Mathematics and Computer Science

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In a society becoming ever more mathematical and computerized, the department seeks to provide courses which introduce all students to the ideas of mathematics and computer science. The department also provides advanced courses for those wishing to specialize in one of these areas. We teach these technical concepts in a manner consistent with the liberal arts aim of the College and in a way that encourages the student to use these abilities to serve others.

Mathematics

The purpose of the mathematics curriculum is to present the basic concepts and methods in modern mathematics, to develop the student's ability to think critically using the axiomatic method, and to apply these ideas to other disciplines. This major provides the mathematical background for students preparing for (1) certification in secondary education; (2) graduate study in a mathematical discipline; (3) a career in an area using mathematics, such as engineering, economics, statistics, or actuarial science.

Students who complete a Mathematics major are granted a Bachelor of Science degree unless they request a Bachelor of Arts degree.

Requirements for a major in Mathematics are 34 hours beyond MATH 231, including MATH 232, 245, 331, 341, 351, and 494. All majors must include at least one applied mathematics course selected from MATH 333 Differential Equations, MATH 385 Topics in Applied Math, or CSI 345 Data Structures and Algorithms. (Secondary Education students meet this applied mathematics requirement with MATH 363 Probability and Statistics.) Supporting course requirements include (i) either PHYS 231 or CSCI 243 and (ii) either CSCI 235, CSCI 243, or CSCI 245 (CSCI 243 cannot count for meeting both supporting courses).

Students planning to teach mathematics on the secondary level must meet certification

requirements listed in the Education Department section of this catalog and must choose MATH 343, 362, and 363 as their elective courses.

Students preparing for graduate study should take MATH 441 and 451.

Requirements for a minor in Mathematics are 20 hours of mathematics courses beyond MATH 101.

Mathematics Courses (MATH)

MATH 101. Quantitative Skills. Topics to develop the student's quantitative competency skills, including estimation, use of calculators and computers, basic algebra, statistics, counting and probability, graphs and tables, problem-solving skills. Prerequisite: Quantitative Skills exam. (2)

MATH 115. College Algebra. Functions and transformations, linear and quadratic inequalities, systems of equations, complex numbers, polynomial and rational functions, sequences, mathematical induction, and the binomial theorem. Prerequisite: SAT Math subject test score of 500 or above, ACT Math score of 22 or above, or SAT Math score of 500 or above. (2)

MATH 125. Mathematics for Elementary and Middle Grade Education**.** Numeration systems, set theory, the whole number, integer number, and rational number systems with associated axioms, operations, relations, and counting principles. Topics from geometry, measurement, logic, and probability and statistics. For elementary education majors only. Prerequisite: Quantitative competency.

MATH 205. Great Ideas of Mathematics. Consideration in an historical context of some significant discoveries in mathematics and ways these discoveries have influenced our knowledge of natural phenomena and the development of culture. Not available to mathematics majors. Prerequisite: Quantitative competency. (2)

MATH 218. Introduction to Calculus with Precalculus Mathematics. Coverage of topics from precalculus mathematics that are needed for the study of calculus, along with an introduction to the main ideas of calculus. Intended as additional preparation for MATH 221 or 231, or as an intuitive introduction to calculus. Not open to those with prior study of calculus.

MATH 221. Applied Calculus. This course covers the ideas of calculus with the applications as the motivation. Covering more topics, the course differs from MATH 231 with less depth of coverage. Topics include limits, definitions and applications of the derivative and integral, and applications of the calculus to functions of several variables. Prerequisite: Precalculus mathematics. This course is not normally open to mathematics majors, and only one of MATH 221 and MATH 231 may be taken for credit. Alternate years.

MATH 231. Calculus I. The limit concept. Definitions of the derivative and integral of functions of one variable, with basic properties and applications. Transcendental functions, methods of integration, and first order differential equations. Three lectures, two hours drill. Prerequisite: MATH 218, or previous calculus experience. (2 or 4)

MATH 232. Calculus II. Infinite series, polar coordinates. Three-dimensional geometry and vector algebra, functions of two and three variables, partial differentiation, multiple integration, and line integrals. Three lectures, two hours drill. Prerequisite: MATH 231 with a minimum grade of C-, departmental validation examination, or advanced placement. (2 or 4)

MATH 245. Linear Algebra. Starting with solving systems of linear equations, matrix algebra is

used to explore vector spaces and linear transformations. Emphasis is given to bases, dimension, eigenvectors, and orthogonality. Prerequisite: MATH 231. (2 or 4)

MATH 263, Introduction to Statistics. An introduction to statistics, sampling theory, and statistical decision making from a solid mathematical basis for non-mathematics majors. Topics treated include discrete and continuous distributions, moments, hypothesis testing, correlation and multiple correlation, regression (linear, non-linear,multivariate),ANOVA, multi-variate analysis with cluster analysis and principle components, contingency tables with tests for independence, sampling theory, and rudimentary non-parametric statistics. Students will use selected software packages for data processing and anyalysis. Prerequisite: MATH 221 or MATH 231.

MATH 295. Topics in Mathematics. Selected topics in mathematics. Cannot be applied to a mathematics major. Prerequisite: Quantitative competency. (1 or 2).

MATH 301. Colloquium. An informal weekly meeting of department faculty and majors to discuss items of current interest. It will include individual research and oral presentation of material. May be retaken once when a different topic is offered. Prerequisite: MATH 231. (1)

MATH 324. Methods of Teaching Mathematics. Theories and methods for teaching mathematics at the middle school or secondary level. Topics include cooperative learning, classroom management, and creative teaching ideas. Consideration of current math technology and curriculum standards. Required of mathematics majors in WheTEP, prior to student teaching. Prerequisite: Acceptance to WheTEP. (2).

MATH 331. Vector Calculus. Vector algebra, properties of transformations, curves and surfaces, line, surface, and volume integrals, Green's, Stokes', and the divergence theorems. Prerequisite: MATH 232. (2)

MATH 333. Differential Equations. An introduction into the theory, methods of solution, and selected applications of ordinary differential equations. Topics include first order equations, second order linear equations with constant coefficients, numerical analysis of ordinary differential equations, Laplace Transforms, series solutions, and systems of differential equations. Prerequisite: MATH 232. (2 OR 4)

MATH 341. Modern Algebra. Basic algebraic properties of groups, rings, and fields. Euclidean construction problems. Prerequisite: MATH 245 or consent of instructor.

MATH 343. Discrete Mathematics. Basic and advanced topics selected from sets and logic, Boolean algebra, functions, algorithms, relations and recursion, combinatorics, graph theory, nature of proof, number theory and cryptography. Prerequisite: MATH 231 or consent of instructor.

MATH 351. Analysis I. Derivation of the properties of continuity, differentiability, integrability, and convergence by use of the limit concept and basic axioms of the real number field. Prerequisite: MATH 232 and 245, or consent of instructor.

MATH 362. Geometry. Selected topics from finite, affine, projective, Euclidean and non-Euclidean geometry from both the axiomatic and transformation approaches. Prerequisite: MATH 245. Alternate years. Offered 2008-09.

MATH 363. Probability and Statistics I. Discrete and continuous probability including conditional probability. Independence and Bayes' Theorem. Expected value, variance, and moments of a random variable. Distributions, methods for identifying distributions, and the Central Limit Theorem. Statistical hypothesis testing, errors, correlation, regression equations, and

analysis of variance. Prerequisite: MATH 232.

MATH 364. Mathematical Modeling. A course designed to develop an appreciation for, an understanding of, and a facility in the use of mathematics in the social and life sciences. Particular problems in political science, ecology, psychology, sociology, economics, anthropology, epidemiology, and business management provide the motivation for the development of tools and techniques employed throughout applied mathematics. Prerequisite: MATH 232 and 245.

MATH 365x. Mathematical Physics. See PHYS 365. Alternate years.

MATH 385. Topics in Applied Mathematics. A topic selected for each semester in which the course is offered that focuses upon a particular applied mathematics discipline in a way that brings important mathematical theory and methods to practice. Possibilities include Numerical Analysis, Dynamical Systems, Applied Linear Algebra, Math Modeling, Cryptography, Number Theory, or Applied Discrete Math. Prerequisite: MATH 232 and MATH 245 or consent of instructor.

MATH 394. Seminar. Study of a topic of mathematics not covered in the other courses. May be retaken when different topics are offered. Prerequisite: consent of instructor. Offered on demand. Last offering was topology. (2)

MATH 441. Algebra II. Review of groups, rings, fields, and mappings. Advanced group theory, leading to the Sylow theorems. Field extensions, leading to the Galois theory. Selected topics from ring theory. Prerequisite: MATH 341. Alternate years. Offered 2008-09. (2 or 4)

MATH 451. Analysis II. Study of topics from real and complex analysis. Prerequisite: MATH 351. Alternate years. Offered 2008-09. (2 or 4)

MATH 463. Probability and Statistics II. Starting from a review of probability distributions and their underlying assumptions and features, this course focuses upon selected problems from experimental design with the mathematical models and methods used to solve them. Topics will be chosen from parametric and non-parametric hypothesis testing, ANOVA, partial and multiple correlation methods, regression, curve fitting, and Monte Carlo simulation. Prerequisite: MATH 363. Alternate years. Offered 2009-10. (2 or 4)

MATH 485. Advanced Topics in Mathematics. Selected topics from advanced mathematics, such as number theory. Prerequisite: MATH 245. Alternate years. Offered 2009-10. (2 or 4)

MATH 494. History and Foundations of Mathematics. A study of the historical development of the main ideas in mathematics, with an emphasis on the nineteenth-century developments in axiomatics, logic, number and set theory which led to the twentieth-century developments in the philosophy and foundations of mathematics. Prerequisites: MATH 341 and 351.

MATH 495. Problems in Mathematics. Independent study for senior majors. A maximum of two hours can be applied to the major. (1-4)

MATH 496. Internship. Graded pass/fail. Prerequisite: junior or senior standing with Mathematics major.

Computer Science

The curriculum in computer science presents the fundamentals of computation—the science

underlying the computing technologies that have become so pervasive in contemporary society. This foundation better prepares one to make choices about how those technologies can and should be applied, at the organizational and societal levels, as well as individually. The deeper study required of a computer science major provides experience in the discipline's methods of analysis and problem-solving. Furthermore, experimental work throughout the curriculum allows majors to develop skills in the design, analysis, and development of software systems, and so provides excellent preparation for a computing-related career, as well as for graduate study in computer science or engineering.

In addition to the general college computing resources described in the Academic Facilities section of this catalog, the department has its own computer lab in Armerding Hall which provides both Unix and Windows environments. Several department servers augment this lab. The local area network provides connectivity between campus labs, servers, all residential housing, and the Internet.

Students who complete a Computer Science major are granted a Bachelor of Science degree unless they request a Bachelor of Arts degree.

Requirements for a major in Computer Science are CSCI 235, 243, 245, 335, 345, 351, 494, and 12 additional hours of computer science above 300. Supporting requirements are PHYS 231, MATH 231, and another four-hour mathematics course numbered higher than 231.

Students preparing for graduate study should take CSCI 445 and at least one of CSCI 365 or CSCI 455.

Requirements for a minor in Computer Science are 20 hours of computer science selected from courses numbered 200 or above.

Computer Science Courses (CSCI)

CSCI 135. Computer Literacy. An introduction to personal computing emphasizing major applications (word processing, spreadsheets, databases, and/or presentations). Other topics include the history and organization of computers, effective use of the Internet, web page design, electronic library resources, and ethical issues of technology. (2)

CSCI 211. Applications of Computing. Survey of the use of computing tools such as spreadsheets, databases, mathematical tools, multimedia, and the World Wide Web for problem solving. Prerequisite: CSCI 135 or consent of instructor. (2)

CSCI 215. Web Design and Programming. An introduction to the design and preparation of pages and sites for the World Wide Web. Topics include principles of design, markup and formatting of pages, tools for developing web content, and use of embedded scripting on client and/or server. No prior programming experience is required. (2)

CSCI 231. Introduction to Computer Science Concepts. A survey of the fundamental ideas and methods in the science underlying computation. Classroom activities and hands-on laboratory investigations emphasize working with both data and process at different levels of abstraction, from logic and circuits to algorithms and formal machines. History of computing and its relation to other disciplines. Societal and ethical issues raised by computing technologies. (Two hours lecture with two hours lab) (2, lin)

CSCI 233. Introduction to Scientific Computing. Introduction to programming and computer analysis of data for scientific applications. Scripting and treatment of numerical issues are

integrated into the content stream.

CSCI 235. Programming I: Problem Solving Algorithms, compilers, and programs in a modern, object-oriented programming language. Types, control structures, modularity, and recursion. Object-oriented fundamentals, encapsulation, interface implementation, and subtype polymorphism. Exceptions, libraries, and file I/O**.**

CSCI 243. Discrete Mathematics and Functional Programming. Sets, logic, the nature of proof, induction, algorithms, algorithm correctness, relations, lattices, functions, and graphs. Functional programming and recursion using the ML programming language.

CSCI 245. Programming II: Object-Oriented Design. A continuation of CSCI 235. Searching and sorting algorithms, their analysis and instrumentation. Software development methodology including revision control and API production. Object-oriented programming, subclassing, inheritance, overriding, and class hierarchies. Abstract data structures including linked lists, stacks, queues, and trees. Software design patterns. Introductory system programming, data representation, and computer organization. Prerequisites: CSCI 235 or department approval.

CSCI 295. Computer Programming. Learning and/or gaining facility with a programming language. A variety of needs are met for learning languages and/or completing specific programming projects. The course is tutorial in format: students complete a series of assignments, or a specified project, working under the general supervision of an assigned faculty member. Students may register more than once, but are limited to a total of four hours. Departmental approval is required for languages to be used and projects to be undertaken. Prerequisites: CSCI 245 or department approval. (1-4)

CSCI 301. Computer Science Colloquium. A departmental forum in which current developments and interdisciplinary topics relating to computer science are discussed. Students who have not completed the prerequisites are encouraged to attend as observers but may not register for credit. Students may enroll more than once, for a maximum total of 2 hours credit. Prerequisites: Department approval. (1)

CSCI 335. Software Development. Principles and practices of software development including design patterns, validation and testing, coordination of team projects. Introduction to data bases and user interface design. Professional issues in computing. Prerequisite: CSCI 243 and CSCI 245.

CSCI 345. Data Structures and Algorithms. Stacks, queues, lists, trees, hashes, basic manipulation algorithms, sorting and searching, information hiding, abstract data types, memory management. Prerequisites: CSCI 243 and CSCI 245.

CSCI 351. Introduction to Computer Systems. An introduction to low-level systems issues from the perspective of the programmer. Representation of both data and program as produced by a compiler; hardware support for memory, input/output, and parallelism; fundamental ideas in operating systems and networking. Prerequisite: CSCI 245.

CSCI 355. Computer Architecture. Computer architecture, low-level C programming, assembly language, parallel programming. Macro definitions, information encoding, addressing techniques, parameter passing, call frames, optimization, and parallel organization. Prerequisite: CSCI 351. Alternate years.

CSCI 361. Computer Graphics. Introduction to graphical programming environments, OpenGL libraries. Rendering three-dimensional images, transformations, windowing, clipping, shading, and image enhancements. Prerequisite: CSCI 345. Alternate years. Offered 2009-10.

CSCI 365. Programming Language Concepts. Formal definition of programming languages including syntax and semantics; recursive descent parsing, data structures, control constructs, recursion, binding times, expression evaluation, compiler implementation; symbol tables, stacks, dynamic allocation, compiler compilers. Prerequisite: CSCI 335 and CSCI 351. Alternate years. Offered 2009-10.

CSCI 371. Database Management Systems. History and motivation for database systems. Entity-relationship model, relational model, SQL overview, keys. Relational algebra and calculus, SQL nested, aggregate, cursor queries, null values. Storage of data on disk systems, file organization, hash and tree indexing. Schema refinement and normal forms. Web-based access of database systems. Transaction processing. Object-oriented databases. Prerequisite: CSCI 335 and CSCI 345. Alternate years. Offered 2008-09.

CSCI 375. Artificial Intelligence. Definition of intelligence, representation of knowledge, search strategies, heuristics, control of process, natural language processing, vision systems, expert systems, robotics. Integrative issues of AI and Christianity. Prerequisite: CSCI 345. Alternate years. Offered 2009-10.

CSCI 394. Seminar. Selected topics in Computer Science at each offering, including such subjects as object-oriented design, e-commerce, human computer interface, networking services. May be taken again when a different topic is offered. Prerequisite: Departmental approval. (2 or 4)

CSCI 395. Computer Science Project. This course consists of a special project supervised by a member of the computer science faculty (CSCI 395 serves as the capstone course for computer science minors). Project proposals must be submitted by the student, along with a proposed number of credit hours, and approved by the department prior to enrollment in the course. Prerequisites: CSCI 335. (2-4)

CSCI 445. Analysis of Algorithms. An introduction to algorithmic efficiency and to techniques for the design and analysis of efficient algorithms. General topics include review of asymptotics, algorithm design techniques (such as divide-and-conquer, dynamic programming, and greedy algorithms), graph algorithms, and NP-completeness. Prerequisite: CSCI 345. Alternate years. Offered 2008-09.

CSCI 455. Operating Systems. Dynamic process activation, system structure, abstract machine, kernels, performance evaluation, memory management, processor management, time management, recovery procedures, file systems, security, scheduling, device management, networks. Prerequisites: CSCI 335 and CSCI 351. Alternate years. Offered 2008-09.

CSCI 494. Social and Ethical Issues in Computing. Study of the ways in which the computer and communications revolution is changing society. Develop an awareness of and sensitivity to the ethical issues that arise in computer science and related professions. Prerequisite: Senior standing in the major. (2)

CSCI 495. Independent Study. An individually adapted study of any aspect of computing science or its relationship to other fields of study. (1-4)

CSCI 496. Internship. Graded pass/fail. Prerequisite: junior or senior standing with Computer Science major. May repeat once for a total of 4 hours. (2 or 4)

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