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 352	Mathematical Biology	
MA 355	Mathematical Modeling	
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 352	Mathematical Biology	
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	Graph Theory and Combinatorics	
or MA 430	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 352	Mathematical Biology	
MA 355	Mathematical Modeling	
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 Mathematics (37)

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	3
MA 357	Mathematical Statistics I	3
MA 358W	Mathematical Statistics II	3
CS 171	Computer Science I	3
CS 172	Computer Science II	3

Requirements for an Applied Mathematics, General Track, B.S. (61)

Core Courses in Mathematics		37
MA 306H	Nonlinear Dynamics and Chaos	3
MA 317	Complex Variables	3
MA 350	Numerical Analysis	3
MA 352	Mathematical Biology	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	General Physics II Lab	1

or PS 154L	Near Space Research Project	
Recommended:		
MA 440	Real Analysis I	3
MA 441	Real Analysis II	3

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

Core Courses in Mathematics		37
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		37
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 an Applied Mathematics, Data Science Track, B.S. (58-59)

Core Courses in Mathematics		37
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	

Core Courses in Computer Science (28)

Required for the International Project Management, Business, Network Systems, and Computer Science Major, B.S. options. The Bioinformatics and Human-Computer Interaction majors have different computer science core requirements.

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 278	Computer Organization and Assembler Programming	3
CS 374	Database Management	3
CS 471	Software Engineering Seminar	1
CS 472	Software Engineering	3
CS 475W	Operating Systems	3
One of the following:		3
CS 370	Programming Languages	
CS 371	Windows Applications Development	
CS 372	Java Applications Development	
Recommended:		
CS 294	Career and Vocation Seminar	

Requirements for a Computer Science Major, B.A. (57) International Project Management Option

Core Courses in Computer Science		28
CS 376	Technology Management	3
BU 274	Principles of Management	3
BU 230	Financial Accounting and Analysis	3
BU 311W	Principles of International Business	3
MA 256	Elementary Probability and Statistics	3
COM 398	Intercultural Communication	3
Completion of an international study experience		3
CS 360	Technology & Culture: Study Abroad Program (or other prior approved international education experiences such as semester-abroad or year-abroad programs, international internship experience.)	
A World Languages & Cultures 201 course or demonstrated second-year language proficiency.		4
One of the following:		4
MA 150	Pre-Calculus	
MA 158	Calculus for Social Sciences	
MA 171	Calculus I	
Recommended:		
CS 301	Internet Applications Development	
CS 313	Networks	
BU 231	Managerial Accounting	

Requirements for a Computer Science Major, B.A. (56) Business Option

Core Courses in Computer Science		28
CS 376	Technology Management	3
BU 230	Financial Accounting and Analysis	3
BU 274	Principles of Management	3
BU 231	Managerial Accounting	3

BU 406	Business Planning and Entrepreneurship	3
or BU 463	Project Management	
EC 210	Principles of Microeconomics	3
EC 211	Principles of Macroeconomics	3
MA 256	Elementary Probability and Statistics	3
One of the following:		4
MA 150	Pre-Calculus	
MA 158	Calculus for Social Sciences	
MA 171	Calculus I	
Recommended:		
CS 301	Internet Applications Development	
CS 313	Networks	

Requirements for a Computer Science Major, B.A. (59) Network Systems Option

Core Courses in Computer Science		28
CS 313	Networks	3
CS 315	Distributed Scalable Computing	3
CS 373	Digital Logic Design (CS 373 is a pre-requisite for CS 401.)	3
CS 379	Hacking and Cybersecurity	3
CS 401	Computer Architecture	3
MA 256	Elementary Probability and Statistics	3
Three upper-division computer science courses		9
One of the following:		4
MA 150	Pre-Calculus	
MA 158	Calculus for Social Sciences	
MA 171	Calculus I	
Recommended:		
CS 376	Technology Management	

Requirements for a Computer Science Major, B.S. (65)

Core Courses in Computer Science		28
CS 373	Digital Logic Design	3
CS 401	Computer Architecture	3
CS 473	Advanced Algorithm Design and Analysis	3
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 278	Discrete Mathematics	3
MA 330	Linear Algebra	3
PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
One of the following:		3
CS 313	Networks	
CS 357	Computer Graphics	
CS 457	Artificial Intelligence	
One of the following:		3

MA 350	Numerical Analysis	
MA 410	Abstract Algebra I	
MA 430W	Graph Theory and Combinatorics	
or MA 430	Graph Theory & Combinatorics	
Recommended:		
MA 256	Elementary Probability and Statistics	
MA 273	Calculus III	
CS 315	Distributed Scalable Computing	
CS 499W	Research Methods	

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 one of the following:		3
MA 281	Differential Equations	
MA 430W	Graph Theory and Combinatorics	
or MA 430	Graph Theory & Combinatorics	
MA 357	Mathematical Statistics I	
Choose one of the following:		3
MA 352	Mathematical Biology	
MA 355	Mathematical Modeling	
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	General Physics II Lab	
or PS 154L	Near Space Research Project	

Complete one writing-intensive course.

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

Required Computer Science courses		12
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	Technology & Culture: Study Abroad Program	

Art Requirements		18
AR 101	Drawing I	
AR 120	2-D Design	
AR 124	Adobe Creative Suite and Indesign	
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 220	3-D Design	
AR 227	Introduction to Time-Based Art Making	
AR 231	Digital Photography I	
AR 426	Web Design II	

Writing Intensive Requirement

Choose one of the following:		3
AR 365W	Contemporary Art Seminar	
CS 499W	Research Methods	
CS 475W	Operating Systems	

Internship Requirement

Choose one of the following:		3
CS 390	Internship	
AR 390	Internship	
Senior Capstone Project Requirement		
Choose one of the following:		2-4
CS 471 & CS 472	Software Engineering Seminar 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 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 (22)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 273	Data Structures	3
CS 278	Computer Organization and Assembler Programming	3
CS 301	Internet Applications Development	3
CS 374	Database Management	3
One of the following:		4
MA 150	Pre-Calculus	
MA 158	Calculus for Social Sciences	
MA 171	Calculus I	

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
CS 378H	How to Make Darn-Near Anything	
COM 482	Media Innovation	

Requirements for an Information Technology Minor (21)

CS 171	Computer Science I	3
CS 172	Computer Science II	3
CS 313	Networks	3
CS 374	Database Management	3
Three of the following:		9
CS 301	Internet Applications Development	
CS 315	Distributed Scalable Computing	
CS 371	Windows Applications Development	
CS 372	Java Applications Development	
CS 379	Hacking and Cybersecurity	

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 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 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 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 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 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 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, even years.

CS 390 Internship 1-4

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 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 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 Basic Concepts in Modern Mathematics 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 4

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. Prerequisite: MA 107 or 500+ SAT. 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- or 500+ SAT. Fall and spring semesters.

MA 158 Calculus for Social Sciences 4

Limits, rates of change, differentiation, graphing and optimization, integration, and business applications. Prerequisites: MA 108 or 550 or above on the SAT. Spring semesters.

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- or 600+ SAT. 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, 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 171, MA 172 & 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 352 Mathematical Biology 3

This course covers the following areas of biology: population growth, neuroscience, epidemiology, predator-prey models, cardiac dynamics and selected special topics. Mathematical topics will include: discrete and continuous differential equations, nonlinear analysis, bifurcation theory. Prerequisite: MA 281. Periodic offering.

MA 355 Mathematical Modeling 3

Exploring the modeling process of real world applications using various mathematical methods which may include difference equations, statistical models, graph theory, game theory, differential equations, and dimensional analysis. Possible areas of application may include physics, biology, or economics, among others. Prerequisites: MA-281 and CS-171. Fall, 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 and 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, even 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.