

Mathematics & Computer Science

The Whitworth Mathematics & Computer Science Department offers a solid foundation in mathematics, statistics, computer programming, data science, databases, networks and software engineering. Talented faculty members in the department's interdisciplinary programs help students learn to apply mathematics and computing skills in the fields of natural science, business and industry, and the social and behavioral sciences.

Believing that God wants all individuals to strive to reach their full potential, department faculty members challenge motivated students by providing them the opportunity to participate in activities that go beyond the traditional classroom experience. These involve state-of-the-art research and development, service-learning projects and teaching-assistant opportunities. Through theory, practice and the pursuit of knowledge, students develop the problem-solving skills that will help them succeed in their professions and in life. The learning outcomes of this major prepare the student to do the following:

Mathematics

- Demonstrate an appropriate level of problem-solving skills using analytical reasoning.
- Communicate mathematical ideas in writing.
- Communicate mathematical ideas orally.
- Demonstrate necessary skills for independent ongoing learning.
- Understand the connections between the student's faith and/or worldview and the theory and practice of mathematics, ethical decision-making, and vocation.
- Understand the role of abstraction in solving problems and proving theorems.
- Work effectively on teams comprising individuals with different skills, habits and backgrounds.

Computer Science

- Demonstrate an appropriate theoretical foundation for computer science.
- Develop software-engineering proficiency.
- Cultivate problem-solving and critical-thinking skills.
- Reinforce interpersonal skills and effective teamwork.
- Demonstrate proficiency in communication skills – written, verbal and presentation.
- Gain an international perspective and the ability to work cross-culturally.
- Understand the need for sound, ethical decision-making and the social and legal implications of those decisions. Consider how faith and/or worldview can inform one's vocation and professional practices.

Computer Science Honors Program

The intent of the honors program is to provide motivated students with the social and academic activities necessary to foster their growth as individuals and their commitment to excellence and service to others. Students enrolled in the program must complete a major in computer science. To qualify for graduation as a Whitworth Computer Science Honors Program graduate, candidates must complete the following requirements by the end of their senior year. Each requirement will be documented in the student's portfolio.

- Apply for admission to the honors program after completing CS 172.
- Maintain an overall cumulative GPA of 3.5 or above.
- Complete the professional-learning requirement by fulfilling each of the following activities:
 - Join either the Association for Computing Machinery or the IEEE Computer Society.
 - Regularly attend ACM/IEEE Computer Society meetings.
 - Participate in the planning and presentation of a minimum of two ACM meetings.
 - Document meeting plans and presentations in the portfolio.
 - Participate in ACM/IEEE activities (social events, special-topics seminars, etc.).
- Complete the service requirement by participating in at least one of the following areas:
 - As a teaching assistant for computer science courses
 - As a research assistant for a computer science faculty member
 - As a lab assistant for the general computing labs

- As a technician for the Whitworth Computing Services Department
- By participating in related service-learning projects
- Complete in a satisfactory manner an internship and/or research assistantship.
- Complete and defend a senior research project.
- Complete one semester of CS 499W, Research Methods.

Requirements for a Mathematics - General Major, B.A. (42-44)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
CS 171	Computer Science I	3
CS 172	Computer Science II	3
or CS 251	Introduction to Data Science	
MA 256	Elementary Probability and Statistics	3
Two of the following:		6
MA 317	Complex Variables	
MA 357	Mathematical Statistics I	
MA 410	Abstract Algebra I	
MA 430W	Graph Theory and Combinatorics	
or MA 430	Graph Theory & Combinatorics	
MA 440	Real Analysis I	
Three of the following not chosen above:		9-11
MA 281	Differential Equations	
MA 306H	Nonlinear Dynamics and Chaos	
MA 328 & MA 329	Math History Study Abroad Prep and Math History	
MA 350	Numerical Analysis	
MA 355	Mathematical Modeling with Biological Applications	
MA 357	Mathematical Statistics I	
MA 358W	Mathematical Statistics II	
MA 360	Number Theory	
MA 362	Cryptography	
MA 365	Geometry	
MA 410	Abstract Algebra I	
MA 411	Abstract Algebra II	
MA 440	Real Analysis I	
MA 441	Real Analysis II	
MA 499W	Research Methods	
CS 473	Advanced Algorithm Design and Analysis	
EN 356 & EN 358	Mathematical Methods I and Mathematical Methods II	
MA 396 courses may apply toward this requirement. See advisor for details.		
Complete one writing-intensive course.		

Requirements for a Mathematics - Education Major, B.A. (42-43)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4

MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
CS 171	Computer Science I	3
CS 172	Computer Science II	3
or CS 251	Introduction to Data Science	
MA 256	Elementary Probability and Statistics	3
MA 365	Geometry	3
One of the following:		3
MA 357	Mathematical Statistics I	
MA 410	Abstract Algebra I	
MA 440	Real Analysis I	
Three of the following not chosen above:		9-10
MA 281	Differential Equations	
MA 306H	Nonlinear Dynamics and Chaos	
MA 317	Complex Variables	
MA 328 & MA 329	Math History Study Abroad Prep and Math History	
MA 350	Numerical Analysis	
MA 355	Mathematical Modeling with Biological Applications	
MA 357	Mathematical Statistics I	
MA 358W	Mathematical Statistics II	
MA 360	Number Theory	
MA 362	Cryptography	
MA 410	Abstract Algebra I	
MA 411	Abstract Algebra II	
MA 430W or MA 430	Graph Theory and Combinatorics Graph Theory & Combinatorics	
MA 440	Real Analysis I	
MA 441	Real Analysis II	
MA 396 courses may apply toward this requirement. See advisor for details.		
Complete one writing-intensive course.		

Requirements for a Mathematics Major, B.S. (55-57)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
CS 171	Computer Science I	3
CS 172	Computer Science II	3
or CS 251	Introduction to Data Science	
Other coursework:		
MA 281	Differential Equations	3
MA 294	Career and Vocation Seminar	1
Three of the following:		9
MA 410	Abstract Algebra I	
MA 411	Abstract Algebra II	
MA 440	Real Analysis I	
MA 441	Real Analysis II	
Six of the following not chosen above:		18-20
MA 306H	Nonlinear Dynamics and Chaos	

MA 317	Complex Variables
MA 328 & MA 329	Math History Study Abroad Prep and Math History
MA 350	Numerical Analysis
MA 355	Mathematical Modeling with Biological Applications
MA 357	Mathematical Statistics I
MA 358W	Mathematical Statistics II
MA 360	Number Theory
MA 365	Geometry
MA 410	Abstract Algebra I
MA 411	Abstract Algebra II
MA 430W or MA 430	Graph Theory and Combinatorics Graph Theory & Combinatorics
MA 440	Real Analysis I
MA 441	Real Analysis II
MA 362	Cryptography
MA 499W	Research Methods
EN 356 & EN 358	Mathematical Methods I and Mathematical Methods II

Complete one writing-intensive course.

Core Courses in Applied Mathematics (31)

Required for all Applied Mathematics Majors, B.S.

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 278	Discrete Mathematics	3
MA 281	Differential Equations	3
MA 294	Career and Vocation Seminar	1
MA 330	Linear Algebra	3
MA 355	Mathematical Modeling with Biological Applications	3
MA 357	Mathematical Statistics I	3
MA 358W	Mathematical Statistics II	3

Requirements for an Applied Mathematics, General Track, B.S. (58)

Core Courses in Mathematics		31
CS 171	Computer Science I	3
CS 172 or CS 251	Computer Science II Introduction to Data Science	3
MA 306H	Nonlinear Dynamics and Chaos	3
MA 317	Complex Variables	3
MA 350	Numerical Analysis	3
EN 356	Mathematical Methods I	2
EN 358	Mathematical Methods II	2
PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		
PS 153L or PS 154L	General Physics II Lab Near Space Research Project	1

Recommended:

MA 440	Real Analysis I	3
MA 441	Real Analysis II	3

Requirements for an Applied Mathematics, Data Science Track, B.S. (58-59)

Core Courses in Mathematics		31
CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 251	Introduction to Data Science	3
CS 273	Data Structures	3
CS 274	Ethic, Soc & Leg Issues in CS	3
CS 374	Database Management	3
CS 457	Artificial Intelligence	3
One of the following:		3-4
CS 471 & CS 472	Software Engineering Seminar and Software Engineering	
CS 499W/MA 499W	Research Methods	
One of the following:		3
CS 355	Introduction to Bioinformatics	
CS 473	Advanced Algorithm Design and Analysis	

Requirements for an Applied Mathematics, Mathematical Economics Track, B.S (58)

Core Courses in Mathematics		31
CS 171	Computer Science I	3
CS 172	Computer Science II	3
or CS 251	Introduction to Data Science	
EC 210	Principles of Microeconomics	3
EC 211	Principles of Macroeconomics	3
EC 320	Intermediate Microeconomic Analysis	3
EC 321	Intermediate Macroeconomic Analysis	3
EC 402	Econometrics	3
Six credits from the following:		6
Upper division economics courses		
MA 390	Internship	
or MA 490	Internship	

Requirements for an Applied Mathematics, Mathematical Finance Track, B.S. (58)

Core Courses in Mathematics		31
CS 171	Computer Science I	3
CS 172	Computer Science II	3
or CS 251	Introduction to Data Science	
BU 230	Financial Accounting and Analysis	3
BU 231	Managerial Accounting	3
BU 357	Financial Management	3
BU 377	Financial Statement Analysis	3
BU 467	Advanced International Corporate Finance	3
BU 477	FORAD: Multi-National Finance	3
One of the following:		3
BU 387	Financial Institutions & Markets	

MA 390 Internship
or MA 490 Internship

See your advisor regarding prerequisites

Requirements for a Computer Science Major, B.S. (64)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 273	Data Structures	3
CS 274	Ethic, Soc & Leg Issues in CS	3
CS 270	Applications Development	3
CS 314	,Serving Humanity with Computing	3
CS 363	Algorithms and Complexity	3
CS 385	Computational Hardware	3
CS 470	Software Engineering Vocation	3
CS 472	Software Engineering	3
CS 474W	Advanced Systems Theories	3
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 278	Discrete Mathematics	3
Any one 200 level Comp Sci elective		3
Any two 300 level Comp Sci electives		6
Any one 300 or 400 level Math elective		3
One science series, either Biology (BI-140 & BI-143 + labs), Chemistry (CH-161 & CH-181 + labs), or Physics (PS-151 & PS-153 + labs)		8

Requirements for Interdisciplinary Computer Science Major, B.A. (48)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 250	Digital Humanities	3
CS 270	Applications Development	3
CS 274	Ethic, Soc & Leg Issues in CS	3
CS 314	,Serving Humanity with Computing	3
CS 350W	Applied Digital Humanities	3
CS 470	Software Engineering Vocation	3
CS 472	Software Engineering	3
Take one 200-level computer science elective		3
Take two 300-level computer science electives		6
Take one Structured Thinking course:		3
MA 278	Discrete Mathematics	
PH 201	Logic	
PH 301	Symbolic Logic	
Complete 9 upper division credits outside Computer Science, Mathematics, Core, independent study, and teaching assistantships		9
Submit a program plan in consultation with a Computer Science advisor and another academic area advisor		

Requirements for a Bioinformatics Major, B.S. (68-69)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 273	Data Structures	3

CS 355	Introduction to Bioinformatics	3
CS 374	Database Management	3
CS 471	Software Engineering Seminar	1
CS 472	Software Engineering	3
CS 473	Advanced Algorithm Design and Analysis	3
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 256	Elementary Probability and Statistics	3
MA 278	Discrete Mathematics	3
BI 140 & 140L	General Biology I: Genes, Cells and Evolution and General Biology I: Genes, Cells and Evolution Lab	4
BI 143 & 143L	General Biology II: Ecology and Evolution and Ecology and Evolution Lab	4
CH 161	General Chemistry I	3
CH 181	General Chemistry II	3
CH 271	Organic Chemistry I	3
CH 278	Organic Chemistry II	3
Choose one of the following:		3-4
BI 363 & 363L	Genetics and Lab: Genetics	
BI 399 & 399L	Molecular Genetics and Molecular Genetics Lab	
BI 355	Introduction to Genomics	
Choose two of the following:		6
MA 281	Differential Equations	
MA 355	Mathematical Modeling with Biological Applications	
MA 357	Mathematical Statistics I	
MA 430W or MA 430	Graph Theory and Combinatorics Graph Theory & Combinatorics	
Note: MA 281 is a prerequisite for MA 355		
Choose one of the following:		3
CH 401	Biochemistry I	
BI 311	General Biochemistry	
Recommended Chemistry Courses		
CH 161L	General Chemistry I Lab	
CH 181L	General Chemistry II Lab	
CH 271L	Organic Chemistry I Lab	
CH 278L	Organic Chemistry II Lab	
CH 401L	Biochemistry I Lab	
Recommended Physics Courses		
PS 151	General Physics I	
PS 151L	General Physics I Lab	
PS 153	General Physics II	
PS 153L or PS 154L	General Physics II Lab Near Space Research Project	
Complete one writing-intensive course.		

Requirements for a Human-Computer Interaction Major, B.A. (53-55)

Required Computer Science courses		21
CS 171	Computer Science I	

CS 172	Computer Science II	
CS 274	Ethic, Soc & Leg Issues in CS	
CS 344	Human-Computer Interaction	
Computer Science Electives		
Choose 3 of the following:		9
CS 273	Data Structures	
CS 301	Internet Applications Development	
CS 320	Quality Assurance in Software,Development	
CS 371	Windows Applications Development	
CS 372	Java Applications Development	
CS 376	Technology Management	
NOTE: With a CS advisor's approval, other CS 396 courses may also count as electives		
Recommended to take one or more of the following:		
CS 313	Networks	
CS 357	Computer Graphics	
CS 360	Math/CS Study Program Abroad	
Art Requirements		18
AR 101	Drawing I	
AR 124	Adobe Creative Suite and Indesign	
AR 222	Design Fundamentals	
AR 323	Typography I	
AR 324	Graphic Design I	
AR 326	Web Design I	
Art Electives		
Choose 2 of the following:		6
AR 210	Painting I	
AR 227	Introduction to Time-Based Art Making	
AR 231	Digital Photography I	
Writing Intensive Requirement		
Choose one of the following:		3
AR 437W	Professional Practice for Artists and Designers	
CS 475W	Operating Systems	
CS 499W	Research Methods	
Internship Requirement		
Choose one of the following:		1
CS 390	Internship	
AR 390	Internship	
Senior Capstone Project Requirement		
Choose one of the following:		3-6
CS 470 & CS 472	Software Engineering Vocation and Software Engineering	
AR 499H	Senior Exhibition Project	

Requirements for a Mathematics Minor (21)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
One of the following:		3

MA 256	Elementary Probability and Statistics	
MA 281	Differential Equations	

Requirements for an Applied Mathematics Minor (21-22)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3
Two of the following:		6-7
MA 306H	Nonlinear Dynamics and Chaos	
MA 317	Complex Variables	
MA 330	Linear Algebra	
MA 350	Numerical Analysis	
MA 355	Mathematical Modeling with Biological Applications	
MA 357	Mathematical Statistics I	
MA 358W	Mathematical Statistics II	
CS 251	Introduction to Data Science	
CS 355	Introduction to Bioinformatics	
EN 356 & EN 358	Mathematical Methods I and Mathematical Methods II	

Requirements for a Mathematics Education Minor (22)

(meets endorsement requirements)

This minor can be completed only by students receiving education certification.

All endorsements subject to change; see School of Education for updated requirements.

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 256	Elementary Probability and Statistics	3
MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
MA 365	Geometry	3
One of the following:		2
EDU 341	Mathematics: Elementary / Middle School Methods (K-9)	
EDU 454	Mathematics in Secondary School	

Note: Students pursuing elementary certification will also take MA 221.

Requirements for a Computer Science Minor (18)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
Two 200 level Computer Science courses		6
Two 300 or 400 level Computer Science courses		6

NOTE: A maximum of 3 credits total of Computer Science Independent Study, Teaching Assistantship, or Internship can be applied to this minor if approved in advance by the CS department.

Requirements for a Communication & Technology Minor (21)

Foundation: Take both courses		6
COM 125	Writing for Mass Media	

or COM 126H	Writing for Digital Media	
CS 171	Computer Science I	
Electives:		12
Six credits of Computer Science courses, 200 level or higher		
Six credits of Communication Studies courses, 200 level or higher		
Capstone: Choose one of the following		3
COM 482	Media Innovation	
CS 250	Digital Humanities	

CS Courses

CS 125 Business Information Systems 3

Introduction to business application software. Students will cover business application software, concepts including Microsoft Excel, Access and, very introductory macro programming for these applications. The course will start with advanced Excel topics, proceed to Access and finish with, introductory macro programming concepts. Students will implement and present a business-related, project using either Excel or Access. Fall and, spring semesters.

CS 171 Computer Science I 3

Introduction to problem-solving, abstraction and, design using the C++ language. Special emphasis, on development of algorithms and writing programs, in a structured form. Recommended: MA 108 or, higher. Fall and spring semesters.

CS 172 Computer Science II 3

Problem-solving, abstraction and design using the, C++ language. Special emphasis on pointer, variables, recursion, and file handling. Introduction to data structures (including stacks, queues, linked lists, and binary trees), classes, and object-oriented programming. Prerequisite: CS, 171 with a minimum grade of C-. Fall and spring, semesters.

CS 178A Excel Basics 1

For continuing studies students only. An, introduction to the use of Excel for business, students, this course prepares students to, understand the basics of Microsoft Excel. This, course uses case-based tutorials to engage, students in applying skills to real-world, situations, making concepts relevant. The course, enhances critical thinking by using the program to, solve problems and create reports. This course is, a 1 credit weekend workshop.

CS 178B Excel Skill Building 1

This workshop is for students whose proficiency in, Microsoft Office includes fundamental Excel, skills. Excel is the software tool that is, essential in today's workforce and students will, benefit from building deeper skills for this, software product. This workshop is especially, important for students who are seeking a career in, business or administration and desire to learn, specific functions, like pivot tables.

CS 250 Digital Humanities 3

The contemporary world is a place full of complex, problems, big data and beautiful things. This, course challenges how we think about engaging with, the technical elements of a digital age, while, leveraging the craft of human connection and, creative flourishing. In this course we will be, exploring and engaging with a multidisciplinary, lens of how people create, analyze, develop, visualize, process and exist in a highly connected, and computer-enabled context. Students will be, asked to pull their own experience and, perspectives from the full breadth of Whitworth's, academic and cocurricular areas. We will also be, learning from experts in diverse fields about how, they are applying digital tools to bear on novel, and important projects. Fall Semester.

CS 251 Introduction to Data Science 3

Project-based course that explores topics and, methodologies of data science using R and Python. Prerequisite: CS 171 with a minimum grade of C-. Spring semester.

CS 270 Applications Development	3
A foundation for developing software applications,,including graphical user interfaces, event,handling, exception handling, multithreading, and,API programming, and more. Any programming,language could be used in this development,,including C#, Java, Rust, Flutter, and more.,Prerequisite: CS 172. Jan Term.	
CS 273 Data Structures	3
An introduction to stacks, queues, recursion,,linked lists, trees, graphs, sorting, and,searching. Emphasis on algorithm analysis.,Prerequisite: CS 172 with a minimum grade of C-.,Fall and spring semesters.	
CS 274 Ethical, Social & Legal Issues in,Computer Science	3
Students will research, discuss, and argue a,variety of current ethical issues related to,computer science. Students will also learn about,the professional organizations' supporting,computer scientists and understand each,organization's code of ethics. Finally, students,will understand how to be professionals in,computer science. Prerequisite: CS 171. Fall and,Spring semesters.	
CS 278 Computer Organization and Assembler,Programming	3
Computer organization and the structure of,digital computers. Work in MASM assembler,language,programming on a PC computer. Prerequisite: CS,172. Fall and spring semesters.	
CS 294 Career and Vocation Seminar	1
Students in this course will learn about different,career and vocational paths related to mathematics,and computer science and go about pursuing a,specific path. Further, students will explore how,their own faith and worldview can interact with,their discipline through vocation discussions.,Also listed as MA 294. Fall semester.	
CS 301 Internet Applications Development	3
An information technology course designed as an,introduction to the tools and methods of Internet,applications development. Special emphasis on,Internet programming languages and the design of,interactive WWW documents. Prerequisite: CS 171.,Also listed as FVNS 301. Jan Term.	
CS 313 Networks	3
Fundamental concepts of computer network theory,,topologies, architecture, and protocol layers.,Provides a foundation in current networking,technology for local area networks, wide area,networks, and the Internet. Prerequisite: CS 273.,Fall semester, odd years.	
CS 314 Serving Humanity With Computing	3
We, as technologists, are not called to merely,create things, but we are called to make good,things. This course challenges students to give,attention to the outcomes of the technical work,they do by developing, creating, maintaining, and,working on Community Engaged Learning projects. In,,alignment with Whitworth's mission, this course,puts direct practice to 'serve humanity.' A,significant amount of work will be put into a,single project that is intended to act as a,resume-filling opportunity to gain important,applied experience.	
CS 315 Distributed Scalable Computing	3
Introduction to concepts of distributed and,parallel processing paradigms. Project development,using a variety of programming technologies.,Development in Windows and Linux Operating,Systems. Prerequisite: CS 273. Fall semester, even,years.	
CS 320 Quality Assurance in Software,Development	3
Students in this course will cover techniques in,testing computer software. Topics will include:,History of software and testing, ad-hoc testing,methods, test plans, formal testing methods,,automation and testing tools, and security,testing. Students will have a firm foundation in,testing as well as improved skills as software,developers. Prerequisite: CS 172. Fall semester,,even years.	

CS 333H Introduction to Programming Contests 1

This course consists of research, practice, and preparation for the annual regional Pacific, Northwest programming competition. This course aims to develop and improve personal techniques for solving difficult algorithmic problems under time pressure. To encourage students to give back to their professional communities in the future, they will each write a contest problem of their own design. Periodic offering.

CS 344 Human-Computer Interaction 3

An introduction to the human-computer interaction (HCI). Students will learn definitions of HCI, the history of computer user interfaces, interaction models, and user-centered design and task-analysis. Students will also learn the principles and guidelines for implementing user interfaces using dialogs, voice input, and multi-modal interfaces. Fall semester, odd years.

CS 350W Applied Digital Humanities 3

Each student will identify and work on a development project that merges their humanities-related interests with Computer Science. This course will guide students through the fun and exciting process of digging deep into both fields in order to uncover what others have discovered and apply these findings to their original and creative project. This will be followed up with experimentation and evaluation. The course guides students in a highly accessible way through the process of doing this research and implementation. This course is an opportunity for students to dig deep into both disciplines with the intention of developing and/or using appropriate computer-based tools in creative and useful ways to further academic knowledge within their chosen application field. Students are encouraged to fully engage with both disciplines while embarking on this journey.

CS 355 Introduction to Bioinformatics 3

This is an interdisciplinary course that integrates molecular biology, biophysics, statistics and computer science. The course provides an introduction to the computational tools, techniques and algorithms that are used by biologists, geneticists and computational chemists to gain a deeper understanding of the fundamental processes that govern biological organisms. Recommended: CS 172. Spring semester, odd years.

CS 357 Computer Graphics 3

Hands-on experience with state-of-the-art computer graphics rendering and display techniques. Emphasis on texture mapping, ray tracing, and 2-D and 3-D object manipulation and animation. Prerequisite: CS 273. MA 330 highly recommended. Also listed as EP 357. Spring semester, odd years.

CS 359 Introduction to Technology & Culture, Study Abroad Program Preparation 1

Required for those students taking part in CS 360; Technology & Culture: Study Abroad Program in Jan Term. In addition to preparing students to experience a foreign culture, this course studies technology from global, economic, religious, gender and intercultural viewpoints. The course serves to build community among the program participants and prepares them for international travel, intercultural sensitivity, and cross-cultural experiences. Taken in preparation for CS 360. Permission of instructor. Fall semester, odd years.

CS 360 Technology & Culture: Study Abroad, Program 3

A Jan Term study program focusing on the interactions between technology and culture. Students will broaden their cross-cultural understanding by exploring the role of technology in another culture as well as the influence the culture has had on technology. Students will participate in university exchanges, visit vital industries, travel to important historical and cultural sites, attend different churches, and engage in other rich cross-cultural experiences, such as service projects. Prerequisite: CS 359. Destination country varies, e.g. Ireland/Britain, India, etc. Jan Term, even years.

- CS 363 Algorithms and Complexity** 3
 In the course students will work to develop the, critical thinking and problem-solving skills, necessary to research, analyze, design, and, develop advanced algorithmic solutions that can, deal with the complexity of real-world problems. A, diversity of disciplines benefit from algorithms, that computer scientists discover and develop., This course focuses on advanced algorithmic, techniques used in solving a wide range of, problems with far-reaching applications. The, course starts by outlining the mathematical, techniques needed to analyze algorithms, it then, moves on to a survey of important algorithms for, dealing with complexity. Students gain practical, experience applying data structures to these, problems. Students end the course by developing, and applying these techniques to a real-world, problem.
- CS 370 Programming Languages** 3
 Concepts and paradigms of programming languages., Topics include: history of programming, languages, language-design principles, syntax,, semantics, data types, control structures,, object-oriented languages, functional programming,, logical programming, and parallel programming., Includes laboratory experience in comparing, paradigms and behaviors of different languages., Prerequisite: CS 273. Fall semester, odd years.
- CS 371 Windows Applications Development** 3
 A foundation for developing conventional Windows, applications using object-oriented and, component-based programming techniques. Topics, include component-based development, network, applications, graphical user interface components,, exception handling, and components for web, applications. Prerequisite: CS 273. Jan Term, even, years.
- CS 372 Java Applications Development** 3
 A foundation for developing conventional, applications in the object-oriented Java, programming language. Topics include Java, programming constructs, multithreading, graphical, user interface components, exception handling, and, Java networking. Prerequisite: CS 172. Jan Term,, odd years.
- CS 373 Digital Logic Design** 3
 Combinatorial and sequential logic circuit design, and analysis. Hands-on experience with modern, design tools, hardware description languages, (e.g. VHDL), and FPGA devices. Topics include, number systems, minimization, multiplexers,, decoders, encoders, code converters, comparators, parity, circuits, and shifters. Recommended: MA, 278 and PS 153. Fall semester.
- CS 374 Database Management** 3
 Comprehensive introduction to design and, development of databases and database, applications. Combined approach of relational, database theory and application development using, popular database management systems. May also, include current trends such as XML databases, data, warehousing, and web interfaces. Prerequisite: CS, 273. Fall and spring semester.
- CS 375 Mobile Application Development** 3
 A foundational approach to developing applications, for smart mobile devices, including smart phones, and tablets. Students will learn what standard, conventions are currently used (e.g. UI design, principles) and how to address limitations of, developing for mobile devices. Prerequisite: CS, 172. Spring semester, even years.
- CS 376 Technology Management** 3
 The course examines theory and practice in, management of information technology and software, projects in internationally competitive, organizations. Study includes leadership of, cross-functional personnel and international, teams, innovative strategies in technical, "cultures", analysis of organizational, structures, project marketing, quality assurance,, and general project management. Prerequisite: CS, 125 or CS 171. Fall semester, even years.
- CS 378H How to Make Darn-Near Anything** 3
 Have you ever had a great idea for a product? Have, you ever wanted to be part of a startup, technology? Students in this course learn the, steps and skills needed to design, build, and, market a new product based on their own interests., Topics include programming skills, user experience, design, testing, marketing, and product promotion., Spring semester, odd years

CS 379 Hacking and Cybersecurity	3
Introduction into the dynamic and critical study,of computer security. This course engages students,directly with the field utilizing hands-on,penetration testing (pen test, white hat hacking,,red teaming), discussion of contemporary,vulnerabilities and best practices, studies of,past bad actors, viruses and exploitations, as,well as taking a step back and considering the,complicated ethical space of cybersecurity.,Prerequisite: CS 273. Spring semester, even,years.	
CS 385 Computational Hardware	3
Our current world relies heavily on,microprocessors, they are built into the multitude,of appliances and devices that we use daily.,Competent computer scientists must understand how,these devices work in order to understand the,implications to society of the correct operation,of these devices. This course covers the,fundamentals of binary arithmetic, assembly,language programming, and the programming of,input/output devices. Emphasis placed on,understanding how assembly instructions support,higher level languages and operating systems.,Other topics may include security and efficiency,of operation.	
CS 390 Internship	1-6
CS 401 Computer Architecture	3
Digital computer system design and analysis.,Topics include: synchronous/asynchronous,sequential machines, parallel structures,,pipelining, and input/output. Includes laboratory,experience in microprocessor design and,architecture. Prerequisite: CS 373. Recommended:.,CS 278. Spring semester.	
CS 454 Computer Science Methods	2
Introduction to computer science curriculum,,instruction, and assessment in the P-12 classroom.,Development of lessons and unit plans based on,best-practice research and ITSE Standards for,Computer Science. Periodic Offering.	
CS 457 Artificial Intelligence	3
Introduction to artificial intelligence concepts.,Foundational theory includes intelligent agents,,search, first-order logic, knowledge,representation, planning, probabilistic reasoning,,and genetic programming. Projects and programming,of robotics as autonomous agents. Prerequisite: CS,273. Spring semester, even years.	
CS 459 Managing Technology	3
For continuing studies students only. Examines,information and skills needed by managers to make,effective and informed decisions in regard to,technological issues. Components will include,technological literacy and innovations, as well as,strategic technology management.	
CS 470 Software Engineering Vocation	3
Preparation course for CS 472, Software,Engineering. The student will learn material to,prepare them for developing a complex software,system, including working with clients and in,teams, software engineering tools, and software,engineering methodologies. Guest speakers from the,software industry will present in class about,their careers to give students a variety of,perspectives on how to deliver software,successfully.	
CS 471 Software Engineering Seminar	1
Software Engineering Seminar covers material,designed to prepare students for CS472, Software,Engineering. Students will learn techniques and,skills to help them succeed in designing and,building a project in a team setting for a real,client, including Agile Development practices,,Software Engineering tools, and professionalism.,Students will also hear from multiple guest,speakers from the software industry. Fall,semester.	
CS 472 Software Engineering	3
Designed as an intensive, project-oriented, senior,capstone course. Topics include software system,analysis and design, software project management,and life cycle, software tools, documentation, and,maintenance. Prerequisites: CS 273 and CS 374.,Senior class standing. Spring semester.	

CS 473 Advanced Algorithm Design and Analysis	3
Advanced study of the design and analysis of,algorithms. Topics include advanced complexity,analysis, advanced recursive algorithms, graph,theory algorithms, optimization problems,,algorithms related to number theory, and other,contemporary topics. Analysis of problems,associated with searching and sorting.,Prerequisites: CS 273 and MA 278. Fall semester.	
CS 474W Advanced Systems Theories	3
This course provides an introductory foundation,,for understanding advanced system theory. A,mixture of theory and application provide the,background for understanding how the operating,system serves as the layer interfacing between,application software and computer hardware.,Theoretical concepts of OS are essential for a,computer scientist, bridging gaps of your CS,undergraduate education. The course also includes,,strengthening of Linux environment navigation.	
CS 475W Operating Systems	3
Introduction to the theory of basic operating,systems. Includes memory management, scheduling,,resource management, synchronization, process and,thread management, security, and concurrent,processes. Prerequisites: CS 273 and CS 278.,Spring semester.	
CS 496 Research Assistantship	1-3
Opportunity to work closely with a professor on a,research project. Prerequisite:,CS 273. Periodic offering.	
CS 499W Research Methods	3
Examination of research methods and a foundation,,for the Computer Science research program. An,opportunity to challenge the advanced and,motivated student. Includes readings,,dissemination methods research projects in current,topics, and working closely with faculty in a,mentoring relationship. Prerequisite: CS 172 or,instructor permission. Periodic offering.	
MA Courses	
MA 107 Math for Liberal Arts	3
Mathematics for the liberal arts student. An,introduction to contemporary mathematics and its,role in society. Current and past applications of,mathematics in the real world will be examined.,Topics may include management science, coding,information, geometric applications, and,statistics. Fall and spring semesters.	
MA 108 Finite Mathematics for Social Sciences	3
A study of mathematical applications to business,,economics, social sciences, and personal finance.,Topics include mathematics of finance, systems of,linear equations, matrices and linear programming.,TI 84 calculator required. Fall and spring,semesters.	
MA 130 College Algebra	3
Focus on building a foundation in algebra before,precalculus. Emphasis on solving various types of,equations and inequalities, and understanding,polynomial, rational, exponential, and logarithmic,functions and their graphs. May also included,,systems of equations and inequalities in two,variables. Fall and spring semesters.	
MA 150 Pre-Calculus	4
Preparation for the calculus sequence. Solving,systems of equations, exponential, logarithmic and,trigonometric functions, and equations with,applications in the social and natural sciences.,Prerequisite: MA 130 with a minimum grade of C-.,Fall and spring semesters.	
MA 158 Calculus for Social Sciences	3
Limits, rates of change, differentiation, graphing,and optimization, integration, and business,applications. Prerequisite: MA 108. Periodic,Offering.	
MA 171 Calculus I	4
Functions, limits, and differentiation. Emphasis,on solving problems numerically and graphically,,as well as algebraically. Prerequisite of MA 150,with a minimum grade of C-. Fall and spring,semesters.	

MA 172 Calculus II	4
Integration, applications of integration, techniques of integration, and infinite series. Prerequisite: MA 171 with a minimum grade of C-. Fall and spring semesters.	
MA 220 Structure of Elementary Mathematics	3
For continuing studies students only. This course is designed for the prospective elementary or middle school teacher. It focuses on development of number systems, vocabulary, and symbolism in the present-day use of arithmetic, algebra, geometry, and statistics.	
MA 221 Math for Elementary School Teachers I	3
For the prospective elementary teacher, includes an introduction to problem solving, set operations, and their application to arithmetic, numeration systems, arithmetic, algebra, and number theory as related to elementary school mathematics curriculum. Does not apply toward the math general education requirement except for candidates for elementary teaching certificates. Fall and spring semesters.	
MA 222 Math for Elementary School Teachers II	3
Course designed for future elementary school teachers. Covers topics of probability, descriptive statistics, geometry, measurement, and motion geometry. Does not apply toward the math general education requirement except for candidates for elementary teaching certificates. Prerequisite: MA 221. Fall and spring semesters.	
MA 256 Elementary Probability and Statistics	3
Descriptive statistics, probability, probability distributions, hypothesis testing, confidence intervals, correlation, and regression. TI 84, calculator required. Fall and spring semesters, and Jan Term.	
MA 256H Honors Elementary Probability and Stats	3
Using explorative data analysis and R to understand data using descriptive statistics, probability distributions, hypothesis testing, confidence intervals, correlation, and regression. Jan Term.	
MA 273 Calculus III	4
Multivariable calculus, including partial differentiation, vector analysis, and multiple integrals. Prerequisite: MA 172 with a minimum grade of C-. Fall and spring semesters.	
MA 278 Discrete Mathematics	3
A study of the foundations of mathematics, (including sets, logic, proof writing, relations, and functions), algorithms, combinatorics, and graph theory. Focus will be on developing logic and problem-solving skills involved in higher mathematics. Prerequisite: MA 171. Fall and spring semesters.	
MA 281 Differential Equations	3
A study of ordinary differential equations and their use in mathematical models in the physical, biological and social sciences, and in economics. Covers analytic and numerical solution techniques. Prerequisite: MA 172. Fall and spring semesters.	
MA 294 Career and Vocation Seminar	1
Students in this course will learn about different career and vocational paths related to mathematics and computer science and go about pursuing a specific path. Further, students will explore how their own faith and worldview can interact with their discipline through vocation discussions. Also listed as CS 294. Fall semester.	
MA 306H Nonlinear Dynamics and Chaos	3
Analytical and numerical analysis of nonlinear systems of difference equations and differential equations. Analysis of these systems using bifurcations and phase planes. Understanding chaotic systems in discrete and continuous systems. Prerequisite: MA 281. Fall semester, odd years.	

MA 317 Complex Variables	3
Introduction to complex numbers, analytic and elementary functions, and integration, series, residues and poles, and conformal mapping. Prerequisite: MA 273. MA 278 can also be taken as co-requisite. Spring semester, odd years.	
MA 328 Math History Study Abroad Prep	1
Required preparatory course for students planning on participating in the Jan term Math History Study Abroad Program. Includes background reading in the history of mathematics, information on specific sites visited while abroad, research for presentation to be given on site in Europe. Prerequisite: MA 172. Fall semester, even years.	
MA 329 Math History	3
Study of the historical and cultural contexts of mathematics through readings, film and site visits in Europe. Prerequisite: MA 172 and MA 328. Jan, Term, odd years.	
MA 330 Linear Algebra	3
Vector spaces, linear transformations, matrices, determinants, Euclidean spaces, systems of equations, and eigenvalues. Prerequisites: MA 172, and a minimum grade of C- in either MA 278 or MA 281. Fall and spring semesters.	
MA 350 Numerical Analysis	3
Elementary discussion of errors, polynomial interpolation, quadrature, linear systems of equations, solutions of non-linear equations, Numerical differentiation, integration, solutions to differential equations. Prerequisites: MA 273, MA 330, and CS 172. MA 278 strongly recommended. Spring semester, even years.	
MA 355 Mathematical Modeling with Biological Application	3
Explore the modeling process using various mathematical methods which may include topics such as differential and difference equations, nonlinear analysis, bifurcation theory, statistical models, and dimensional analysis. Possible areas of application may include population dynamics, neuroscience, epidemiology, cardiac dynamics, cellular dynamics, and selected special topics. We will explore connections of biological models to the fields of physics, economics, and chemistry among others. Prerequisite: MA 281. Fall semester, even years.	
MA 357 Mathematical Statistics I	3
A theoretical study of probability, random variables, their distributions and characteristics of distributions. TI 84 calculator required. Prerequisites: MA 273, and a minimum grade of C- in MA 278. Fall semester.	
MA 358W Mathematical Statistics II	3
A theoretical study of confidence intervals and estimators, test of hypothesis, ANOVA, regression, and correlation, and non-parametric methods. TI 84 calculator required. Prerequisite: MA 357. Spring semester, even years.	
MA 360 Number Theory	3
Divisibility, congruence, prime numbers, Diophantine equations, quadratic reciprocity, and number theoretic functions. Emphasis on mathematics education and problem-solving. Prerequisites: MA 172 and a minimum grade of C- in MA 278. Periodic offering.	
MA 362 Cryptography	3
This course will provide an overview of the mathematical and historical concepts related to cryptography. Students will explore the theoretical foundations of both classical and modern cryptographic systems, as well as relevant topics in number theory. Both the making and breaking of these systems will be covered. Prerequisite: MA 278 with a minimum grade of C-. Jan Term, odd years.	

MA 365 Geometry	3
A development of Euclidean geometry with attention, paid to axiomatic systems. Consideration of, transformational geometry and non-Euclidean, geometries. Required for high school mathematics, teachers. Prerequisites: MA 171 and a minimum, grade of C- in MA 278. Fall semester, even years.	
MA 390 Internship	1-4
MA 410 Abstract Algebra I	3
Study of group theory, including cyclic groups,, isomorphisms, permutation groups and applications., Emphasis on theory and proof. Prerequisites: MA, 172 and a minimum grade of C- in MA 278. Fall, semester, odd years.	
MA 411 Abstract Algebra II	3
Rings, integral domains, homomorphisms, and, fields. Emphasis on theory and proof., Prerequisite: MA 410. Spring semester, even years.	
MA 430 Graph Theory & Combinatorics	3
Study of paths and circuits, trees, planarity and, duality, coloring of graphs, digraphs and, networks, permutations and combinations,, multinomial theorem, generating functions,, principle of inclusion and exclusion, and, recurrence relations. Prerequisites: MA 172 and a, minimum grade of C- in MA 278. Also listed as MA, 430W. Spring semester.	
MA 430W Graph Theory and Combinatorics	3
Study of paths and circuits, trees, planarity and, duality, coloring of graphs, digraphs and, networks, permutations and combinations,, multinomial theorem, generating functions,, principle of inclusion and exclusion, and, recurrence relations. Prerequisites: MA 172 and a, minimum grade of C- in MA 278. Spring semester.	
MA 440 Real Analysis I	3
Sets and functions, properties of the real, numbers, completeness axiom, elements of point-set, topology, and sequences. Prerequisites: MA 273 and, a minimum grade of C- in MA 278. Fall semester,, even years.	
MA 441 Real Analysis II	3
Limits of functions, continuity, differentiation,, Riemann integration, and infinite series of, numbers and functions. Prerequisite: MA 440., Spring semester, odd years.	
MA 490 Internship	1-6
MA 496 Research Assistant	1-3
Opportunity to work closely with a professor on a, research project. Periodic offering.	
MA 499W Research Methods	3
Examination of research methods and a foundation, for the Mathematics or Mathematics education, research program. An opportunity to challenge the, advanced and motivated student. Includes readings,, dissemination methods research projects in current, topics, and working closely with faculty in a, mentoring relationship. Prerequisite: CS 172 or, instructor permission. Also listed as CS 499W., Periodic offering.	