Executive Summary
University of Utah
Bachelors in Applied Mathematics
10 September 2009

Program Description

Professionals with solid mathematical and interdisciplinary skills are increasingly the central players in tackling many of today's scientific, technological, medical, security, and societal challenges. The Applied Mathematics Major will encourage students who love mathematics to explore one or more of these applications and connections as potential career paths, by tackling mathematically-intense upper division courses available throughout the University. Conversely, this degree is designed to encourage and guide motivated students from other mathematically-oriented disciplines to strengthen their mathematical background by completing a double major. In this way it will enhance interdisciplinary studies, without diverting students from major programs of allied departments.

The interdisciplinary focus of the Applied Mathematics Major distinguishes it from the existing Mathematics Major. Like the existing Major, the Applied Mathematics Major has core courses in calculus, physics, linear algebra, differential equations and introductory analysis. Additionally, students in the Applied Mathematics Major take foundational courses which are especially important for interdisciplinary work: programming, discrete mathematics, probability/statistics and complex analysis. A course in numerical analysis replaces the second semester of theoretical analysis required for the Mathematics Major. Applied Mathematics Majors complete at least 5 courses beyond the core requirements. Up to 3 of these electives may be taken from other departments on campus, as long as they have significant mathematical content and are approved by the Departmental adviser.

Role and Mission Fit

Some students completing the Applied Mathematics Major will enter the workforce directly and make significant contributions to business, industry or government; most will use the major as preparation for further career development. In addition to mathematics and mathematically-oriented disciplines such as computer science, engineering, medicine, physics, economics, business, and the earth sciences, many emerging fields require the combination of mathematical thinking and interdisciplinary skills.

This program is consistent with and appropriate to the University of Utah's mission to serve the wider community through "the discovery, creation and application of knowledge." Students will be able to utilize and disseminate their applied mathematical knowledge and skills throughout their career as they participate in Utah's job market. The interdisciplinary nature of the Applied Mathematics Major is consonant with the University's mission to "advance rigorous interdisciplinary inquiry."

Faculty

Please indicate the number of discipline specific faculty and level of preparation of the faculty who will support the program. Tenure includes already tenured and tenure-track.

Number of faculty with Doctoral degrees	Tenure	***42***	Contract	***27***	Adjunct	***4***
Number of faculty with Master's degrees	Tenure		Contract	***7***	Adjunct	***2***
Number of faculty with Bachelor's degrees	Tenure		Contract		Adjunct	
Other Faculty	Tenure		Contract		Adjunct	

Market Demand

The variety and importance of jobs for which an interdisciplinary mathematics background is important are two of the reasons that "Mathematician" was recently listed as the very top career choice in a national study, as reported in the January 26, 2009 Wall Street Journal article, "Doing the math to find good jobs." A good source for careers requiring Applied Mathematics major skills is the Society for Industrial and Applied Mathematics (SIAM) website http://www.siam.org/careers/thinking.php . Ideally, students should begin exploring which of these careers might interest them while they are still undergraduates, and the Applied Mathematics major provides an effective framework to do this exploration and preparation.

Past University of Utah Mathematics majors have graduated, possibly pursued further training or certification, and ultimately entered the work force in a variety of capacities and settings: education (K-12, junior college and senior university settings); biotech; engineering (computer, civil, electrical, mechanical); finance; public sector; medicine. See Appendix D for a list of businesses and entities that currently employ our graduates.

Student Demand

According to a survey conducted in Spring 2009, approximately 30 current Utah Mathematics students may be interested in pursuing the Applied Mathematics Major. This program of study will be attractive as a double major to the students of undergraduate programs residing in the University of Utah's Colleges of Science, Mines and Engineering, as well as to students in Finance and Economics programs. In an informal canvassing undertaken by one of our undergraduates, 30 students from allied programs listed their names and current majors, expressing interest in a double major which would include Applied Mathematics. We expect that student demand will increase as this program becomes established.

Statement of Financial Support.

Indicate from which of the following the funding will be generated: (Provide the detail for funding as part of the “Financial Analysis” section included in the full proposal.)

- Legislative Appropriation ..... ☐
- Grants ..... ☐
- Reallocated Funds ..... ☐
- Tuition dedicated to the program ..... ☐
- Other ..... ☐

Similar Programs Already Offered in the USHE

Although a signfiicant number of national programs and several out of state peer universities support an applied mathematics major, no such major is currently available at any Utah State Higher Education institution.

Section I: The Request

The University of Utah Mathematics Department requests approval to offer a Bachelor of Science Degree in Applied Mathematics, effective Spring 2010.

Section II: Program Description

2.1 Complete Program Description

Professionals with solid mathematical and interdisciplinary skills are, and will continue to be, central players in tackling many of today's scientific, technological, medical, security, and societal challenges. The Applied Mathematics Major will encourage students who love mathematics to explore one or more of these applications and connections as potential career paths, by tackling mathematically-intense upper division courses available throughout the University. Conversely, this degree is designed to encourage and guide motivated students from other mathematically-oriented disciplines to strengthen their mathematical background by completing a double major.

The interdisciplinary focus of the Applied Mathematics Major distinguishes it from the existing Mathematics Major. Like the existing Major, the Applied Mathematics Major has core courses in calculus, physics, linear algebra, differential equations and introductory analysis. Additionally, students in the Applied Mathematics Major take foundational courses which are especially important for interdisciplinary work: programming, discrete mathematics, probability/statistics and complex analysis. A course in numerical analysis replaces the second semester of theoretical analysis required for the Mathematics Major. Applied Mathematics Majors complete at least 5 courses beyond the core requirements. Up to 3 of these electives may be taken from other departments on campus, as long as they have significant mathematical content and are approved by the Departmental adviser.

Core coursework

Title	*Catalog Number*	*CH*
Calculus	MATH 1210, 1220, 2210 (or equivalent)	11
Physics Sci/Eng	PHYS 2210, 2220 (or 3210, 3220)	8
Discrete Mathematics/Intro Proofs	MATH 2200 or CS 2100	3
Linear Algebra	MATH 2270	4
Differential Equations	MATH 2280 (or 2250 and 3150)	4 or 6
Intro Programming	CS 1000 (or CS 1020, 1021, 2000)	3 or 4
Foundations of Analysis I	MATH 3210	4
Complex Analysis	MATH 3160 or 4200	2 or 4
Probability/Statistics	MATH 5010 or 3070	3 or 4
Numerical Methods	MATH 5610 or 5600 (or equivalent)	4

(If student plans to take one semester of numerical analysis, they should take MATH 5600.)

Electives: At least 5 courses from the following list and approved by the student's Mathematics advisor. Up to three courses from other departments may be substituted, as long as they have significant mathematical content and are approved by the advisor.

Title	*Catalog Number*	*CH*
Foundations of Analysis II	MATH 3220	4
Medical Mathematics	MATH 3900	4
Intro to Number Theory	MATH 4400	3
Into to Topology	MATH 4510	3
Fluid Dynamics	MATH 4750	3
Undergraduate Research Math.	MATH 4800	3
Actuarial Mathematics	MATH 5030	3
Stochastic Processes I, II	MATH 5040, 5050	3,3
Statistical Inference I, II	MATH 5080, 5090	3,3
Mathematical Biology I, II	MATH 5110, 5120	3,3
Real Analysis	MATH 5210	4
Applied Fourier Analysis	MATH 5215	3
Matrix Analysis	MATH 5250	3
Modern Algebra I	MATH 5310	3
Intro ODE I, II	MATH 5410, 5420	4,3
Intro PDE	MATH 5440	3
Chaos and Nonlinear Systems	MATH 5470	3
Numerical Analysis I, II	MATH 5610, 5620	4,4
Applied Mathematics I, II	MATH 5710, 5720	3,3
Mathematical Modeling	MATH 5740	3
Topics in Applied Math	MATH 5750	3
Intro Math Finance I, II	MATH 5760, 5765	3,3

2.2 Purpose of Degree

Professionals with solid mathematical and interdisciplinary skills are, and will continue to be, central players in tackling many of today's scientific, technological, medical, security, and societal challenges. The Applied Mathematics Major will encourage students who love mathematics to explore one or more of these applications and connections as potential career paths, by tackling mathematically-intense upper division courses available throughout the University. Conversely, this degree is designed to encourage and guide motivated students from other mathematically-oriented disciplines to strengthen their mathematical background by completing a double major.

Some students completing the Applied Mathematics Major will enter the workforce directly and make significant contributions to business, industry or government; most will use the major as preparation for further career development. In addition to mathematics and mathematically-oriented disciplines such as computer science, engineering, medicine, physics, economics, business, and the earth sciences, many emerging fields require the combination of mathematical thinking and interdisciplinary skills.

2.3 Institutional Readiness

This major relies on the existing Departmental infrastructure. New organizational structures will not be required. The courses utilized by the plan of study are already in place. The implementation of the Applied Mathematics Major is likely to enhance the Department's usual and continual process of program and course modification, renewal and creation, just as this proposal is an outgrowth of that process. The enhancement will essentially be a cost-free side effect of the additional "experimental" data we will obtain

by tracking the Applied Mathematics Major outcomes, in the same way and framework that we currently track the regular Math Major.

Faculty

No additional faculty are required. The mathematics and allied departments already support the required classes.

Staff

No additional staff is required.

Library and Information Resources

No additional library and information resources are required.

Admission Requirements

The current open admission policy for the existing Mathematics Major will hold for the Applied Mathematics Major.

Student Advisement

For Freshman and Sophomore students, advising will begin with the Department's academic advisor. The Major's expectations and requirements will be made explicit to each student verbally and in writing. The academic advisor will aid students in short- and long-term planning for their individual program of undergraduate study.

As students become more advanced, designated Applied Mathematics faculty members will assist students in selecting upper-division electives. When necessary, mathematics faculty will consult with faculty members in allied departments to find suitable external elective courses to meet a student's particular needs and interests.

Justification for Graduation Standards and Number of Credits

To graduate under this program, in addition to the required course work, all Applied Mathematics Majors are required to:

- receive a "C" or better and an overall GPA of at least 2.3, in Major coursework.
- complete an exit interview the semester the student graduates.

The overall GPA requirement for courses within the major is not currently required for the standard Mathematics Major. We institute the GPA requirement for the Applied Mathematics Major as a reflection of the fact that students who complete this major should display the industriousness and abilities which will predict their later success in challenging interdisciplinary mathematics careers. The Mathematics Department uses exit interviews with graduating students to solicit comments and suggestions about the strengths, weaknesses, and possible improvements for our programs, and to get information about our students' future plans and careers.

Between 61 to 74 credit hours are required to complete the course work within the Applied Mathematics Major. This range is within the accepted limits for a bachelors program, and is somewhat more than the minimum of 56 credit hours required for the standard Mathematics Major. The extra course work as compared to the Mathematics Major reflects the fact that this interdisciplinary major requires competency in basic programming, combinatorics and statistics. Many of these extra topics are also required for majors in allied fields, facilitating completion of double majors without onerous total credit hour demands. Counting other University requirements, students receiving a BS in Applied Mathematics are required to complete at least 103 credit hours, at most 113 credit hours. This is within the 126 credit hour limit for a BS.

External Review and Accreditation

External consultants were not involved in developing the program. No special accreditation is required.

Projected Enrollment

Year	Student Head Count	# of Faculty*	Student-to-Faculty Ratio**
1	20	42	0.47:1
2	30	42	0.71:1
3	40	42	0.95:1
4	50	42	1.19:1
5	50	42	1.19:1

* total number of tenure track Math faculty.
** marginal change in student to faculty ratio; current ratio (math majors:faculty) is approximately 6.74:1.

Expansion of Existing Program

Total Mathematics Undergraduate Enrollment

Year	03-04	04-05	05-06	06-07	07-08	08-09
Total Students	256	281	284	283	280	290
Pre-Majors	69	56	37	33	49	51
Full-Majors	152	181	195	195	179	189
Teaching Majors	35	44	52	55	52	50

Section III: Need

Program Need

Areas of mathematics application are becoming increasingly broad. Beyond the traditional connections between applied mathematics, physics, and engineering, we are now seeing advances in biology, medicine, economics, finance, computer science, and even in the social sciences, that are being led by fundamentally mathematical ideas. Applied mathematics is aimed at building these interdisciplinary bridges, and the University of Utah is an ideal environment in which to build them. No other USHE institution offers an Applied Mathematics Major. To improve the educational opportunities for Utah citizens, and for the benefit of our state and country, Utah should have such a program.

Labor Market Demand

The variety and importance of jobs for which an interdisciplinary mathematics background is important are two of the reasons that "Mathematician" was recently listed as the very top career choice in a national study, as reported in the January 26, 2009 *Wall Street Journal* article*, "Doing the math to find good jobs."* A good source for careers requiring Applied Mathematics major skills is the *Society for Industrial and Applied Mathematics* (SIAM) website http://www.siam.org/careers/thinking.php . Ideally, students should begin exploring which of these careers might interest them while they are still undergraduates, and the Applied Mathematics major provides an effective framework to do this exploration and preparation. Past University of Utah Mathematics majors have graduated, possibly pursued further training or certification, and ultimately entered the work force in a variety of capacities and settings: education (K-12, junior college and senior university settings); biotech; engineering (computer, civil, electrical, mechanical); finance; public sector; medicine. See Appendix E for a list of businesses and entities that currently employ our graduates.

Possible career directions for Applied Mathematicians, as found on the SIAM website (http://www.siam.org/careers/thinking/work.php):

- Aerospace and transportation equipment manufacturers such as The Aerospace Corporation; Boeing; Ford Motor Co.; General Motors; Lockheed Martin; and United Technologies.
- Chemical and pharmaceutical manufacturers such as DuPont; GlaxoSmithKline; Kodak; Merck & Co., Inc.; Pfizer; and Wyeth.
- Communications service providers such as Clear Channel Communications; Qwest Communications; and Verizon.
- Computer service and software firms such as Adobe; Google, Inc.; Kuberre Systems; The MathWorks, Inc.; Mentor Graphics; Microsoft Research; Mosek; MSC Software Corporation; Palo Alto Research Center; ThomsonWest; and Yahoo Research.
- Consulting firms such as Daniel H. Wagner Associates and McKinsey & Company.
- Electronics and computer manufacturers such as Bell Laboratories, Alcatel-Lucent; Hewlett-Packard; Honeywell; IBM Corporation; Motorola; Philips Research; and SGI.
- Energy systems firms such as Lockheed-Martin Energy Research Corporation and the Schatz Energy Research Center (SERC).
- Engineering research organizations such as AT&T Laboratories – Research; Exxon Research and Engineering; NEC Laboratories America, Inc.; Schlumberger-Doll Research; and Telcordia Technologies.
- Federally funded contractors such as the Mitre Corporation and RAND.
- Financial service and investment management firms such as Citibank; Moody's Corporation; Morgan Stanley; and Prudential.
- International government agencies such as the Defence Science and Technology Organisation, DSTO (Australia); French Atomic Energy Commission, CEA/DAM; and National Research Council Canada.
- Medical device companies such as Baxter Healthcare; Boston Scientific; and Medtronic.
- Nonprofit organizations such as the American Institute of Mathematics (AIM) and SIAM.
- Producers of petroleum and petroleum products such as Amoco; Exxon Research and Engineering; and Petróleo Brasileiro S/A, Petrobras.
- Publishers such as Birkhauser and Springer.

- University-based research organizations such as the Institute for Advanced Study; the Institute for Mathematics and Its Applications (IMA); and the Mathematical Sciences Research Institute (MSRI).
- U.S. government agencies such as the Institute for Defense Analyses (IDA); NASA's Institute for Computer Applications in Science and Engineering; National Institute of Standards and Technology (NIST); National Security Agency (DIRSNA); Naval Surface Warfare Center, Dahlgren Division; Supercomputing Research Center; and the U.S. Department of Energy.
- U.S. government labs and research offices such as the Air Force Office of Scientific Research; Lawrence Berkeley National Laboratory; Los Alamos National Laboratory; Oak Ridge National Laboratory; Pacific Northwest National Laboratory; and Sandia National Laboratories.

Student Demand

According to a survey conducted in Spring 2009, approximately 30 current Utah Mathematics students may be interested in pursuing the Applied Mathematics Major. This program of study will be attractive to the students of undergraduate programs residing in the University of Utah's Colleges of Science, Mines and Engineering, as well as to students in Finance and Economics programs. In an informal canvassing undertaken by one of our undergraduates, 30 students from allied programs listed their names and current majors, expressing interest in a double major which would include Applied Mathematics. Bringing analytic and quantitative skills imparted through this degree program to jobs in the physical and life sciences, engineering, medical, or financial fields will give dual majors an advantage over single-degree holders in the competition for employment, or in post-graduate work leading to employment. Mathematically inclined students in the following majors could benefit from a double major in Applied Mathematics:

Accounting
Architecture
Biology
Biology (teaching)
Biomedical Engineering
Chemical Engineering
Chemistry
Chemistry (teaching)
Civil Engineering
Computer Engineering
Computer Science
Earth Science Composite (teaching)
Economics
Electrical Engineering
Environmental Earth Science
Environmental Studies
Finance
Geological Engineering
Geology
Geophysics
Information Systems
Material Science & Engineering
Mechanical Engineering
Metallurgical Engineering

Meteorology
Mining Engineering
Pharmacy
Physics
Physics (teaching)

Similar Programs

Successful Applied Mathematics Major programs exist at many top-level academic institutions in the United States: In the western United States, some of the top programs are at the University of Arizona, UCLA, University of Colorado, University of Washington and UC Berkeley. According to the *Peterson's Guide*, 190 institutions offer Bachelor degrees in Applied Mathematics. No such major is currently available at any Utah State Higher Education institution.

Collaboration with and Impact on Other USHE Institutions

No such major is currently available at any Utah State Higher Education institution.

Benefits

Establishing this major will benefit the University of Utah, the USHE system, individual students, the state and the country as a whole, by providing students with rigorous training in the tenets and tools of Applied Mathematics. Graduates of the program will ultimately be prepared to enter the workforce and make significant contributions. Some graduates will begin their careers directly after their bachelors degree. For others, the training and interest in allied fields such as the potential dual majors listed above will lead to post-graduate training in these allied fields, and this training will lead to careers like those listed earlier in this document, in the section "Labor Market Demand."

Consistency with Institutional Mission

This program is consistent with and appropriate to the University of Utah's mission to serve the wider community through "the discovery, creation and application of knowledge." Students will be able to utilize and disseminate their applied mathematical knowledge and skills throughout their career as they participate in Utah’s job market. The given interdisciplinary nature of the study of Applied Mathematics is consonant with the University's mission to "advance rigorous interdisciplinary inquiry."

Section IV: Program and Student Assessment

Program Assessment

Primary Program goals:
#1: Provide the Utah job market with workers with a rigorous background in Applied Mathematics.
#2: Give students a foundation of Mathematical skills to bring to applied problems.
#3: Strengthen the mathematical background of students in allied majors by providing a viable path towards double majoring in mathematics.

#4: Encourage students with interests in applied mathematics to investigate real world applications and potential career paths during their undergraduate years, through coursework and interactions in allied departments (see 'Labor Market Demand').
#5: Increase the number of interdisciplinary students majoring in Applied Mathematics.

Secondary Program goals:
#1: Increase educational and research collaborations among the faculty of the Mathematics Department with faculty in the allied departments.
#2: Compete for training grants that support the development of foundational research and education programs for interdisciplinary study.

Program Assessment:
The mathematics advisor will monitor students' progress and satisfaction through traditional indicators (GPA, enrollment numbers, program retention, post-graduation placement, graduation exit surveys) and required periodic one-on-one meetings with students. Other quantitative and qualitative indicators will be tracked and analyzed to assess the execution of program goals: frequency of student advising sessions; number of undergraduate research projects undertaken by Majors; number of mathematics faculty collaborating with allied faculty on joint papers, cross-listed courses developed, co-mentoring of students in research settings, and the writing of interdisciplinary grant proposals.

After the third year of the program, the department will initiate a review of the program. Student and faculty input and indicators (GPA, enrollment numbers, program retention, post-graduation placement, graduation exit surveys) will be compiled and analyzed. A group chosen from faculty in the allied departments, professionals in industry, and program graduates will be asked to evaluate the program's suitability and rigor. The external evaluators will be encouraged to offer criticism and possible directions for program improvements.

Expected Standards of Performance

Competencies necessary for students who ultimately plan for a career in a mathematically-intensive field:

1) skill in programming, statistics, proofs, analysis, linear algebra, and numerical methods.
2) competence in upper-division mathematically-intense courses.
3) ability to model and analyze applied mathematics and interdisciplinary problems.

Foundational and elective coursework provides a foundation in the topics of applied mathematics and in the ability to think mathematically: to think logically; to develop models of real-world problems; to analyze these models; to quickly learn the new concepts demanded by particular models.

The Applied Mathematics Major requires a higher average GPA than the existing Mathematics Major. This is an enhanced major; interdisciplinary work is challenging because it requires a broad base of competencies and the ability to see connections between seemingly disparate fields. It is challenging for a student to complete a double major. The students that we attract from the allied fields will be the academically stronger and more industrious students. The Mathematics students who opt for the Applied Mathematics track will be more outward and forward looking in terms of their future career options.

Section V: Finance

Budget

Financial Analysis Form					
	Year 1	Year 2	Year 3	Year 4	Year 5
Students					
Projected FTE Enrollment	20	30	40	50	50
Cost Per FTE	3,500	3,500	3,500	3,500	3,500
Student/Faculty Ratio	.47	.70	.93	1.16	1.16
Projected Head Count	20	30	40	50	50
Projected Tuition					
Gross Tuition	241,433	222,118	204,349	206,392	212,584
Tuition to Program	241,433	222,118	204,349	206,392	212,584

5 Year Budget Projection					
	Year 1	Year 2	Year 3	Year 4	Year 5
Expenditures					
Salaries & Wages	6,613,018	6,083,977	5,597,258	5,653,231	5,822,828
Benefits	1,827,833	1,681,606	1,547,078	1,562,549	1,609,425
Total Personnel	8,440,851	7,765,583	7,144,336	7,215,780	7,432,253
Current Expense	200,000	184,000	169,280	170,973	176,102
Travel	15,000	13,800	12,696	12,823	13,208
Capital	20,000	18,400	16,928	17,097	17,610
Library Expense	12,000	11,040	10,157	10,258	10,566
Total Expense	8,687,851	7,992,823	7,353,397	7,426,931	7,649,739
Revenues					
Legislative Appropriation	8,096,674	7,448,940	6,853,025	6,921,555	7,129,202
Grants & Contracts	314,177	289,043	265,919	268,579	276,636
Donations	0	0	0	0	0
Reallocation	30,000	27,600	25,392	25,646	26,415
Tuition to Program	241,433	222,118	204,349	206,392	212,584
Fees	5,567	5,122	4,712	4,759	4,902
Total Revenue	8,687,851	7,992,823	7,353,397	7,426,931	7,649,739
Difference					
Revenues - Expenditures	0	0	0	0	0

Budget Comments

Given the current state of the economy, we project an 8% cut in Years 2 and 3. A turn-around is projected in the following years: increases of 1% in Year 4 and 3% in Year 5.

Funding Sources

This program utilizes the existing Departmental infrastructure. No new faculty, staff, or resources are needed.

Reallocation

No reallocation of funds will be required by the proposed program.

Impact on Existing Budgets

The current Mathematics base budget will cover this program. The existing Mathematics Majors will not be affected.

Appendix A: Program Curriculum

All Program Courses

Title	*Catalog Number*	*CH*
Calculus	MATH 1210, 1220, 2210 (or equivalent)	11
Physics Sci/Eng	PHYS 2210, 2220 (or 3210, 3220)	8
Discrete Mathematics/Intro Proofs	MATH 2200 or CS 2100	3
Linear Algebra	MATH 2270	4
Differential Equations	MATH 2280 (or 2250 & 3150)	4 or 6
Intro Programming	CS 1000 (or CS 1020, 1021, 2000)	3 or 4
Foundations of Analysis I	MATH 3210	4
Complex Analysis	MATH 3160 or 4200	2 or 4
Probability/Statistics	MATH 5010 or 3070	3 or 4
Numerical Methods	MATH 5610 or 5600 (or equivalent)	4
Core Courses	**Sub-total**	**46 to 52**
Elective Courses	**Sub-total**	**15 to 22**
	Total	**61 to 74**

Mathematics Elective Courses		*CH*
Foundations of Analysis II	MATH 3220	4
Medical Mathematics	MATH 3900	4
Intro to Number Theory	MATH 4400	3
Into to Topology	MATH 4510	3
Fluid Dynamics	MATH 4750	3
Undergraduate Research Math.	MATH 4800	3
Actuarial Mathematics	MATH 5030	3
Stochastic Processes I, II	MATH 5040, 5050	3 or 3
Statistical Inference I, II	MATH 5080, 5090	3 or 3
Mathematical Biology I, II	MATH 5110, 5120	3 or 3
Real Analysis	MATH 5210	4
Applied Fourier Analysis	MATH 5215	3
Matrix Analysis	MATH 5250	3
Modern Algebra I	MATH 5310	3
Intro ODE I, II	MATH 5410, 5420	4 or 3
Intro PDE	MATH 5440	3
Chaos & Nonlinear Systems	MATH 5470	3
Numerical Analysis I, II	MATH 5610, 5620	4 or 3
Applied Mathematics I, II	MATH 5710, 5720	3 or 3
Mathematical Modeling	MATH 5740	3
Topics in Applied Math	MATH 5750	3
Intro Math Finance I, II	MATH 5760, 5765	3 or 3

Physics Elective Courses		*CH*
Modern Optics I & II	PHYS 3410	4
Intro to Quantum Theory & Relativity	PHYS 3740	3
Principles of Thermodynamics & Statistical Mechanics	PHYS 3760	3
Classical Mechanics I	PHYS 4410	4
Classical Mechanics II	PHYS 4420	4
Theoretical Classical Mechanics & Quantum Mechanics	PHYS 5010	3
Theoretical Electricity & Magnetism & Statistical Physics	PHYS 5020	3
Introduction to Nuclear & Particle Physics	PHYS 5110	3
Introduction to Quantum Mechanics	PHYS 5450	4
Quantum Mechanics & Statistical Mechanics	PHYS 5460	4
Solid-State Physics I	PHYS 5510	3
Solid-State Physics II	PHYS 5520	3
Introduction to Disordered Solids	PHYS 5530	3
Extragalactic Astronomy & Cosmology	PHYS 5580	3

Civil & Environmental Engineering Elective Courses		*CH*
Structural Analysis I	CVEEN 3210	3
Hydraulics	CVEEN 3410	4
Structural Analysis II	CVEEN 5210	3
Quantitative Methods in Transportation Operation	CVEEN 5530	3
Nuclear Engineering I with Laboratory	CVEEN 5700	4
Applied Nuclear Engineering with Lab	CVEEN 5710	4

Electrical & Computer Engineering Elective Courses		*CH*
Fundamentals of Electromagnetics & Transmission Lines	ECE 3300	4
Fundamentals of Signals & Systems	ECE 3500	4
Introduction to Feedback Systems	ECE 3510	4
Introduction to Quantum Theory & Relativity	ECE 3740	3
Introduction to Microwave Tubes & Electron Devices	ECE 5330	3
Numerical Techniques in Electromagnetics	ECE 5340	3
Random Processes	ECE 5510	3
Digital Communication Systems	ECE 5520	3
Digital Signal Processing	ECE 5530	3
Survey of Function Approximation Methods	ECE 5550	3
Control of Electric Motors	ECE 5570	3

Biomedical Engineering Elective Courses		*CH*
Biophysics	BIOEN 5001	4
Engineering Principles in Bioinstrumentation	BIOEN 5101	4
Biomechanics	BIOEN 5201	4

Principles of Ultrasound	BIOEN 5480	3

Computer Science Elective Courses		*CH*
CS 4150: Algorithms	CS 4150	3
CS 4550: Simulation	CS 4550	3
CS 5150: Advanced Algorithms	CS 5150	3
CS 5310: Robotics	CS 5310	3
CS 5320: Computer Vision	CS 5320	3
CS 5630: Scientific Visualization	CS 5630	3

Chemical & Fuels Engineering Elective Courses		*CH*
Fluid Mechanics	CH EN 3353	3
Heat Transfer	CH EN 3453	3
Process Design	CH EN 4253	3

Mechanical Engineering Elective Courses		*CH*
Reliability Engineering	ME EN 5030	3
Quality Assurance Engineering	ME EN 5040	3
Advanced Modeling & Control	ME EN 5200	3
State Space Methods (also listed as CH EN 5203)	ME EN 5210	3
Advanced Strength of Materials	ME EN 5300	3
Vibrations	ME EN 5400	3
Intermediate Dynamics	ME EN 5410	3
Engineering Elasticity	ME EN 5500	3
Introduction to Finite Elements	ME EN 5510	3
Intermediate Thermodynamics	ME EN 5600	3
Modern Physics in Engineering	ME EN 5610	3
Intermediate Fluid Dynamics	ME EN 5700	3
Aerodynamics	ME EN 5710	3
Computational Fluid Dynamics	ME EN 5720	3
Thermal Systems Design	ME EN 5810	3

Meteorology Elective Courses		*CH*
Dynamic Meteorology	ATMOS 5110	3
Physical Meteorology	ATMOS 5210	3
Remote Sensing of the Environment	ATMOS 5410	3
Biophysical Ecology	ATMOS 5495	4
Synoptic Meteorology I	ATMOS 5530	3
Synoptic Meteorology II	ATMOS 5540	3

Materials Science & Engineering Elective Courses		*CH*
Thermodynamics of Solids	MSE 5032	4
Kinetics of Solid-State Processes	MSE 5034	3
Transport Phenomena in Materials Science & Engineering	MSE 5061	3

Semiconductor Device Physics II	MSE 5202	3
Introduction to Composites	MSE 5475	3

Metallurgical Engineering Elective Courses		*CH*
Proton Exchange Membrane Fuel Cells	MET E 5610	3
Mineral Processing I	MET E 5670	3
Mineral Processing II	MET E 5680	3
Hydrometallurgy	MET E 5700	3
High-temperature Chemical Processing	MET E 5710	4
Rate Processes	MET E 5750	3
Process Synthesis, Design, & Economics	MET E 5760	4

Mining Engineering Elective Courses		*CH*
Mine Ventilation & Air Conditioning	MG EN 5050	3
Heat Energy Systems	MG EN 5060	3
Mechanics of Materials	MG EN 5150	3
Rock Mechanics Applications	MG EN 5160	3
Introduction to Finite Element Modeling in Geomechanics	MG EN 5290	3
Hydraulic Systems	MG EN 5320	3

Geology & Geophysics Elective Courses		*CH*
Geophysics	GEO 3010	3
Structural Geology & Tectonics	GEO 3060	3
Global Geophysics	GEO 5060	3
Igneous Geodynamics	GEO 5110	3
Geochemical Thermodynamics & Transport	GEO 5120	3
Seismology I: Tectonophysics & Elastic Waves	GEO 5210	3
Seismology II: Exploration & Engineering Seismology	GEO 5220	3
Physical Fields I: Gravity, Magnetics, & Thermal Physics	GEO 5230	3
Physical Fields II: Electromagnetic Methods	GEO 5240	3
Inversion Theory & Applications	GEO 5250	3
Heat & Fluids	GEO 5310	3
Signal & Image Processing in the Geosciences	GEO 5320	3
Earthquake Seismology & Hazard Assessment	GEO 5330	3
Groundwater	GEO 5350	3
Fluid Dynamics of Earth Materials	GEO 5360	3
Solute Transport & Subsurface Remediation	GEO 5390	3

Economics Elective Courses		*CH*
Intermediate Microeconomic Analysis	ECON 4010	3
Intermediate Macroeconomic Analysis	ECON 4020	3

Finance Elective Courses	*CH*

Fundamentals of Investing	FINAN 3000	3
Financial Management	FINAN 3040	3
Introduction to Investments	FINAN 3050	3

Appendix B: Program Schedule

For each level of program completion, present, by semester, a suggested class schedule—by prefix, number, title, and credit hours. This section should preferably be presented in tables similar to the table found in Appendix A.

Applied Mathematics Major

Freshman Year: Fall

Title	*Catalog Number*	*CH*
Calculus I	MATH 1250 (or 1220 or 1270)	4
Physics Sci/Eng I	PHYS 2210 (or 3210)	4
College Writing	WRTG 2010	3
General Ed Elective 1		3
	Sub-total	**14**

Freshman Year: Spring

Title	*Catalog Number*	*CH*
Calculus II	MATH 1260 (or 2210 or 1280)	4
Physics Sci/Eng II	PHYS 2220 (or 3220)	4
Intro Programming	CS 1000 (or 1020, 1021, 2000)	3
General Ed Elective 2		3
	Sub-total	**14**

Sophomore Year: Fall

Title	*Catalog Number*	*CH*
Discrete Math	MATH 2200 (or CS 2100)	3
Linear Algebra	MATH 2700	4
General Ed Elective 3		3
American Institution Elective		3
	Sub-total	**13**

Sophomore Year: Spring

Title	*Catalog Number*	*CH*
Probability/Statistics	MATH 3070 (or 5010)	3 or 4
Differential Equations	MATH 2280	4
Foundations of Analysis I	MATH 3210	4
General Ed Elective 4		3
	Sub-total	**14 to 15**

Junior Year: Fall

Title	*Catalog Number*	*CH*
Major Elective 1		3 or 4

Major Elective 1		3	or	4
Numerical Methods	MATH 5610 (or 5600)	4		
History of Math (or other CW course)	MATH 3010	3		
	Sub-total	**13**	**to**	**15**

Junior Year: Spring

Title	*Catalog Number*	*CH*		
Complex Analysis	MATH 3160 (or 4200)	2	or	3
Numerical Analysis II	MATH 5620 (or other elective)	3	or	4
General Ed Elective 5		3	or	4
Major Elective 3		3		
	Sub-total	**11**	**to**	**14**

Senior Year: Fall

Title	*Catalog Number*	*CH*		
Elective		3		
General Ed Elective 6		3		
Diversity Elective		3	to	5
Major Elective 4		3	to	4
	Sub-total	**12**	**to**	**15**

Senior Year: Spring

Title	*Catalog Number*	*CH*		
Elective		3		
Elective		3		
Major Elective 5		3	to	4
International Elective		3		
	Sub-total	**12**	**to**	**13**
	Total	**103**	**to**	**113**

Mechanical Engineering and Applied Mathematics Double Major

Freshman Year: Fall

Title	*Catalog Number*	*CH*
Calculus I	MATH 1270 (or 1220)	4
General Ed Elective 1		3
Intro to Robotic System Design	ME EN 1000	3
General Chemistry I	CHEM 1210	4
General Chemistry Laboratory I	CHEM 1215	1 to 6
	Sub-total	**15 to 20**

Freshman Year: Spring

Title	*Catalog Number*	*CH*
Calculus II	MATH 1280 (or 2210)	4
Physics Sci/Eng I	PHYS 2210 (or 3210)	4
Statics and Strength of Materials	ME EN 1300	4
College Writing	WRTG 2010	3
	Sub-total	**15**

Sophomore Year: Fall

Title	*Catalog Number*	*CH*
Intro Unix	CS 1010	0.5
Matlab/C++	CS 1000	3
ODEs	MATH 2250	3
Physics Sci/Eng II	PHYS 2220 (or 3220)	4
Dynamics	ME EN 2080	4
Material Science	MSE 2160	3
	Sub-total	**17.5**

Sophomore Year: Spring

Title	*Catalog Number*	*CH*
Thermodynamics I	ME EN 2300	2
Numerical Techniques in Engineering	ME EN 2450	2
Linear Algebra	MATH 2270	4
Electrical & Computer Engineering for Nonmajors	ECE 2210	3
Concurrent Engineering I: Manufacturing	ME EN 2650	3
Manufacturing Laboratory	ME EN 2655	1
American Institutions		3
	Sub-total	**18**

Sophomore Year: Summer

Title	*Catalog Number*	*CH*		
Discrete Mathematics	MATH 2200 (or CS 2100)	3		
PDEs for Engineers	MATH 3150	2		
Applied Statistics	MATH 3070 (or 5010)	3	or	4
	Sub-total	**8**	**to**	**9**

Junior Year: Fall

Title	*Catalog Number*	*CH*
Thermodynamics II	ME EN 3600	3
Fluid Mechanics	ME EN 3700	4
Applied Complex Variables	MATH 3160	2
Mechatronics I	ME EN 3200	4
Strength of Materials	ME EN 3300	4
Professionalism & Ethic Seminar	ME EN 3900	0.5
	Sub-total	**17.5**

Junior Year: Spring

Title	*Catalog Number*	*CH*		
Concurrent Engineering I: Manufacturing	ME EN 2650	3		
Foundations of Analysis I	MATH 3210	4		
Mechatronics II	ME EN 3210	4		
Structured Engineering Design Methodology	ME EN 3910	3		
ME/MATH Technical Elective		3	to	6
	Sub-total	**17**	**to**	**20**

Junior Year: Summer

Title	*Catalog Number*	*CH*		
ME/MATH Technical Elective		3	to	6
Survey of Numerical Analysis	MATH 5600	4		
	Sub-total	**7**	**to**	**10**

Senior Year: Fall

Title	*Catalog Number*	*CH*		
General Ed Elective		3		
General Ed Elective		3		
General Ed Elective		3		
ME/MATH Technical Elective		3	to	6
Diversity Elective		3		
Engineering Design I	ME EN 4000	3		
	Sub-total	**18**	**to**	**21**

Senior Year: Spring

Title	*Catalog Number*	*CH*
General Ed Elective		3
General Ed Elective		3
Concurrent Engineering II	ME EN 4050	2
Engineering Design II	ME EN 4010	3
ME/MATH Technical Elective		3 to 6
ME/MATH Technical Elective		3 to 6
	Sub-total	**17 23**
	Total	**150 to 171**

Appendix C: Faculty

List current faculty within the institution, with their qualifications, to be used in support of the program. Do not include resume.

Name	*Position*	*PhD*		
		Year	*Area*	*Institution*
Adler, Fred	Professor	1991	Mathematical Ecology	Cornell University
Alali, Bacim	Assistant Professor/Lecturer	2008	Partial Differential Equations	Louisiana State University
Alfeld, Peter	Professor	1977	Approximation Theory	University of Dundee
Balk, Alexander	Professor	1988	Nonlinear Phenomena	Moscow Institute of Physics & Technology
Bertram, Aaron	Professor	1989	Algebraic Geometry	UCLA
Bestvina, Mladen	Distinguished Professor	1984	Topology	University of Tennessee
Borisyuk, Alla	Assistant Professor	2002	Mathematical Biology	New York University
Bressloff, Paul	Professor	1988	Mathematical Biology	Kings College
Bromberg, Ken	Associate Professor	1998	Topology	UC Berkeley
Brooks, Robert	Professor	1963	Topological Algebra	Louisiana State University
Cashen, Christopher	Assistant Professor/Lecturer	2007	Group Theory	University of Illinois - Chicago
Cherkaev, Andrej	Professor	1979	Applied Mathematics	Leningrad Polytechnical Institute
Cherkaev, Elena	Professor	1988	Applied Mathematics	Leningrad University
Ciubotaru, Dan M.	Assistant Professor	2004	Lie Groups	Cornell University
Conus, Daniel	Assistant Professor	2008	Probability Theory	Swiss Federal Institute of Technology
de Fernex, Tommaso	Associate Professor	2002	Algebraic Geometry	University of Illinois - Chicago
Dillies, Jimmy	Assistant Professor/Lecturer	2006	Algebraic Geometry	University of Pennsylvania
Dobson, David	Professor	1990	Applied Mathematics	Rice University
Docampo Alvarez, Roi	Assistant Professor/Lecturer	2009	Algebraic Geometry	University of Illinois - Chicago
Du, Jian	Research Assistant Professor	2008	Mathematical Biology	SUNY Stonybrook
Easton, Robert W.	Assistant Professor/Lecturer	2008	Algebraic Geometry	Stanford
Ethier, Stewart	Professor	1975	Applied Probability	University of Wisconsin
Fogelson, Aaron	Professor	1982	Mathematical Physiology	New York University
Golden, Ken	Professor	1984	Applied Mathematics	New York University
Guevara-Vasquez, Fernando	Assistant Professor/Lecturer	2008	Differential Equations	Rice University
Gustafson, Grant	Professor	1968	Ordinary Differential Equations	Arizona State University
Hacon, Chris	Professor	1998	Algebraic Geometry	UCLA
Hecht, Henryk	Associate Chair	1974	Lie Groups	Columbia University
Horvath, Lajos	Professor	1982	Probability & Statistics	Szeged University
Huang, Hsiang-Ping	Research Assistant Professor	1999	Functional Analysis	National Tsing Hua University
Jiang, Yungfeng	Assistant Professor/Lecturer	2007	Number Theory	University of British Columbia

Joseph, Mathew	Assistant Professor/Lecturer	2009	Stochastics	University of Wisconsin - Madison
Keener, Jim	Distinguished Professor	1972	Applied Mathematics	CalTech
Khoshnevisan, Davar	Professor	1989	Probability & Statistics	UC Berkeley
Kim, Peter Sehoon	Research Assistant Professor	2007	Mathematical Biology	Stanford University
Korevaar, Nick	Professor	1981	Differential Geometry, PDEs	Stanford University
Lakuriqi, Enkeleida K.	Assistant Professor/Lecturer	2008	Algebraic Geometry	University of Pennsylvania
Lee, Yuan-Pin	Associate Professor	1999	Algebraic Geometry	UC Berkeley
Lin, Joyce	Assistant Professor/Lecturer	2009	Fluid Mechanics	UNC Chapel Hill
Lodh, Remi Shankar	Assistant Professor/Lecturer	2008	Algebraic Geometry	Rheinische Friedrich-Wilhelms Universitaet
Macri, Emanuele	Assistant Professor/Lecturer	2006	Stability Conditions	SISSA, Trieste
Milicic, Dragan	Professor	1973	Lie Groups	University of Zagreb
Milton, Graeme	Distinguished Professor	1985	Materials and Fluids	Cornell University
Niziol, Wieslawa	Associate Professor	1991	Algebraic Geometry	Princeton University
Onofrei, Daniel T.	Assistant Professor/Lecturer	2007	Partial Differential Equations	Worceter Polytechnic Institute
Paupert, Julien	Assistant Professor/Lecturer	2007	Geometry	Universite Pierre-et-Marie-Curie
Rassoul-Agha, Firas	Associate Professor	2003	Probability Theory	New York University
Roberts, Paul	Professor	1974	Commutative Algebra	McGill University
Savin, Gordan	Professor	1988	Automorphic Forms	Harvard University
Schmitt, Klaus	Professor	1967	Nonlinear Analysis, Differential Equations	University of Nebraska
Singh, Anurag	Associate Professor	1998	Commutative Algebra	University of Michigan
Sircar, Sarthok	Research Assistant Professor	2009	Mathematical Biology	University of South Carolina
Smale, Nathan	Professor	1987	Differential Geometry	UC Berkeley
Stirling, Spencer	Assistant Professor/Lecturer	2008	Math and Physics	University of Texas at Austin
Tao, Jing	Assistant Professor/Lecturer	2009	Geometry	University of Illinois - Chicago
Taylor, Joe	Professor	1964	Group Representations	Louisiana State University
Toledo, Domingo	Professor	1972	Differential Geometry	Cornell University
Toth, Damon J. A.	Research Assistant Professor	2007	Mathematical Biology	University of Washington
Trapa, Peter	Associate Professor	1998	Lie Groups	MIT
Treibergs, Andrejs	Professor	1980	Differential Geometry	Stanford University
Trombi, Peter	Professor	1970	Lie Groups	University of Illinois
Tucker, Don	Professor	1958	Differential Equations, Functional Analysis	University of Texas
Wortman, Kevin	Assistant Professor	2003	Topology	University of Chicago
Yao, Lingxing	Research Assistant Professor	2008	Mathematical Biology	University of North Carolina
Zajac, Mark	Research Assistant Professor	2008	Mathematical Biology	Notre Dame University
Zhu, Jingyi	Associate Professor	1989	Computational Fluid Dynamics	New York University

Appendix D: Sample of Current Employers of Undergraduate Alumni

Allegiance Inc
Alpine School District
American Pacific
ATG Inc
Big Horn County School District #4
BluePoint Pool Service, LLC
Boise School District
Bonneville Power Administration
C.R. Bard (Bard Access Systems)
California Air Resources Board
Calypso Technology
Church of Jesus Christ of Latter-Day-Saints
Clark County School District
Clark Planetarium
COMPanion Corp.
Connecticut Technical High School System
Davis School District
Deutsche Bank Securities
EMIA
Eons, Inc.
Equation Consulting
Exploratorium
Fitchburg State College
General Dynamics
General Electric
Goldman Sachs
Google
Grace School District
Granite School District
Harford Community College
HealthInsight
Henderson Trauman, PC
IBM
iCrossing
IM Flash Technologies
Ingenix
InterContinental Hotels Group
Jacobs
Jordan School District
Kohler Co.
Lincoln Financial Advisors
Mercer
Merit Medical
Metropolitan State University
Michael F. Pingree M.D. P.C.
MITRE Corporation
Models for Learning, Inc.
Mound Valley Electric
Murray City School District
Nemean Networks
New York University
Niche Associates
North Slope Borough School District
OnDialog, Inc.
Provo School District
Raytheon
Reliant Energy
Rowland Hall St Marks
Salt Lake Community College
Salt Lake County Library System
Stress Engineering Services
Summit County Park City
Technicolor
The Boeing Company
The Hartford Financial Services
The McGillis School
The Modellers
The Ritz-Carlton Hotel Company
The Winter Sports School in Park City
Travelers
U.S. Department of State
University of Utah Hospital
University of California, Santa Barbara
University of Chicago, Department of Statistics
University of Rochester Medical Center
Department of Orthopedics
University of Utah
University of Utah School of Medicine
University of Utah, Department of Pediatrics
University of Wisconsin
US Army Combined Arms Center
US Government
US NAVY
Utah Department of Health
Utah Department of Technology Services
Utah Dept of Health
UVU
Wake Forest University Baptist Medical Center
Walgreens
Wasatch Electric

Waterford School
Xapio
Zion Bancorporation