in courses numbered 100 or above in one of the designated fields.

Applied Mathematics: Allied Field (1), (2), (3), (4), (6), (9), (10) or (11).
Computational Mathematics: Allied Field (4) or (5).
Mathematics of Management: Allied Field (7).

Students interested in Mathematics of Management are advised to include Econ 11 and 12 in their choice of Humanities and Social Sciences courses, and to include BSAD 60 and 61 in their choice of Allied Field courses. Those wishing to minor in Business Administration should contact the School of Business Administration and also take BSAD 173 and two other courses chosen from BSAD 168, 170, 174, 177, 178 and 272.

THE COLLEGE OF ARTS AND SCIENCES

The mathematics or statistics major within the College of Arts and Sciences allows you to concentrate in mathematics while at the same time pursuing a broad foundation in the liberal arts which includes a minor in another discipline as well. The curriculum leads to the Bachelor of Arts degree in mathematics. The UVM catalogue provides full details of major, minor, distribution, grade point average and other college requirements in the beginning of the section on the Arts and Sciences College. A brief summary of requirements is given below. Checklists for the fulfillment of requirements, including lists of approved courses for various categories, are provided on pages 50-52.

Mathematics majors may choose from the two concentrations listed below. Students interested in any of these should consult an advisor in the Mathematics and Statistics Department.

Mathematics: Math 21, Math 22, Math 121, Math 52, and Math 124, plus 18 additional credits in mathematics or statistics courses at 100 level or above, with at least 12 hours numbered 200 or higher.

Statistics: CS 21. Thirty-three hours of mathematics or statistics courses numbered 21 or higher, including Math 21, 22 and 121 and 124; Stat. 141, 143, or 211; Stat 151 or 251; Stat 201; Stat 221 or 227; Stat 241 or 261; and Stat 281 or 293. At least 12 hours must be in mathematics and statistics courses numbered 200 or above.

General College Requirements (The following can all be found in the University Catalogue, http://www.uvm.edu/academics/catalogue2012-13/, the definitive source for this information)

    A. *Race Relations & Ethnicity*   One course from approved list.
    B. *Non-European Cultures* One course from the list of approved courses
                          (may overlap with one distributive course.)

College Distribution Requirements (All 7 categories must be completed.)

    1. *Foreign Language: Two courses in the same foreign language at the appropriate level, as determined by the offering department.*
    2. *Mathematical Sciences:* One mathematics course numbered 17 or higher, or statistics 51 or higher or computer science 11 or above or Philosophy 13.
    3. *Fine Arts*: One course in art history, dance, film and television studies, studio art, music, or theater (except speech).
    4. *Literature*: One course from the list of approved courses.
    5. *Humanities*: Two courses from the list of approved courses.
    6. *Social Sciences*: Two courses from the list of approved courses.
    7. *Natural Sciences*: Two courses, one of which must include a laboratory experience, from the list of approved courses.

Minor Subject Requirements
Candidates must declare and complete a minor subject as described in the catalogue under Arts and Sciences. Note that mathematics majors may minor in statistics. (See information on pages 53 and 54.) A second major is also an option.

Total Hours
A total of 120 hours, see the catalogue for the details of where these 120 hours may be taken.

MATHEMATICS HONORS THESIS PROGRAM

If you would enjoy the freedom to explore a particular topic in depth, and if you would appreciate the challenge, satisfaction and recognition that come from working closely with a faculty member to produce a mathematical exposition which is uniquely your own, then you should consider writing a Senior Honors Thesis. Students with a GPA of 3.0 or higher in all courses for their sophomore and junior work are welcome; those with a GPA of 3.2 or higher in the mathematics major are especially encouraged to participate. This program leads to College Honors for majors in the College of Engineering and Mathematical Sciences and to Departmental Honors for majors in the College of Arts and Sciences, and provides excellent preparation for research-oriented careers and for graduate study in mathematics.

Preparation for the thesis begins during the junior year, when you must identify a willing advisor and either a topic of study or a project to carry out. A written non-technical proposal must be submitted and approved in time to file an Honors Application Form. Detailed information on this procedure is available from faculty, your advisor, or the Department Office.

In the fall of your senior year, you should enroll in Math 293 for 1-3 credits. Then in the spring, you will enroll in Math 294 for 1-2 credits and Math 283 for 1 credit. Math 283 is the junior- senior seminar in which each participant gives one fifty-minute presentation. Your presentation will be a report on your thesis topic.

Your chosen thesis advisor can help you with the selection of a thesis topic or project, if you like, and will act as a resource person throughout the year. Different faculty members have different styles and areas of expertise, so you will want to choose carefully and clarify expectations at the outset. See the faculty profiles in the appendix to this handbook for some guidance, and discuss your options with your academic advisor and other professors.

The thesis should represent substantial investigation of a mathematical topic or project which goes beyond course work, and a clear and original exposition of that topic or project. Originality of results is not required.

After making a presentation in Math 283 and earning a grade of B- or better on your thesis, you will be awarded honors and recognized on Honors Day. The title of your thesis will be listed in the program at Commencement, and the designation ``Honors Thesis'' will appear on your transcript. In the case of a grade below B-, your transcript will list the independent study project as Math 295 (Special Topics), rather than Math 294 (Senior Honors Thesis).

THE STATISTICS HONORS THESIS PROGRAM

All statistics majors receive research and analysis experience through Statistics Practicum (Stat 281), which is normally taken in the senior year for three credits. However, if you want to try something special, and are interested in getting more

deeply involved in a particular research project, consider doing an Honors Thesis. Typically, you would register for Stat 293 in the Fall of your senior year (3 credits) and Stat 294 in the Spring of your senior year (3 credits), but the credits can be split other ways at your convenience to total 6 credits. Also you may begin your research in the summer preceding your senior year. Satisfactory completion of 293 would fulfill your practicum requirement of the major.

Potential topics are numerous, and are not just restricted to "pure" statistical research. Some past theses have been done in collaboration with professors in other departments (e.g. business and clinical medicine). If you think you may be interested, please contact the Director of the Statistics Program. You must choose a statistics advisor for your thesis. Your thesis committee will contain at least two statisticians, but can contain other faculty of the university as well.

The best time to consider the thesis is at pre-registration time in the spring semester of your junior year. You prepare a proposal for approval during the first few weeks of your senior year. To be eligible for the thesis program, the College of Engineering and Mathematical Sciences requires that you have at least a 3.0 cumulative GPA for your sophomore and junior years, while the College of Arts and Sciences requires a 3.2 cumulative GPA and at least three semesters on the Dean's list. Your thesis, upon completion, will be presented orally to the thesis committee and other interested students or faculty. At graduation, your transcript and the graduation program will list your thesis title and the honors designation. See the description of this program in the Division of CEMS part of the catalogue. Go for it!

MINOR IN MATHEMATICS

The Department of Mathematics Statistics offers a minor in mathematics which is available to students in all UVM undergraduate major programs. Please contact the Chair of the Department at James.Burgmeier@uvm.edu or 656-2940 as soon as you think you may be interested in pursuing the mathematics minor.

Requirements: Math 21, 22 or 19, 23; Math 52 or 121, and nine additional credits in mathematics courses numbered 100 or above. If both Math 52 and 121 are taken, Math 121 counts as one of the three 100- or 200-level courses needed. The course plan for a mathematics minor must be approved by a mathematics faculty advisor.

MINOR IN STATISTICS

The Statistics Program offers a minor in statistics which is available to students in any UVM undergraduate major program. Please contact the Director of the Statistics Program at 656-2940 as soon as you think you may be interested in pursuing the statistics minor, so that any questions you have can be answered.

Admissions: You will be asked to complete a background form and will be assigned a Minor Advisor, who will ultimately approve your program completion. You are also invited to take part in the social and professional activities of the Statistics Student Association.

Requirements:

1) Each student will have a minor advisor from the Statistics Program, appointed by the Program Director, in consultation with the student and faculty.

2) One course in Calculus (3-4 credits). This could include Math 19, 20, 21, or 22 for example, or one year of calculus at the high school level.

3) Fifteen (15) credits of statistics courses selected in consultation with their advisor in order to represent a cohesive package related to their educational and career goals and to their mathematical background

   a) Three (3) credits of introductory methods are required. Stat 141: Basic Statistical Methods or Stat 211: Statistical Methods I is recommended. No more than 6 credits of Stat 11/111/141/211 may be counted towards the minor

   b) Three (3) credits of probability are recommended. Stat 51: Discrete Probability Models; Stat 151: Applied Probability; or Stat 251: Probability Theory is recommended.

   c) Experience in computing through relevant course work is required. Stat 201: Statistical Analysis via Computers is recommended, but students could meet this requirement by taking an appropriate CS or Math course. (CS 16 or above, Math 52)

   d) For students who have taken Stat 151 or 251, a semester course in statistical inference is recommended (i.e., Stat 241: Statistical Inference or Stat 261: Statistical Theory I).

   e) The elective credits may include independent project or practicum work, such as Stat 191: Special Projects or Stat 281: Statistics Practicum, or even Stat 293-294: Undergraduate Honors Thesis.

   f) Elective methods courses would include:
      Stat 200: Medical Biostatistics
      Stat 221: Statistical Methods II
      Stat 223: Applied Multivariate Analysis
      Stat 224: Statistics for Quality and Productivity
      Stat 225: Applied Regression Analysis
      Stat 227: Statistical Methods for the Behavioral Sciences
      Stat 229: Reliability and Survival Analysis
      Stat 231: Experimental Design
      Stat 233: Design of Sample Surveys
      Stat 237: Nonparametric Statistical Methods
      Stat 253: Applied Time Series and Forecasting
      Stat 295: Special Topics in Statistics

Note for Mathematics Majors in the College of Arts and Sciences:

It is possible for you to major in mathematics and minor in statistics; however you can only double count one 3 credit course in your major and minor (CAS rule). Thus you must earn 12 credits in statistics beyond any statistics courses counted in your major courses.

Note for Mathematics Majors in the College of Engineering and Mathematical Sciences:

There is currently no provision for double counting of courses in major and minor programs. Thus you would need to earn 15 credits in statistics beyond any statistics courses counted in meeting your major requirements.

IV. ADVISING

There is no substitute for careful planning, and in that regard your advisor is an indispensable resource. Rapport between you and your advisor adds an experienced and knowledgeable dimension to your long-range academic planning. Career options, course selection for the upcoming semester, and other educational or personal decisions are matters you can discuss with your advisor. Frequently, a relationship that began as student/advisor blossoms into a friendship that lasts beyond college graduation. Be sure to find an advisor with whom you are compatible, and cultivate that relationship. In what follows we list some of the technical aspects and details of the advising process.

HOW TO GET AN ADVISOR

You are assigned an advisor when you enter UVM. However, in some cases (e.g., if you enter with major "undeclared") the faculty member assigned to you may not be in a discipline of interest to you. Students considering a major in mathematics or statistics should have an advisor who is a faculty member of the Department of Mathematics & Statistics. To obtain an advisor in the department or to find out who your advisor is, stop by the department office and ask.

CHANGING YOUR ADVISOR

It is easy to change your advisor. If you decide to change and want a specific faculty member as your advisor, you must discuss this with the faculty member involved. If you do not have a specific advisor in mind, but desire to have an advisor from Mathematics and Statistics, come to the department office and make your wishes known to the department's administrative assistant, the department Chair, or other faculty member. By the way, it is not your job to make sure that your records are transferred to your new advisor; however, it is a good idea to check before the next advising period to make sure that your new advisor has your records.

If you are changing advisors at the same time you change majors, the two processes

can be combined. When you inform the Dean's Office that you are changing your major, that office will inform the Department of Mathematics & Statistics. At that time you will be assigned a new advisor. If you have a specific choice of advisor, be sure to make your preference known at this time. If you are not changing majors but still wish to change advisors, the department office will handle this for you.

MEETING WITH YOUR ADVISOR

Your advisor can be an invaluable source of information. Your experience at UVM can only be enhanced by getting to know your advisor, and other faculty. The best way to meet with your advisor is to see him/her during office hours or call for an appointment. The Department Office has a list of office hours, email addresses and telephone numbers. If your advisor's office hours conflict with your schedule, you will need to make an appointment. Make appointments directly with your advisor. If you cannot reach your advisor for an appointment, leave a message requesting a return call.

DECIDING IF GRADUATION REQUIREMENTS ARE MET

In the College of Arts and Sciences, the Dean's Office determines if you have met the requirements for graduation. They will send you a letter before your fourth year listing which requirements still need to be met. It is extremely important that you review this letter carefully. If you have any questions about it, you should consult your advisor and/or the Dean's Office.

In the College of Engineering and Mathematical Sciences, it is the advisor who decides if you have met the requirements for graduation. You need to work carefully with your advisor to be sure that you are meeting all of the necessary requirements.

It is ultimately your responsibility to make sure that all requirements are met. You need to read and follow the catalogue carefully so that there are no problems. However, if you encounter any difficulties, be sure to ask for help.

Ordinarily, you will follow the requirements listed in the catalogue for the year you first enrolled at UVM. However, if you leave and then return, you will be expected to fulfill the requirements in the catalogue for the year that you return. If this happens and your requirements change, you need to discuss this with your advisor.

You may discuss with your advisor alternative ways of fulfilling your requirements. If you both agree that your request makes sense, you may petition the appropriate college for the change. The request must be approved by your advisor, the Department Chair, and then the college.

TAKING A COURSE PASS/NO PASS

The rules for taking a course under the PASS/NO PASS option are as follows:

1. You must be a degree student.
2. You must be at least a sophomore.
3. You cannot be on academic trial.
4. You cannot take more than six courses using this option.
5. The course must be a free elective. This means that it is not being used to fulfill any requirement except attaining the necessary hours to graduate.
6. You are expected to complete all of the required course work.
7. Any grade of D- or higher will be recorded as a PASS. A grade of F will be recorded as NO PASS. Neither grade will affect your grade point average.
8. Physical education activity courses, even the required ones, may be taken on a PASS/NO PASS option. These do not count toward the six courses that you are allowed under this option.

If you decide to take a course under this option, you may obtain the necessary form from the Registrar's Office. You then need to consult your advisor for approval. Note that the deadline for choosing the PASS/NO PASS option is within two weeks of the beginning of the semester.

WHAT TO DO IF YOU STARTED WITH MATH 19 OR 20

You may have decided that you want to major in mathematics or statistics after completing Math 19 and/or Math 20. In this case, you must decide where to enter the Math 21, 22, 121 sequence; it is crucial to obtain expert advice from your advisor.

If you have completed Math 19 and wish to change to the 21, 22, 121 sequence, there are two options. You can take Math 21 next or you can take Math 23. If you choose to take Math 21 you would follow that with Math 22 and Math 121. In this case you will receive credit toward graduation for both Math 19 and Math 21 upon completion of Math 22. If you do well in Math 19, then the second option is to take Math 23. This is a transition course designed to fill in the gaps between Math 19 and Math 21 as well as cover all the material in Math 22. Following your successful completion of Math 23 you would enter Math 121. Only in unusual cases should you consider going from Math 19 directly to Math 22.

If you have completed Math 19 and 20, and then decide to major in mathematics or statistics, you should enter the Math 21, 22, 121 sequence with Math 22. If you decide to enter the sequence with Math 21, you will receive credit toward graduation for only Math 19, 21 and 22. That is, if you take all four of Math 19, 20, 21 and 22, then 11 of these 14 hours will count toward graduation.

Even though the requirements for either a major or minor in mathematics or statistics explicitly state that you must take Math 21, you should not take Math 21 after Math 22.

TRANSFER CREDIT FOR COURSES TAKEN AT ANOTHER INSTITUTION

The Office of Transfer Affairs (367 Waterman, Ext. 60867) coordinates transfer activities, but, ultimately, each department determines if a transfer course is equivalent to one in its department.

If you transfer to UVM from another school, the Office of Transfer Affairs will coordinate which courses transfer. If you have questions about their decisions, discuss them with your advisor. It is sometimes possible to get changes made if you provide additional information.

If you plan to take courses at another institution after you have entered UVM (e.g., summer courses), get approval for these courses before you take them. The Dean's Office has a form which, upon completion, guarantees transfer credit if you finish the course satisfactorily. Getting prior approval will eliminate many problems which might occur about the transfer of credit. If you take a course without prior authorization, saving the course syllabus, notes and exams will be helpful in gaining transfer approval.

REPEATING A COURSE

You may repeat a course at any time for any reason. The most common reasons for repeating a course are to improve your grade in the course or to improve your understanding of the material in the course. If you repeat a course, it will appear on your transcript both times and both grades will count toward your cumulative grade point average. However, the course will not count twice toward credits needed for graduation. If you do repeat a course, you need to be careful not to count the course twice when you figure your total credits.

THE MOST IMPORTANT THING TO REMEMBER!

Your advisor is a great resource in all aspects of planning your schedule of courses, and ensuring that your course selections meet graduation requirements. However, you are ultimately responsible for deciding which courses to take and whether they meet the degree requirements. Read the requirements carefully!

V. SUPPORT AND EMPLOYMENT

The guiding philosophy of building a strong relationship with your advisor applies as well to instructors in your courses. An integral part of the educational experience, especially in demanding technical courses such as those in mathematics or statistics, is a one-on-one or small group interaction during your instructor's office hours. Make sure that you take advantage of these opportunities for personalized learning outside the classroom. As we said earlier, both your instructor and your advisor want you to succeed, and they are an invaluable source of information. Getting to know them, and other faculty as well, will enhance your experience at UVM.

Here are some study strategies that foster positive learning experiences. Keep up with your mathematics and statistics courses, including homework assignments, on a daily basis. It is difficult, sometimes impossible, to "cram" for exams in subjects as demanding as mathematics. When you have questions, get them answered as soon as possible, either by the instructor, by knowledgeable classmates, or by other Department faculty. Mathematical learning is often sequential, and unfilled gaps in one's knowledge can hurt later on. The importance of group learning should also be emphasized. Mathematical learning is not a competitive event, but a shared activity, and you should feel free to organize study sessions with your classmates. Some additional sources of support, as well as employment opportunities, are indicated below. In seeking help, remember that your first approach should be via your instructor during his/her office hours, or by making an appointment.

WALK-IN TUTORING & HELP SESSIONS

Throughout the semester, the department runs help sessions Monday through Thursday in the early evening. These sessions offer walk-in help for anyone enrolled in a mathematics course from Math 1 through Math 22. No appointment is necessary; the sessions are staffed by graduate students. For more information on these sessions and their meeting times please contact the department at 802-656-2940 or the Department of Mathematics & Statistics homepage on the web by clicking on "Classes" and then "Help Sessions".

EMPLOYMENT AS A GRADER

You may fill out an application in the Department Office to be a student grader. A student grader has the responsibility of grading quizzes and homework, under the direction of the course instructor.

WORK-STUDY

Besides the grading job, there is an additional opportunity open to you if you have work-study hours. You can work as a student assistant (answering phones, delivering mail, etc.) in the Mathematics & Statistics Department office. In general, work-study students develop close personal relationships with faculty and staff that last long after graduation. Call 656-2940 for details. In addition, there are ongoing campus research projects that could use you as a research assistant, particularly if you have programming, computing and statistical skills. See the Statistics Program Director if you are interested in being a statistical research assistant.

For more information about undergraduate research, visit http://www.uvm.edu/ugresearch and http://www.uvm.edu/~honcoll/?Page=research.html&SM=felmenu.html

DEPARTMENTAL TUTORING

The Department maintains a list of students who are willing to do private tutoring in mathematics and statistics. If you would like to receive private tutoring, contact the department office or check the website by clicking on "Classes" then "Find a Tutor".

LEARNING COOPERATIVE

The Learning Cooperative is located in 244 Commons Living/Learning. All tutoring and special sessions are run by peers. A study skills session is available which offers advice about test- taking, taking notes, and attending lectures. The session is free for all students. There is also a writing center for reviewing papers.

If you are interested in becoming a tutor, you should fill out an application with the Learning Cooperative and obtain a recommendation from a professor in the subject in which you want to tutor.

VI. CAREERS, SUMMER PROGRAMS, & STUDY ABROAD

Mathematical sciences majors possess quantitative skills, strong problem-solving talent, and analytical and organizational abilities. Employers are strongly interested in these broad and transportable skills, and will hire mathematics and statistics majors for positions requiring analytical and logical capabilities. Familiar careers are teacher, actuary, and statistician; but there are many more which are not so well known, including: systems engineer, programmer, analyst, cartographer, associate engineer, research assistant, bank officer, and financial consultant. If you wish to see a list of the types of jobs held by UVM mathematics and statistics alumni, ask your academic advisor.

CAREER SERVICES

Career Services provides a number of career related services and resources to undergraduates, including career counseling and advising, job search workshops, a career information library, and job postings. Also, Career Services offers mock interviews to help you prepare for employment or graduate school interviews. A complete listing and detailed description of all the Career Services functions can be found in the University of Vermont Placement Manual which can be obtained at their office at the Living/Learning Center.

ON-CAMPUS INTERVIEWS

Numerous representatives visit the University during the fall and spring semesters to interview graduating students for full-time employment or for postgraduate study. Interviewers may come from private business and industry, from state and federal government, or from national graduate school programs. Information on preparing for these interviews (including mock interviews) can be found at the Career Services website under "Job Search Tool Kit". Also, interviewers frequently conduct employer information sessions on the evening before they conduct interviews. These sessions are open to anyone and can be a good way to learn about various companies and the types of positions they offer. Interview and information session schedules are posted in the Career Services lobby at the Living/Learning Center.

COOPERATIVE EDUCATION PROGRAM (CO-OP)

A cooperative education (CO-OP) program is offered to students with cumulative grade-point averages placing them in the upper half of their class. Before acceptance, each candidate must be interviewed and approved by the program coordinator and the prospective employer. The program lets students apply their learning to a full-time, paid position in a business, industrial, or government setting.

INTERNSHIPS

These are similar to co-op work experiences, but with fewer requirements and less structure. The work schedules are more flexible and the student may participate at any time. The CEMS Co-op Coordinator can provide more information on this type of student employment.

SUMMER RESEARCH

About 20 colleges and universities throughout the nation including several in neighboring states, conduct summer research programs for undergraduates in the mathematical sciences. These programs provide students an opportunity to explore particular areas of mathematics in depth and to become involved in research methodology. For more information consult the department office or your advisor.

STUDY ABROAD

Studying abroad for a semester or a full year can provide you with a unique experience during your UVM career. There are many programs available. Consult your advisor to decide which courses to take to ensure fulfillment of graduation requirements. The Office of International Educational Services provides all study abroad information (see http://www.uvm.edu/~oies/).

Of particular interest to mathematics students is the "Budapest Semesters in Mathematics" in Budapest, Hungary. Sponsored by St. Olaf's College, this program offers courses (taught in English) for students from the United States and Canada. World-renowned professors and enthusiastic participants have made this one of the most successful of all programs for young mathematicians.

CAREERS FOR STATISTICS MAJORS

Broadly speaking, statisticians make decisions in the face of uncertainty. Over the past century, the increase in human understanding of the natural world has accelerated tremendously due to the invaluable contributions made by empirical statistical methods. Florence Nightingale, a charter member of the American Statistical Association (ASA), described statistics as: "the most important science in the whole world: for upon it depends the practical application of every other science and of every art: the one science essential to all political and social administration, all education, all organization based on experience, for it only gives results of our experience." While some statisticians devote their professional lives to advancing theory in probability or mathematical statistics, most, whether theoretical or applied, collaborate with other professionals from a variety of disciplines in designing experiments, gathering information, interpreting data, and making inferences.

In particular, statisticians provide significant contributions in the following settings: quality control and reliability within business and industry; sample survey work and market research with organizations such as Gallup and Nielsen or similar organizations in Burlington; federal government agencies including The Food and Drug Administration, The Census Bureau, The Center for Disease Control, The Environmental Protection Agency, The Bureau of Labor Statistics, The National Institute for Standards and Technology: fisheries, and agricultural biology;

geological sciences (estimating risk of earthquakes and locating oil reserves); social, psychological, and educational research; biomedical investigations dealing with such diverse problems as cancer, cardiovascular disease, sudden infant death syndrome, and AIDS; epistemologies studies; evaluation of new compounds within the biopharmaceutical industry; health care review and quality improvement; insurance; telecommunications; meteorological modeling and hurricane prediction.

According to the Bureau of Labor Statistics, the demand for statisticians is currently strong and is expected to increase through the end of the decade. Statisticians become involved with a diverse group of professionals and problems, and typically report high levels of satisfaction with their work. Salaries and advancement opportunities continue to be excellent.

The ASA is one of the oldest professional organizations in the United States and is the chief assembly for statisticians in this country. Students may affiliate with the ASA at reduced rates. Benefits of membership include subscriptions to Amstat News and STATS: the magazine for Students of Statistics, plus the membership directory. Both publications feature a monthly section on career opportunities for statisticians, and in November of each year, issues a comprehensive list U.S. and Canadian schools that offer degrees in statistics. A major event every August is the annual meeting of the ASA where thousands of statisticians gather to discuss their work and explore new career opportunities.

VII. EXTRACURRICULAR ACTIVITIES

The Mathematics and Statistics Department invites students to join together for social, educational, and athletic activities which promote a sense of community and fun. Listen for announcements in your mathematics and statistics classes, watch the notices posted in the department office, the department website or simply call 656-2940 and ask to be referred to the appropriate contact person.

STATISTICS STUDENT ASSOCIATION

The Statistics Student Association (SSA) was started in the fall of 1991. It was organized to bring together graduate and undergraduate statistics majors (as well as others with an interest in statistics). The group meets several times during the semester, both formally and informally. Social gatherings in the past include: student and faculty dinners, Bove's dinners and pizza lunches, bowling and ski trips. The SSA also schedules guest speakers throughout the year. These talks are at the request of the members of the group. The topics range from career talks, to advising, to theoretical and applied statistics topics. Meetings are held in the basement of Mansfield House or in the departmental conference room. Anyone interested in mathematics and/or statistics is welcome to participate.

Note that we have a chapter of Mu Sigma Rho, the National Statistics Honorary

Society, here at UVM. The qualifications for election to membership are given in Appendix 1. Mathematics or statistics majors are eligible for consideration.

DEPARTMENT EVENTS

Fall Picnic. Each year, the entire department gathers with friends and family members for a potluck picnic to welcome everyone back from summer activities and kick off the new academic year. On a weekend close to Labor Day, we spend an afternoon in the park picnicking, playing volleyball, and socializing.

Fall Hike. On a weekend in September or October students, faculty, family and friends hit the trails for a local day hike.

Recreational Sports Teams. Mathematics and statistics undergraduates, graduate students and faculty members often join together to form volleyball, basketball, and softball teams. Table tennis is a popular activity in the basement of the Henry Marcus Lord House at 16 Colchester Avenue. Drop by and challenge your professors or fellow students to a game, or even organize a tournament if you like.

Holiday Potluck. At the end of the Fall Semester, usually on a reading day during the exam period, the entire department gathers to share favorite dishes and to celebrate the holiday season, occasionally with a good-natured participatory parlor game.

Spring Softball Challenges. Undergraduates and graduate students traditionally challenge faculty to a spring softball game. Enthusiasm as a player or spectator is the only criterion for participation.

Putnam Mathematics Competition. This annual event involves more than three thousand undergraduates throughout the United States and Canada, giving them a chance to represent their colleges and universities, to enjoy a challenge, and perhaps earn some recognition and even prize money. UVM invites all who are interested to join our team, come to practice sessions in the Fall, and take the Examination on the morning and afternoon of the first Saturday in December. Participants are treated to lunch at a local restaurant on that day.

Mathematics Awareness Celebration. The nationally observed Mathematics Awareness Week occurs in the second half of the month of April, but the Mathematics Awareness Committee at UVM schedules related events throughout the Spring semester. Past activities have included a distinguished lecture series, a video film series, the design and sale of UVM mathematics and statistics T-shirts, a poster contest for elementary and middle schools, prizes for those listeners of the campus radio station who can answer questions related to mathematics, and a game night.

Mathematics and Statistics/Biostatistics Colloquia Series. Be sure to attend some of the special talks given by the UVM faculty/staff/students and by invited speakers from

outside UVM. Many talks are directed specifically at undergraduates. Information on these colloquia is distributed by email as well as listed on the department homepage.

VIII. ACCELERATED MASTER'S PROGRAMS

ACCELERATED MASTER'S DEGREE PROGRAMS IN MATHEMATICS

The Accelerated Master's Program (AMP) in mathematics is designed so that students with strong ability and motivation can complete a bachelor's degree in mathematics, science or engineering, as well as a master's degree in mathematics within five years. The first four years of this AMP consist of an undergraduate program that includes the core requirements for a minor in mathematics together with other courses that lay a solid mathematical foundation; this portion culminates in a bachelor's degree. During the fifth year, students take courses that complete the requirements for the master's degree in mathematics. The Accelerated Masters Program is specially designed to integrate the undergraduate and graduate portions so that students in it receive both the breadth and depth they would achieve had they completed the two degrees separately. Moreover, they experience a profound appreciation for the depth, beauty, and applicability of mathematics, which comes from being steeped in the rich course of study this program entails.

Requirements for Admission

The Accelerated Master's Program in mathematics is designed for students who are mathematics majors, or who are majors in science or engineering with a minor in mathematics. A student must declare his/her wish to enter the Accelerated Masters Program in mathematics in writing to the Department Chair before the end of the sophomore year, and before taking Math 241.

Students will take the sequence Math 241, 242 after they have completed this notification and met with the Director. They normally complete this sequence during their junior year, but may complete it earlier provided the notification described above has been followed. (The notification is to ensure that AMP students are subjected to the same standards and workload as the graduate students in Math 241 and 242.) Math 241 and 242 will count concurrently for both the undergraduate and graduate degrees; these are the only courses that may be used for concurrent credit.)

Formal application for the Accelerated Master's Program in mathematics is made during the spring semester pre-registration period of a student's junior year. The student carries out the usual procedure for admission to the M.S. Program in mathematics, including letters of recommendation (application forms are available online or from the Graduate College office, and must be returned there). The

student's admissions essay must specifically address why the student wishes to enter the Accelerated Master's Program. GRE's need not be completed until the fall semester of the applicant's senior year.

In addition to the above, applicants must achieve the following by the end of their junior year:

1. Completion of the mathematics core (Math 21, 22, 52, 121, 124, and either 241 or 251) and an overall GPA of 3.0 or higher,

2. Completion of Math 241 and Math 242 with grades of B+ or better in each, and

3. Completion of a least two additional 200-level mathematics or statistics courses with grades of B+ or better in each.

Requirements for Advancement to Candidacy

Students who have been admitted to the Accelerated Master's Program in mathematics normally advance to candidacy at the end of their senior year. The criteria for advancement to candidacy are:

1. Completion of a bachelor's program in mathematics at UVM, or completion of a bachelor's program in science or engineering at UVM with a minor in mathematics;

2. Satisfactory performance on the general and subject portions of the GRE exams (to be taken by the fall semester of the applicant's senior year);

3. Completion of at least two additional mathematics or statistics courses at the 200-level with a grades of B or better in each (these are in addition to Math 241, 242 and the two 200-level courses required for admission to the program); and

4. Completion of Math 333 with a grade of B or better. (This course may not be counted towards the student's undergraduate degree, and so must be taken as an overload).

5. Completion of Math 251 with a grade of B or better. (The students must take this course after they have identified themselves as an AMP student so that they are subjected to the same standards and workload as other graduate students; this course will, however, count toward their undergraduate degree.)

Students who have been admitted to the AMP on the completion of their junior year but who fail to meet the requirements for advancement to candidacy for the M.S. degree will only be permitted to continue towards their M.S. degree after review by the Graduate Program Committee and with the written approval of the Director of the Graduate Program in mathematics. ["Regular" M.S.

Program students advance to candidacy upon successful completion of Math 241 and 242.] See the graduate mathematics major handbook for more details.

Requirements for Completion of the Master's Degree Portion of the Program

As noted above, before advancing to candidacy the students must complete: (i) their bachelor's program, normally by the end of their fourth year, (ii) Math 241 and 242, both of which may be counted for credit towards the M.S., and (iii) Math 333, which contributes four credits towards the M.S. Thus a total of 20 credit hours remain to be completed, normally within two semesters.

Students must now complete the additional course/thesis requirements of the M.S. program as paraphrased from the (revised) graduate catalogue:

Students must already have or must acquire the knowledge of the following courses: Math 251 and 331, as well as one of 252, 273 or 330. Students must satisfactorily complete at least three 300-level mathematics courses, including the seminar 382. By approval of the student's advisor, up to six hours from an area of minor concentration may be used to fulfill the degree requirements. With the approval of the Director of the Mathematics Graduate Program, students may elect the thesis option, which requires six semester hours of thesis research in place of six hours of course work.

Students who take any of Math 251, 252 or 273 as part of their undergraduate degrees (in which case these will not count toward the 20 remaining graduate credit hours) must acquire any additional knowledge for which graduate students in these courses are responsible, for example special topics that are not included in the standard syllabi for these courses. Students are encouraged to consult professors who have taught these courses in recent semesters. These courses may not be retaken for graduate credit.

ACCELERATED MASTER'S DEGREE PROGRAMS IN STATISTICS AND BIOSTATISTICS

A Master's degree in statistics or in biostatistics can be earned in a shortened time by careful planning during your junior and senior years at UVM. Please discuss this possibility with the Statistics Program Director as soon as you think you may be interested in this program. For example, the M.S. could be earned in just one additional year, because 6 credits of your undergraduate courses can also be counted concurrently towards the M.S. degree requirements.

You need to apply to the Graduate College for admission to the AMP while still an undergraduate, just prior to taking the first statistics course that you wish to count both towards your Bachelor's and Master's degrees. For the statistics M.S. you can select from Stat 221, 224 or 251, while for the biostatistics M.S. you would

select from Stat 200, 221 or 241. You must also acquire sufficient breadth in statistics before graduation by taking Stat 201 and one or two other 200 level elective statistics courses (e.g. Stat 225, 229, 233, 237, 252a, 252b, 253, 281, 295). The number of selected breadth courses (1 or 2) matches the number of concurrent credit courses you want to include (1 or 2). After graduation with your B.A. or B.S. degree you would become a candidate for the M.S. degree.

APPENDIX 1: AWARDS

Each year, the Department of Mathematics & Statistics presents a number of awards at the Honors Day celebrations in both the College of Engineering and Mathematical Sciences and the College of Arts and Sciences. Thanks to a generous gift from the late Sang Kil Nam, an internationally prominent businessman and philanthropist, each year two students, typically one majoring in mathematics and one in statistics, receive a Sang Kil Nam Scholarship to further their educations. These awards may go to either an undergraduate or graduate student. The outstanding major in the B.A. degree program also receives an award at the College of Arts and Sciences Honors Day ceremony; and the outstanding sophomore, junior, and senior majors in the B.S. degree program receive an award and recognition from the College of Engineering and Mathematical Sciences at the Commencement ceremonies in May. An undergraduate Achievement Award in statistics is also given annually. In each case the recipient receives a monetary gift as part of the award.

In addition to the above Department awards, students majoring in mathematics and statistics are eligible for college or university-wide awards. In recent years, for example, students majoring in mathematics have received the Maria Franca Morselli leadership award, the Dean's Award for outstanding service to the College of Engineering and Mathematical Sciences, and the Senior Leadership Award given by the Office of Student Affairs.

Regardless of your major, you may be eligible for election to Mu Sigma Rho, the National Statistics Honorary Society. You need to have taken at least 5 credits of statistics courses at the 200 level, with at least a 3.25 GPA in all statistics courses. You also need to be in the upper third of your class in all course work. Election to Mu Sigma Rho takes place annually in the spring semester, and normally would occur in your senior year.

APPENDIX 2: FACULTY AND INTERESTS

Name	Year @ UVM	Area of Expertise	Email
Aguiar, Neil, M.S. Lecturer	1996	Statistics Education	Neil.Aguiar@uvm.edu
Aleong, John, Ph.D. Professor	1976	Experimental Design, Reliability Control, and Statistical Methods	John.Aleong@uvm.edu
Archdeacon, Dan S, Ph.D Professor	1982	Graph Theory, Combinatorics	Dan.Archdeacon@uvm.edu
Ashikaga, Taka, Ph.D. Professor	1973	Discriminant Analysis, Pattern Recognition, Program Evaluation	Takamaru.Ashikaga@uvm.edu
Badger, Gary, M.S. Lecturer	1981	Biostatistical, Statistical Computing	Gary.Badger@uvm.edu
Bagrow, James, Ph.D. Assistant Professor	2013	Complex Systems and Mathematical Modeling	James.Bagrow@uvm.edu
Bentil, Daniel, Ph.D. Associate Professor.	1995	Biomathematics	Daniel.Bentil@uvm.edu
Benway, Karen, M.S. Lecturer	2012	Statistics	Karen.Benway@uvm.edu
Bunn, Janice, Reseach Associate Professor	2000	Medical Biostatistics	Janice.Bunn@uvm.edu
Burgmeier, James, Ph.D Dept Chairman, Professor	1969	Numerical Analysis, Modeling, Software, Computer-Assisted Education	Jim.Burgmeier@uvm.edu
Buzas, Jeffrey, Ph.D. Director Stat Program, Professor	1993	Measurement Error Modules, Statistical Computing	Jeff.Buzas@uvm.edu
Callas, Peter, Ph.D. Research Associate Professor	1994	Epidemiology and Medical Biostatistics	Peter.Callas@uvm.edu
Cole, Bernard ("Chip") Ph.D. Proefessor	2007	Biostatistics, Community and Family Medicine	Bernard.Cole@uvm.edu
Cooke, Roger, Ph.D. Professor Emeritus	1968		Roger.Cooke@uvm.edu
Crocker, Abigail, M.S. Lecturer	2011	Statistics	Abigail.Crocker@uvm.edu
Danforth, Christopher,Ph.D. Associate Professor	2006	Chaos, Mathematical Modeling, Computational Methods	Chris.Danforth@uvm.edu

Dickey, Douglas, M.Ed. Lecturer	1991	Mathematics Education, Statistics	Douglas.Dickey@uvm.edu
Dinitz, Jeffrey H, Ph.D. Professor	1980	Combinatorics	Jeff.Dinitz@uvm.edu
Dodds, Peter, Ph.D Professor	2006	Applied Mathematics, Complex Systems and Networks, Contagion, Modeling	Peter.Dodds@uvm.edu
Dummit, David, Ph.D. Professor	1984	Algebraic Number Theory	David.Dummit@uvm.edu
Edwards, Erika, Ph.D. Research Assistant Professor	2012	Epidemiology; Applied biostatistics	Erika.Edwards@uvm.edu
Foote, Richard M, Ph.D. Professor	1981	Group Theory, Algebraic Number Theory	Richard.Foote@uvm.edu
Golden, Kenneth I, Ph.D. Professor	1984	Applied Mathematics	Kenneth.Golden@uvm.edu
Gross, Kenneth I, Ph.D. Professor	1987	Harmonic Analysis, Group Representations	Kenneth.Gross@uvm.edu
Jefferys, William, Ph.D. Adjunct Professor	2006	Bayesian Statistics and Decision Theory	William.Jefferys@uvm.edu
Julianelle, Anthony, Ph.D. Senior Lecturer	1995	Mathematics Education, Geometry	Anthony.Julianelle@uvm.edu
Karstens, Karla, M.S. Senior Lecturer	1987	Mathematics Education	Karla.Karstens@uvm.edu
Koehler, Vincent. M.S. Senior Lecturer		Mathematics Education	Vincent.Koehler@uvm.edu
Kost, Larry L, M.S. Senior Lecturer	1973	Numerical Methods, Computer Assisted Education	Larry.Kost@uvm.edu
Kudrle, Joseph, M.S. Senior Lecturer	2003	Mathematics Education	Joseph.Kudrle@uvm.edu
Laird, Judi, M.S. Research Assistant Professor		Mathematics Education	Judi.Laird@uvm.edu
Laird, Robert, M.S. Research Assistant Professor		Mathematics Education	Robert.Laird@uvm.edu
Lakin, William D, Ph.D. Professor Emeritus	1989	Fluid Dynamics, Biomedical Mathematics, Applied and Computational Mathematics	Bill.Lakin@uvm.edu
Lakoba, Taras, Ph.D. Associate Professor	2003	Perturbation Theory, Fiber Optics, and Nonlinear Waves	Taras.Lakoba@uvm.edu
Lawlor, John C, M.S. Senior Lecturer.	1974	Combinatorial Problem Solving, Geometry	John.Lawlor@uvm.edu

Merrill, Katherine, M.S. Lecturer	2009	Statistics Education	Katherine.Merrill@uvm.edu
Mickey, Ruth, Ph.D. Professor	1985	Categorical Data, Epidemiology, Biostatistics	Ruth.Mickey@uvm.edu
Ojala, Susan, M.Ed Research Associate Professor	2007	Mathematics Education	Susan.Ojala@uvm.edu
Read, Helen, M.S. Senior Lecturer	1988	Utilizing Computers and Calculators in Mathematics Instruction	Helen.Read@uvm.edu
Rogers, Thomas, M.S. Senior Lecturer	2002	Mathematics Education	Thomas.E.Rogers@uvm.edu
Rosebush, Joan, M.Ed. Senior Lecturer	1997	Prevention of Mathematics anxiety	Joan.Rosebush@uvm.edu
Sands, Jonathan, Ph.D. Professor	1986	Algebraic Number Theory, Computational Number Theory	Jonathan.Sands@uvm.edu
Single, Richard, Ph.D. Associate Professor	2001	Statistical Genetics/Genomics and Biostatistics	Richard.Single@uvm.edu
Son, Mun, Ph.D. Professor	1985	Time Series, Regression Analysis, Bootstrapping, and Sequential Analysis	Mun.Son@uvm.edu
Warrington, Gregory, Ph.D. Assistant Professor	2009	Algebraic combinatorics	Gregory.Warrington@uvm.edu
Weaver, Sheila, M.S. Senior Lecturer	1985	Biostatistics, Statistics Education	Sheila.Weaver@uvm.edu
Wilson, Michael, Ph.D. Professor	1986	Fourier Analysis	Mike.Wilson@uvm.edu
Yang, Jianke, Ph.D. Professor	1994	Applied Mathematics	Jianke.Yang@uvm.edu
Yu, Jun, Ph.D. Professor	1990	Fluid Dynamics, Biomedical Mathematics, Applied and Computational Mathematics	Jun.Yu@uvm.edu

APPENDIX 3: COURSE DESCRIPTIONS

A. Description of Mathematics Elective Courses

The following are expanded course descriptions that instructors have provided. The official course descriptions can be found in UVM's online catalogue. Click "Courses," then "Browse Courses by Subject," then "Mathematics" or "Statistics".

Math 141 *Real Analysis in One Variable*. Math 141 may be viewed as an extension of the main ideas from calculus: limits, derivatives, integrals, and convergence of sequences and series. In this course, you study the basic properties of sets of real numbers and analyze the behavior of real-valued functions defined on subsets of the reals. This course focuses on learning techniques in developing rigorous proofs. The course proceeds at a pace that will allow students more time to develop facility with the precise logical reasoning that underlies analysis on the real line, and indeed, the structure of the real number field itself. As an additional learning aid, there will be an optional recitation/homework session each week.

Math 151 *Groups and Rings* What are you doing when you solve a linear equation? You are adding or multiplying both sides of the equation by the same amount. The reason this works is that arithmetic has nice properties: the operations are associative, there is a 0 that doesn't change a quantity under addition, etc. This course studies sets with operations that satisfy similar rules. If there is one operation, you have a group, if there are two you have a ring. This
generality allows the same techniques to apply in radically different settings. This course offers an introduction to the basic concepts of abstract algebra emphasizing examples, including modular arithmetic, symmetric groups, cyclic groups, and polynomial rings.

Math 161 *Development of Mathematics*. The historical development of mathematics in various civilizations, including Egypt, Mesopotamia, Greece, India, China, the Islamic world, and early modern Europe. Special attention is paid to issues such as the advantages and disadvantages of axiomatic developments, acceptable principles of definition and inference, and applications that different cultures have made.

Math 173 *Basic Combinatorial Theory*. This course deals with "enumeration theory" or how to count. This course primarily emphasizes problem solving and does not include many proofs. Through the extensive use of problem sets and class examples, the student learns how to count many different types of arrangements and to create problem solving techniques which are appropriate for a particular problem. Sample problems are: (1) How many different orders for 10 hot dogs are possible if there are four different varieties of hot dogs? (2) How many different ways are there to get a full house in a five card poker hand? (3) How many ways can you assign 20 people to 5 different rooms so that there is at least one person in each room? (4) How many different necklaces can be made with 4 red, 5 blue, and 6 green beads?

This course is invaluable for anyone interested in computer science, statistics, or the teaching of mathematics. Most students find this to be an enjoyable (and challenging) course. We have had many students return years after taking this course to tell us of its usefulness in their everyday work.

Math 230 *Ordinary Differential Equations.* This course develops elementary theory of differential equations with emphasis on methods of solution that are useful in a wide variety of applications. Many problems directly from engineering and science are studied. For example, if a mass is attached to a coiled spring, pulled down an additional 3 inches and released, what is the subsequent motion of the mass? If a colony of bacteria has population of 100 cells now, and 3 hours later there are 10,000, how many bacteria will the colony contain after 5 hours? A problem that involves estimating the time of the death of a murder victim is another interesting example. Topics include: solutions of linear equations; separable equations; applications of linear equations; Laplace transforms; series solutions of differential equations; nonlinear equations and the phase plane.

Math 235 *Mathematical Models and their Analysis.* This course considers several models of classical and modern science. Examples include: formation of rainbows, motion on a roller-coaster, input-output models in economics, Google's PageRank algorithm, nonlinear pendula (including an inverted pendulum), smoothing of noisy experimental data, and the black body radiation. The emphasis in describing each model is made on presenting mathematical techniques which are: (i) commonly used by applied mathematicians, physicists, and engineers, and (ii) are covered in the undergraduate courses on Calculus and Linear Algebra. Examples of such techniques are: linearization, Taylor series, and eigenvector expansions. Thus, one of the goals of this course is to show the students some real-world applications of these fundamental techniques. The other major goal is to coach students on giving presentations. To this end, the course includes, instead of exams, two projects: a midterm and a final. There, the students are to read a contemporary research paper (with some mathematical content) and give a presentation about it to the class. Before each presentation, every student is required to practice his/her talk in front of the instructor, and the instructor gives the feedback and advice on how to improve the talk. The feedback is also given after each presentation.

Math 237 *Introduction to Numerical Analysis.* This course develops methods for obtaining numerical solutions to problems too difficult to be solved "in closed form." In addition, the course explores the effect of fixed precision arithmetic when using a computer with these methods. Topics include: methods for solving $f(x) = 0$ and a discussion on efficiency of the computations; methods for solving systems of n equations with n unknowns, and the effect of having nearly duplicate information (ill-conditioned systems); the problem of generating a function or functions to describe a given set of data (interpolation, splines, least squares); and the estimation of definite integrals too difficult to anti-differentiate.

Math 238 *Applied Computational Methods.* This course focuses on numerical solutions to differential equations. Numerical methods are developed for solving

problems occurring in engineering and science, such as describing the motion of an oscillating pendulum and the flow of air over a thin airfoil. Computer algorithms which implement these methods are studied. Topics include: Runge-Kutta methods for initial-value problems; multistep methods; stability; stiff differential equations; the shooting method for boundary-value problems; finite difference and finite element methods.

Math 240 *Fourier Series and Integral Transforms.* The purpose of the course is to study integral operators and related Fourier series expansions which are essential in solving initial and boundary value problems for differential equations. Topics covered include Green's functions for initial and boundary value problems, Laplace transforms, classical and more general Fourier expansions, eigenvalue methods for boundary value problems. Applications may include mathematical modelling of heat flow and wave propagation, which historically led to the discovery of Fourier series.

Math 241 *Analysis in Several Real Variables I.* Together with Abstract Algebra, Analysis provides a solid foundation for advanced mathematics. In our undergraduate curriculum, these topics are introduced in Math 251 and Math 241. In this course, you study the basic properties of sets of real numbers, including the topology of Euclidean n-dimensional spaces, and analyze the behavior of real-valued functions defined on subsets of these spaces. To permit applications of these concepts in other areas, far-reaching generalizations of the concept of distance are investigated. Students taking Math 241 will be well-prepared for the sequel course, Math 242; for advanced undergraduate courses requiring mathematical analysis; for graduate study in mathematics; or for advanced study involving theoretical research in the physical sciences and engineering. Mathematics graduate students must enrolled in Math 241 if they need a preparatory course for the 300-level real analysis courses.

Math 242 *Analysis in Several Real Variables II.* This course places calculus of several variables on a solid foundation through careful presentation of some of the most important achievements in mathematics. By appropriately extending the definitions of differentiation and integration to R^n the following questions can be answered. (1) How can single integrals, multiple integrals, and infinite series be unified into a single concept, and what results stem from this unification? (2) When does it happen that the mixed second partials with respect to x and y are not equal? (3) When does $f(x,y) = 0$ imply that y is a function of x?

Math 251 *Abstract Algebra I.* Wherever there is symmetry, it may be described by the fundamental concept of a "group". So powerful is this concept that it not only pervades much of mathematics, but its usefulness in simplifying problems extends to many other sciences as well. Several examples of groups are already familiar to you: the set of positive real numbers with the operation of multiplication, the set of polynomials with the operation of addition, the set of invertible two by two matrices with the operation of matrix multiplication, or the set of moves of the

Rubik's cube with the operation of composition. The term "abstract algebra" refers to the fact that the concepts studied in this course are general enough to apply to a multitude of situations, thereby introducing algebraic structure. Because of the breadth of its usefulness, and the beautiful introduction to the development of mathematical theory that it provides, abstract algebra is vital to a deeper understanding of advanced mathematics.

Math 252 *Abstract Algebra II.* Why is it impossible to trisect an angle by ruler and compass construction, to construct a regular heptagon, or to solve for the roots of a quintic equation by radicals? These questions, which occupied mathematicians for centuries, will be answered in this course. The key is to observe the occurrence of structures with extensive algebraic properties, and to analyze these structures. For example, a major goal of this course is to provide a deeper understanding of fields, vector spaces, and linear algebra. The culmination of the course comes in the beautiful relationship, first discovered by Galois, between these concepts and the concept of a group. This relationship especially applies to the study of roots of polynomials and yields striking facts such as the insolvability of the quintic.

Math 255 *Elementary Number Theory.* Number theory has been called the "Queen of Mathematics", because it involves the development of a wide variety of useful methods and produces beautiful and profound results concerning one of the most basic objects in mathematics: the set of integers. This course allows one to appreciate the work of many mathematical giants and some of the relationships among geometry, algebra, and analysis. Those interested in the history or teaching of mathematics, or in obtaining a concrete introduction to some of the concepts of abstract algebra will find this to be an attractive course which can be taken early in the major. The ideas found here, originally thought to be purely theoretical, now find applications of critical importance to society. For instance, the making and breaking of secret codes, the efficient use of computer memory, and the security of automatic teller machines are some of the areas to which the ideas in this course have made a significant contribution.

Math 260 *Foundations of Geometry.* Geometry is a singularly fascinating, highly intricate, extensive and challenging field of mathematics which can be studied and pursued with very little mathematical prerequisites. The contents of this course may vary from year to year, reflecting the breadth of the field and the personal preferences of the instructor. In recent years, the course has consisted of two main parts: Modern Elementary Geometry and Non-Euclidean Geometry. Complex numbers and their properties are used to model the plane and to prove such theorems as the Nine Point Circle Theorem, Morley's Theorem and Pascal's Mystic Hexagram Theorem. The second part of the course is a mind-stretching excursion into hyperbolic geometry, where squares don't exist and parallel lines are not everywhere equidistant.

Math 264 *Vector Analysis.* This course begins with a study of the fundamental algebraic properties of vectors in Euclidean spaces. Applications in geometry and physics are explored, including: analysis of curves and surfaces in Euclidean space; geodesics; rigid body motion in classical mechanics; thermodynamic processes;

electromagnetic processes; fluid dynamics; and special and general relativity.

Math 266 *Chaos, Fractals, and Dynamical Systems*. What does it mean for an object to have non-integer dimension? Under what circumstances do small changes in the initial state of a system lead to large changes in the future state? For how long can we expect to be able to predict any natural phenomenon? This course explores the incredible breadth of nonlinear dynamics through careful study of discrete dynamical systems, sensitive dependence on initial conditions, chaos, bifurcations, fractals and chaotic attractors. Each topic is described using examples from the physical and natural world, and explored using computer programs.

Math 268: *Mathematical Biology and Ecology*. Mathematical biology and ecology is a very fascinating and fast growing interdisciplinary field. It entails the use of mathematical modeling techniques to solve problems in the ecological, life and biomedical sciences. In this course, mathematical models, which suggest possible mechanisms that may underlie specific biological processes, are developed, analyzed and validated. With each topic discussed, the modeling scenario consists of (i) the development of the mathematical model and assessment of its realism; (ii) mathematical analysis of the model and clues to numerical computations; (iii) biological interpretation of the results, and model predictions. The course places emphasis on the use of models to predict what may follow under tested and untested conditions. The goals of this course are: (i) critical understanding of the use of differential equation methods in mathematical biology and ecology, and (ii) exposure to specialized mathematical and computational techniques which are required to study differential equations that arise in mathematical biology and ecology. Popular topics that are covered in this course include population dynamics modeling, dynamics of infectious diseases, enzyme kinetics, wave phenomena in biology, reaction-diffusion mechanisms, and biological pattern formation. By the end of this course students will be able to derive, solve, understand, interpret, discuss, and critique discrete and differential equation models of biological and ecological systems. Prerequisite: Math 124, Math 230 or permission of Instructor.

Math 272 *Applied Analysis*. The first part of this course discusses the solution of equations of wave motion, heat flow, and electric potential by Fourier and Fourier-Bessel series via separation of variables and "eigenfunction series." Applications include: the motion of vibrating strings and membranes; one and two dimensional heat flow; and the Dirichlet problem. The second part of the course discusses functions of a complex variable, including differentiation, integration, and evaluation of integrals around closed paths. Important results are: the Cauchy integral theorem and formula; Taylor and Laurent series; the calculus of residues; conformal mapping; and Schwarz-Christoffel mappings.

Math 273 *Combinatorial Graph Theory*. A graph is a collection of points together with lines joining pairs of these points. Graphs are used to model a wide variety of situations. For example, the points may represent microprocessors with the lines representing communication channels. When can we lay out the computer circuit without crossing wires? Or perhaps the points of a graph represent people and the

lines indicate friendships. When can we pair together the people so that everyone is with a friend? Or perhaps the points are airports and the lines are flights. How can a traveler arrange her schedule to minimize the total cost of her trip? These and other topics are explored in Math 273, Combinatorial Graph Theory. The questions above are respectively special cases of graph planarity, matching theory, and the Hamilton cycle problem. You will also study paths and trees in graphs (connection problems), Eulerian cycles (postman problems), and point and line colorings (storage and scheduling). Finally, what does all this have to do with the five Platonic solids and the thirteen semiregular polyhedra? Take the course and find out!

Math 274 *Numerical Linear Algebra*. In a first course in linear algebra you learn things like how to solve systems of linear equations, invert matrices when possible, find eigenvalues, do orthogonal projections. All of these are important in applied mathematics and sciences that use mathematics, but all of them require special care when done on a large scale, using floating point arithmetic. Small errors, such as the error introduced by trying to make a base-16 floating point number out of 1/3, can be magnified into errors larger than the true answers, if you use inappropriate techniques. In fact, this can occur even when using the best techniques in some situations. In Math 274 we study ways to evaluate linear algebra problems for their potential to magnify errors. We look at good computer algorithms for linear algebra problems, emphasizing "stability properties" -- that is, the ability to keep errors from growing unnecessarily. In most offerings of the course the specific topics we study are: (1) singular value decompositions and matrix norms (powerful tools for evaluating the error potential of many problems), (2) algorithms for solving linear systems and linear least squares problems, and (3) algorithms for eigenvalue computation. You will do several computing projects whose purpose is to illustrate the concepts and get you to think about related issues. An ability to program in a standard language is not essential. The computing will be done using the MATLAB system or *Mathematica*. You will use this system at the "top", or interactive level, but won't need to write any programs from scratch. To take this course, you need a solid grasp of basic linear algebra, including the concepts of vector space, subspace, basis, and linear independence. This course is for fourthyear undergraduates or beginning graduate students.

Math 283 *Junior-Senior Seminar*. This is a one-credit course, which is intended to run every other Spring semester, whose content is determined by you, the student. Here you will receive the opportunity to investigate and lecture on a mathematical topic of your own choice. Faculty members will assist you in choosing a topic and sources based on your interests, and help you to perfect a 50- minute presentation to be made to your peers. All mathematics majors are strongly encouraged to enroll in this course as a unique and important part of your undergraduate training. Participants generally find that this chance to work closely with faculty and to compare experiences with fellow math majors provides personal growth and fun.

Math 195 and 295 *Special Topics.* Math 195 and 295 add variety to the schedule of course offerings by providing for the study of different topics each semester upon the initiative of students or of faculty members. A student or group of students interested in pursuing a particular topic may request to enroll in one of these courses for this purpose. They may approach a particular faculty member, or ask the chair of the department for assistance in locating a suitable instructor. Faculty members tend to be quite receptive when students come forward with ideas demonstrating a real enthusiasm for mathematics. Another possibility is that a faculty member may announce the intention to teach a Math 295 course on a topic of particular interest to him or her. Watch for these announcements in your mathematics classes or consult your advisor. These courses often involve some independent study and other activities which take advantage of their intimate and informal nature.

Math 293-294 *Undergraduate Honors Thesis.* Math 293 and 294 are the courses to enroll in if you wish to write a thesis during your senior year and graduate with honors. The prerequisites are that you hold a grade point average for sophomore and junior work of 3.0 or better, that you have identified a faculty member who is willing to serve as your thesis advisor, and that you have submitted a short thesis proposal by the end of your junior year. Please see the description of the honors thesis program in Section III for further details.

B. Description of Statistics Courses

Stat 51 *Probability with Statistics (Fall, Spring).* This course does not require calculus, and can be taken by first year students in mathematics and statistics. It covers the basic reasoning used in probability models of the real world, with statistical applications. After your first year, you should take Stat 151 described below, which provides a deeper view of probability.

Stat 141 *Basic Statistical Methods (Fall, Spring, Summer).* Each of us, in a myriad of ways, is forced to make decisions in the face of uncertainty. The purpose of statistics is to develop strategies to cope with these difficulties. You will learn how to quantify problems, sample scientifically, collect valid and reliable information, prepare graphic displays, extract meaning from data, make inferences, and predict future events. How is it that statisticians can call an election when only a small fraction of the vote has been counted? How does a long-distance telephone company prepare for Mother's Day? How it is possible to decide which of two competing treatments will be most effective in combating deadly diseases such as AIDS or cancer? Why doesn't randomization add further confusion to our already incomplete state of knowledge? How can insurance companies offer competitive premiums and remain solvent? You will learn how to choose appropriate strategies to address a variety of problems. You will command powerful statistical techniques via a modern statistical software package, MINITAB, using your microcomputer. While no one is able to make correct decisions all of the time, you will learn how to reach valid conclusions with a high degree of confidence.

Stat 151 *Applied Probability* (Fall, Spring, Summer). According to the great probabilist Bruno di Finetti, "Probability does not exist!" Probability is a construct of the human mind and, as such, is used to quantify our beliefs. This course involves the study of random phenomena. The notion of probability is developed from an experimental as well as a theoretical perspective. Some typical areas of inquiry include: system reliability, false positive and false negative errors in drug testing, distribution of lunar boulders at the Apollo landing site, maximizing expected profit in business, jury selection, traffic flow, life expectations for humans and manufactured products, the risk posed to the Hubble Telescope by orbiting man- made debris, and computer generation of pseudo random numbers. You will have an opportunity to use some of the skills acquired in other mathematics courses, especially in the areas of: elementary set theory, combinatorics, infinite series, exponential and logarithmic functions, and definite integral evaluation. This is a good preparation for 200 level statistics courses, particularly 251. Stat 151 and 141 are both introductory and can be taken in any order.

Stat 191 *Special Projects (Fall, Spring)*. The projects that the students have taken on in this course have typically been done in order for them to gain practical experience in some area of statistical application or statistical software. You may work with a statistics professor or other researchers on campus helping them with data entry, software development, and statistical analysis of their data. A paper would be written summarizing some aspect of the research experience. Such a project could also be set up with quality control personnel in various organizations in the region, so that you could get experience in measurement, inspection, quality control, or experimental design issues. The course credit varies with the hours per week committed to the project. The Program Director should be consulted if such work experience appeals to you.

Stat 200 *Medical Biostatistics and Epidemiology (Fall).* This class provides an overview of the design and analysis of medical studies. Emphasis is placed on human investigations. At the beginning of the semester, concepts of incidence, prevalence and risk, rate and odds ratios are introduced. Observational studies (case-control and cohort) and experimental studies (clinical trials) are described in detail. Recent articles from journals such as the NEW ENGLAND JOURNAL OF MEDICINE are read and discussed to illustrate different design and analysis strategies. Emphasis is placed on interpretations rather than on calculations. A basic understanding of the statistical concepts of estimation and hypothesis testing is assumed. This is an excellent course for premedical students and others interested in the health sciences.

Stat 201 *Statistical Analysis via Computers (Fall, Spring).* This course is designed to give students practical experience using SAS statistical software to perform data analysis. This is a critical skill needed by all scientists. Probably you have already been exposed to the statistical methodology in Stat 141 (or Stat 211), which allows this course to focus on the application of these methods to real world data. Problems encountered in the process of data collection, coding, keypunching, and data screening are discussed in detail. You will learn how to decide between the use

of parametric and nonparametric procedures based upon examining the statistical assumptions. You are required to do a class project that involves analyzing a data set supplied either by the student or the instructor.

Stat 211 *Statistical Methods I (Fall, Spring, Summer)*. There is no statistics prerequisite for this course, although many students in the course will have taken Stat 141 first. If you are already a Junior or Senior, you can take this course with no statistics background. If you did extremely well in Stat 141, you may decide to pass over Stat 211 and take other more advanced statistics courses instead. The emphasis in Stat 211 is on statistical methods, and less on their probabilistic foundations. More advanced methods (at a greater depth) are covered here than in Stat 141. Graduate students in other disciplines can take this as a useful preparation for doing data analysis in their research work.

Stat 221 *Statistical Methods II (Fall).* The first half of this course is devoted to regression. It begins with a review of the straight line regression model. This model is then generalized to multiple regression. Correlations (simple, partial and multiple) are also discussed. The second half of the course is devoted to basic experimental designs where the analysis of variance is used. The one-way analysis of variance model for fixed and random effects is discussed. The randomized complete block design is discussed next, followed by the two-way analysis of variance (fixed, random and mixed models) with equal and unequal sample sizes. Finally, the analysis of covariance is introduced. The SAS computer package is used. This is a core course for statistics majors and minors and for actuarial students.

Stat 223 *Applied Multivariate Analysis (Spring).* The class provides a broad overview of a variety of statistical techniques applicable to multivariate data. The following procedures are introduced: canonical correlation, discriminant analysis, logistic regression, analysis of survival data, principal components, factor analysis and categorical data analysis. Emphasis is on the application of these techniques and the interpretation of the results of the analysis, rather than on theoretical details. Extensive use is made of the BMDP and SAS computer packages.

Stat 224 *Statistics for Quality and Productivity. (Fall).* One of the most dramatic changes to have taken place in American industry has been our recent precipitous drop in market share in key sectors (automotive, electronics, etc.). A key strategy in regaining world-class competitiveness is continually working to improve the quality of industrial systems, process and products. Key players in this quality movement since the early 1980's have included statisticians, with Deming being particularly well known. More recently, all organizations, including health care and other service organizations are considering total quality management (TQM) as a philosophy. This has expanded career opportunities for statisticians, and knowledge of this area will enhance your employability. This course considers the statistical tools that are essential for improving quality: statistical process control (SPC), control charts, capability and measurement studies, sampling inspection, and sequential/stagewise sampling.

Stat 225 *Applied Regression Analysis (Fall, Spring, Summer).* Regression analysis is concerned with how to predict the values of one variable (y) from the given values of other variables, the simplest example being a straight line (linear) relation $y = f(x) = ax + b$. With real data collected on y and x the function f never exactly explains y in terms of the x values, and so one typically uses a least squares error approach to obtain the best fitting functions to the data. Regression analysis is the basic method used in business, economics and other social/behavioral sciences, health and other biological sciences, and engineering and other physical sciences to fit mathematical models to real data. The standard models and assumptions are reviewed, fitting methods discussed (with software and appropriate matrix methods), and methods of checking the fit (residual analysis) are covered. Linear, multiple, polynomial, logistic, and ridge regressions are included. Important forecasting applications provide some of the examples. Statistical software such as MINITAB and SAS is used.

Stat 229 *Survival Analysis (Alternate Years).* Reliability of a product or system concerns the probability that it will be able to perform its intended function for a certain period of time. A variety of probability distributions are presented which have been found to be useful in describing time-to-failure of products or in counting the numbers of events taking place in a given time interval such as repairs, failures, accidents, logins to computer systems, etc. The design of life tests and their data analysis are discussed. Important applications of these and other nonparametric statistical techniques occur in biostatistics and clinical trials where the subject is termed survival analysis.

Stat 231 *Experimental Design (Spring).* This is a more advanced applications course, and is extremely valuable in the planning and analysis of experimental data for business, engineering, physical science, clinical, behavioral and social science investigations. A variety of useful standard designs are covered and the analysis of data by ANOVA (Analysis of Variance) is included. Examples are done using SAS software. You can take this course after Stat 141 or 211, but you would be better prepared by taking Stat 221 first.

Stat 233 *Survey Sampling (Fall).* Simple random, stratified, systematic and cluster sampling schemes are introduced. For each scheme, point and variance estimation results are discussed. Both theoretical and applied concepts are discussed. For example, you will learn how to show that some point estimators are unbiased and how to derive some variance estimators. Practical aspects of performing surveys, such as constructing a frame, training interviewers, constructing and pretesting questionnaires, etc. are also discussed. Mail, telephone and household surveys are considered. Case study applications are discussed by visiting speakers.

Stat 235 *Categorical Data Analysis.* Measures of association and inference for categorical and ordinal data in multiway contingency tables. Log-linear and logistic regression madels. Particularly in the social and behavioral sciences, but also in the medical and natural resources sciences, many of the key variables of interest are categorical in nature. This course covers modern approaches to the

analysis of such data. A variety of case study applications are analyzed with statistical software.

Stat 237 *Nonparametric Statistical Methods (Fall).* Some types of data (categorical or ordinal) require the use of nonparametric statistical methods. A variety of procedures for interval estimation and hypothesis testing are covered. Related methods are also used with quantitative data in order to avoid specific distributional assumptions that would otherwise ned to be made. Computer-intensive tests, such as exact tests for categorical and rank data, and randomization or bootstrapping, are illustrated.

Stat 241 *Statistical Inference (Spring).* This is a basic course in mathematical statistics with some review of needed probability results. It is required for statistics majors. This is a good follow-up course to Stat 151 for mathematics majors; but you may get more out of it if you wait and take this after having had some applications courses as well.

Stat 251 *Probability Theory (Fall).* This is a more advanced introduction to probability theory than Stat 151; and would be an excellent course to take if you were going on to graduate school in programs like mathematics, statistics, and operations research, or were interested in actuarial studies.

Stat 253 *Applied Time Series and Forecasting (Alternate Years).* A fundamental problem in business, economics, engineering and other sciences is providing forecasts for the future values of data collected in time order. Modern statistical models (autoregressive integrated moving average models) are developed in this course, which can be used in the analysis of time series data, fitting models to these data, checking forecast errors, and providing future forecasts. Seasonal effects are considered as well. If information from other series (x) can be used to aid in the forecast of y, then one can use transfer function models for the analysis. You gain practical experience in fitting a variety of real series with the latest software methods.

Stat 261 *Statistical Theory I (Spring).* This is a more advanced introduction to statistical theory than Stat 241; and could be taken in addition to 241 if there is time in your program. If you really enjoy Stat 251, this would be a natural follow-up, and would put you in an advanced position for graduate work in statistics.

Stat 265 *Integrated Product Development (Spring).* This is a valuable elective course for those students interested in quality control and in working for an industrial organization. It is a team- taught course by faculty in engineering, business administration and statistics. Students work in cross-disciplinary teams to design a product and develop a business plan for it.

Stat 293/294 *Undergraduate Honors Thesis (Fall, Spring).* Please see the discussion previously in Section III. For statistics majors, this could be an alternative to the Stat 281 requirement.

Stat 281 *Statistics Practicum (Fall, Spring).* This is a required course for statistics majors, but could be taken by other mathematics majors. You will work independently on a research-related project, which may have elements of an experimental design, observational study, clinical trial, sample survey, forecasting study, or computer simulation. The study generally has important applications for the company or research group that you are working with. The choice of project can be yours, or you can be matched to an on-going project of a UVM professor, or to a project of interest to a local company. The most important outcome of the course is a paper which summarizes the study and the data analysis you have done.

APPENDIX 4: CURRICULUM CHECKLISTS

A. BS in Mathematics

Student: _____   **BS in Mathematics**

ID #: _____   **2012-2013**

CORE:					CREDITS
MATH 21 4 Calculus I	**MATH 22** 4 Calculus II	**MATH 121** 4 Calculus III	**MATH 52** 3 Fundamentals of Mathematics	**MATH 124** 3 Linear Algebra	27
MATH 241 3 Analysis in Several Real Variables I	**MATH 251** 3 Abstract Algebra	**CS 21** 3 Computer Programming			

MAJOR COURSES: A minimum of 21 credit hours of MATH, STAT or CS numbered 100 or above. Of these 21 credit hours, at least 9 must be in MATH or STAT, and at least 12 must be numbered 200 or above.

CREDITS

21

ALLIED FIELDS: 24 credit hours: at least 6 credits numbered 100 or above; at least 6 credits in fields 1, 2, 3, 4 or 5. Absolutely no courses from the 'major courses' above can be used to fulfill an allied field requirement. There is no overlapping!

CREDITS

1. Physical Sciences	4. Engineering	7. Business Administration	10. Environmental Sciences/Studies
2. Biological Sciences	5. Computer Sci. (64 or higher)	8. Psychology	11. Natural Resources
3. Medical Sciences	6. Agricultural Sciences	9. Economics	

24

HSS: English 1 plus 21 credit hours from categories I, II & III. At least 6 credit hours must be taken in at least 2 different categories.

Category I: Chinese, Classics, English, French, General Literature, German, Greek, Hebrew, Italian, Linguistics, Russian, Spanish, World Literature

Category II: Art, Film, Music, Philosophy, Religion, Speech, Theatre

Category III: Anthropology, Area & Int'l Studies, Communication Sciences, Economics, Geography, History, Political Science, Psychology, Sociology, Vermont Studies, Women's Studies

Category I: Language & Literature	**ENGS 001** 3 Written Expression					24
Category II: Fine Arts, Philosophy & Religion						
Category III: Social Sciences						

96 credits are defined above. Total credits required for graduation are 120, including two 3-credit courses satisfying the University Diversity requirement. Check to be sure that this requirement has been met.

* CHECKSHEET FOR CEMS STUDENT SERVICES USE, NOT INTENDED FOR OFFICIAL ACADEMIC ADVISING *

B. BS in Statistics

Student: _____

ID #: _____

CORE:						CREDITS
MATH 21 4	**MATH 22** 4	**MATH 121** 4	**MATH 124** 3	**CS 21** 3		**18**
Calculus I	Calculus II	Calculus III	Linear Algebra	Computer Programming		
STAT 201 3	**STAT 141, 143 or 211**	**STAT 151, 153 or 251**	**STAT 221 or 227**	**STAT 241 or 261**	**STAT 281 or 293**	**18**
Statistical Analysis Via Computer	Statistical Methods or Statistics for Engrs.	Applied Probability, Prob/Stat for CS, or Probability Theory	Statistical Methods II or Statistical Methods for Behavioral Sciences	Statistical Inference or Statistical Theory I	Statistics Practicum or Undergrad Honor's Thesis	

MAJOR: An additional 6 credits in STAT (must have a total of 24 STAT credits including core courses); at least 2 additional credits in MATH, STAT or CS numbered 100 or above (must have a total of 45 credits of MATH, STAT or CS including applicable core courses); a total of 18 credit hours of MATH, STAT, or CS must be numbered 200 or above (core courses can be used to fulfill this requirement); no more than 120 credit hours can be CS

					8-24

ALLIED FIELDS: 24 credit hours with at least 6 credits numbered 100 or above and at least 6 credits in fields 1, 2, 3, 4 or 5. **CREDITS**

Absolutely no courses from the 'major courses' above can be used to fulfill an allied field requirement.
One course must include a laboratory experience in either science or engineering.

1. Physical Sciences   4. Engineering   7. Business Administration   10. Environmental Sciences/Studies
2. Biological Sciences   5. Computer Sci. (64 or higher)   8. Psychology   11. Natural Resources
3. Medical Sciences   6. Agricultural Sciences   9. Economics

				24

HSS: English 1, Speech 11 plus 18 credit hours (for a total of 24 credit hours) of HSS from categories I, II & III. At least 6 credit hours must be taken in at least 2 different categories.

Category I: Chinese, Classics, English, French, General Literature, German, Greek, Hebrew, Italian, Linguistics, Russian, Spanish, World Literature

Category II: Art, Film, Music, Philosophy, Religion, speech, Theatre

Category III: Anthropology, Area & Int'l Studies, Communication Sciences, Economics, Geography, History, Political Science, Psychology, Sociology, Vermont Studies, Women's Studies

Category I: Language & Literature	**ENGS 001** 3	**SPCH 011** 3				**24**
	Written Expression	Effective Speaking				
Category II: Fine Arts, Philosophy & Religion						
Category III: Social Sciences						

93 credits are defined above. Total credits required for graduation are 120, including two 3-credit courses satisfying the University Diversity requirement. Check to be sure that this requirement has been met.

* CHECKSHEET FOR CEMS STUDENT SERVICES USE, NOT INTENDED FOR OFFICIAL ACADEMIC ADVISING *

C. BA General/Distribution Requirements

```
COLLEGE    OF    ARTS    AND    SCIENCES
```

BACHELOR OF ARTS 2013-2014 Degree: - CAS General Requirement
- University-Wide Diversity Requirements
- Distribution Requirements

Students must complete the following courses that comprise the college requirements for the Bachelor of Arts Degree.

- Courses applied toward satisfaction of these requirements *may not be taken on a pass/no pass basis*.
- Each semester special topics courses (95, 96, 195, 196, 295, 296), as well as courses that are cross-listed with those below, are offered which may meet general and distribution requirements. Check with the Dean's Office if you have a question about a specific course.

CAS GENERAL REQUIREMENT - NON-EUROPEAN CULTURES (3 credit course)

- Must be completed by all students pursuing a Bachelor of Arts degree.
- A course used to fulfill Non-European Cultures General Requirement may also be applied towards a Distribution Requirement.
- The courses listed in **bold** below indicate introductory courses most commonly offered.

<p align="center">NON-EUROPEAN CULTURES: One course from the list below:
Course: _____</p>

ONLY the courses listed below satisfy BOTH the CAS Non-European Cultures and the 2013-2014 University-Wide D2 Requirements.	
ANTH 21, 23, 24, 28, 59, 104, 152, 160, 161, 162, 163, 165, 166, 172, 179, 180, 184	**HST** 9, 10, 35, 36, 40, 41, 45, 46, 55, 62, 63, 67,106, 107, 140, 141, 146, 149, 150, 151, 211, 240, 250, 252
ARTH 8, 146, 184, 185, 186, 187, 188, 189, 192, 285	**MU** 7, 107
CLAS 145, 149	**PHIL** 10 (only East/West course title),121, 221
DNCE 5, 31	**POLS** 157, 168, 174, 175, 176, 177, 266, 280
EC 40, 45	**REL** 20, 21, 26, 29, 130, 132, 141, 145, 163, 167, 234
ENGS 179, 182	**SOC** 171, 212, 272
ENVS 167, 182	**WGST** 116
GEOG 50, 150, 151, 154, 156	**WLIT** 20, 109, 119, 145
GRS 1, 200	

UNIVERSITY-WIDE DIVERSITY REQUIREMENT

- In addition to the CAS General Requirement (see above), complete one 3-credit course in **Diversity Category 1 (D1): Race and Racism in the U.S.**

<p align="center">Course: _____</p>

BACHELOR OF ARTS DISTRIBUTION REQUIREMENTS

- No more than two courses from the same department may be used to satisfy the distribution requirements.
- No single course may satisfy more than one category, except a foreign language course, which fulfills the literature category and can also fulfill the category of foreign language.
- Courses that satisfy major and minor requirements may also be used to fulfill distribution requirements.
- Except where noted, only courses of three credits or more will satisfy distribution requirements.

<p align="center">**IMPORTANT NOTE**</p>

- Students at UVM are responsible for knowing and complying with all requirements for their respective degrees as stated in the University Catalogue and on this distribution sheet.
- Not all courses listed are offered every semester, or every year, so please plan accordingly.
- The College of Arts and Sciences reserves the right to make changes in the course offerings, degree requirements, regulations and procedures as educational and financial considerations require, subject to and consistent with established procedures and authorizations for making such changes.