INTERDISCIPLINARY COMPUTATIONAL DATA-ENABLED SCIENCE AND ENGINEERING

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Faculty (Interdisciplinary, listed by their Specialized Track)

Computational Biology and Bioinformatics

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Faculty

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Dr. H.C. Huang, Assistant Professor
Dr. R. Kafoury, Associate Professor
Dr. J. Stevens, Professor
Dr. T. Taylor, Assistant Professor

Computational Science and Engineering

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Faculty/Computer Science

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Dr. F. C. Dancer, Assistant Professor
Dr. S. Hong, Associate Professor
Dr. J. Jackson, Associate Professor
Dr. M. Manzoul, Professor
Dr. N. Meghanathan, Professor
Dr. L. A. Moore, Professor
Dr. T. Pei, Professor
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Computational Physical Science

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Faculty

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Dr. Tigran Shahbazian, Professor
Dr. Jiange Zhou, Assistant Professor
Dr. G. Hill, Professor
Dr. Md. Hossain, Professor
Dr. M. Huang, Professor
Dr. J. Leszczynski, Presidential Distinguished Professor
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Computational Mathematics and Statistical Sciences

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Dr. Yonghua Yan, Assistant Professor
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Faculty

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Dr. `Emeka Nwagwu, Professor
Dr. Issac Perkins, Professor
Dr. Jung Lee, Professor
Dr. Marinelle Payton, Professor
Dr. Sophia Leggett, Professor
Dr. B. Graham, Associate Professor
Dr. R. Kafoury, Associate Professor
Dr. R. Kulawardhana, Assistant Professor
Dr. J. Stevens, Professor

Masters

- Computational and Data-Enabled Science & Engineering (M.S.) (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/computational-data-enabled-science-engineering/computational-data-enabled-science--engineering-ms/)

Doctoral

- Computational Data-Enabled Sciences and Engineering (Ph.D.) (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/computational-data-enabled-science-engineering/computational-data-enabled-sciences-engineering-phd/)

Course Descriptions

BIO 501 ENVIRONMENTAL SCIENCE (3 Hours)
An introductory course for non-major graduate students dealing with the science of the environment and man's relationships through political, social, economic, and ethical processes.

BIO 506 HUMAN ENVIRONMENT & NATURL SYS (3 Hours)
Emphasis placed on fundamental problems that confront man from day to day. Topics among others for discussion are ecology, population, energy, food, transportation and land pollution.

BIO 507 BIOLOGY FOR ELEMENTARY TEACHER (3 Hours)
Prerequisite: None.
The application of biological procedures and techniques at the elementary school level with emphasis on selected topics in biology.

BIO 509 GENERAL GENETICS (3 Hours)
Prerequisite: ; Bio 318.
A study of the principal concepts of heredity to include the application of classical and modem genetics.

BIO 511 BIOSTATISTICS (3 Hours)
This course is designed for students in biological sciences with no advanced training in mathematics. Basic concepts in statistical methods and experimental techniques and their general applicability in biology will be stressed.

BIO 512 NATURAL RESOURCES & CONS (3 Hours)
A study of our natural resources with emphasis on their origin, properties, use and misuse and good conservation practices.

BIO 513 HUMAN NUTRITION (3 Hours)
Prerequisite: Bio 233 or 218 and CHEM 241.
Review of nutrient sources, requirements and deficiency diseases of man. Emphasis on nutritional metabolism under normal and pathological conditions, and current research.

BIO 515 MOLECULAR BIOLOGY (3 Hours)
Study of the structure, synthesis, isolation and interactions of macromolecules of biological interest.

BIO 517 MAMMALIAN PHYSIOLOGY (3 Hours)

BIO 523 ECOLOGY (3 Hours)
Prerequisite: Senior standing or consent of instructor.
A study of the tropic relationships and energy transfer in ecosystems.

BIO 530 ADVANCED MICROBIOLOGY (3 Hours)
Prerequisite: BIO 313; CHEM 242.
Special techniques for culturing microorganisms. Includes a survey of some of the important microbes in medicine, industry and public health.

BIO 531 INVERTEBRATE ZOOLOGY (3 Hours)
Prerequisite: BIO 114, CHEM 142.
Intended for students who wish to obtain a comprehensive knowledge of the invertebrates.

BIO 532 ADVANCED PARASITOLOGY (3 Hours)
Prerequisite: BIO 331; CHEM 142, 242.
The physiology of specific parasite and host-parasite relationships will be studied in great detail. Clinical specimens will be studied.

BIO 540 CELL BIOLOGY (3 Hours)
Prerequisite: BIO 111, 119 or 121, 313, and CHEM 241.
Study of cell anatomy as revealed by electron microscopy. Emphasis on bioenergetics, cell metabolism and current cell research.

BIO 550 IMMUNOLOGY & SEROLOGY (3 Hours)
The study of antibodies that are elicited in response to antigens and the difference between the protoplasm of one organism and another as reflected in the blood.

BIO 561 MOLECULAR VIROLOGY (3 Hours)
An introduction to the types of viruses that infect humans, animals, plants, and bacteria, their mode of replication, mode of swiping cellular functions, human viral diseases and viral vaccines, and drug development, and the medical and economic significance of viral diseases in public health.

BIO 570 HUMAN PHYSIOLOGY (3 Hours)
Prerequisite: BIO 115, CHEM 242.
The study of physiological processes related to the human. The physiological systems to be examined are: gastro-intestinal, renal, endocrine, neural, and reproductive.

BIO 575 ENDOCRINOLOGY (3 Hours)
Prerequisite: BIO 115, 218; CHEM 142, 242.
The basic fundamentals of endocrinology. The role of the endocrine glands and their products (hormones) in the maintenance of a constant internal environment in living organisms.

BIO 576 HISTOPATHOLOGY (3 Hours)
Prerequisite: BIO 115, 218, and 441.
Provides general consideration of the principal concepts of tissues and cellular pathology, with emphasis on human tissues and pathology. The course prepares students for further studies in medicine, dentistry, and allied health fields.

BIO 587 INDEPENDENT STUDY (2-4 Hours)
Prerequisite: Graduate standing in biology.
Students will elect a specific topic that is not covered in other biology courses. The student, working independently, will be required to submit a research paper that includes an exhaustive review of literature.

BIO 589 GRADUATE SEMINAR (1 Hour)
A course designed for survey of biological literature. The student will be required to prepare and present reports and assigned projects. Required of all students.

BIO 599 THESIS RESEARCH (1-6 Hours)
Thesis representing original research. (Required for M.S. students)

BIO 610 ENVIRONMENTAL MICROBIOLOGY (3 Hours)
The study of the roles of microorganisms in natural systems with attention given to the examination of nutrient cycles, methods of analysis of microbial biomass and activities as well as the functional roles of microorganisms.

BIO 615 PRINCIPLES OF BIOREMEDIATION (3 Hours)
This course uses modern knowledge in life sciences, as well as new developments in biotechnology to address important issues related to environmental clean-up of hazardous wastes. The nature of environmental pollution is reviewed, and basic concepts in molecular biology, biochemistry, and microbiology and plant physiology are applied to demonstrate the significance of bioremediation and phytoremediation in pollution control. Therefore, an emphasis is put on the use of biological methods and processes for the remediation of contaminated soils and water resources.

BIO 620 INDEPENDENT STUDY (1-6 Hours)
Students will elect a specific topic that is not covered in other biology courses. The student, working independently, will be required to submit a research paper that includes an exhaustive review of literature.

BIO 623 SYSMS BIO & SIGNALING NETWORKS (3 Hours)
The objectives of the Systems Biology course is to prevent methods for modeling and analyzing biological systems, in particular cellular systems. It is designed to cover intracellular processes, including enzymatic reactions, polymerization processes, gene expression, gene-environment interactions, and signal transduction. Also the course introduces mathematical modeling fundamentals, including deterministic models, includinglinear regression methods, explains the differences between linear and nonlinear regression, and illustrates how to determine input variables to improve estimation accuracy during experimental design. The material covers the process-function-behavior sequence in cells and illustrates how modeling and analysis of signal transduction units play a mediating role between process and function.

BIO 650 ANALYSIS OF HORMONE ACTION (3 Hours)
Prerequisite: Graduate status and consent of the instructor.
An analysis of the cellular mechanisms of hormone action. The role of target tissues, receptors, hormone analogs and, metabolic inhibitors in studies of hormone action will be discussed.

BIO 689 ADVD TPCS IN COMPUTATIONAL BIO (3 Hours)
The Advanced Topics in Computational Biology will introduce the students to data-driven models of molecular interaction networks and applications of discrete algorithms, data mining, and machine learning to the modeling and analysis of molecular interactions and computational disciplines in systems biology networks.

CDSE 700 SEM N COMP DATA SCI & ENG (1-3 Hours)
Prerequisite: CDSE Ph.
Computational Data-enabled Science & Engineering (CDS&E). Covers Trends and challenges in Computational Data-Enabled Science and Engineering (CDS&E) and occupational outlook. A student seminar forum on contemporary topics and issues in CDS&E designed for survey of CDS&E literature. The student will be required to prepare and present reports and assigned projects. D, students.

CDSE 701 INT N COMP DATA SCI & ENG (1-3 Hours)
Prerequisite: CDSE Ph.
Internship in Computational Data-Enabled Science and Engineering (CDS&E). Covers Industrial Internships training in Computational Data-Enabled Science and Engineering (CDS&E) and occupational outlook in a specific concentration track of the CDS&E Ph.D. program. This include summer (or an academic term(s) of internship or research participation with industry, research laboratories or other academic research centers. The student will be required to prepare and present reports and assigned projects based on the activities of the internships. D. students.

CDSE 702 CURRENT TRENDS IN CDS&E (1-3 Hours)
Prerequisite: CDSE Ph.
Current Trends in Computational Data-Enabled Science and Engineering (CDS&E). Covers Topics in Computational Data-Enabled Science and Engineering (CDS&E) specific to a concentration track of the CDS&E Ph.D. program that are not covered in the regularly listed courses to fit the research interest of the student. D. students.

CDSE 899 DISSERTATION RESEARCH (1-9 Hours)
Prerequisite: permission of advisor.
Dissertation representing independent and original research in the area of Computational Data-Enabled Science and Engineering (CDS&E) Ph.D. disciplinary program concentration tracks.

CPE 500 SOFTWARE ENGINEERING (3 Hours)
Examination of the software development life cycle; requirements elicitation; system design; Unified Modeling Language (UML) focus on design; risk analysis; configuration management; testing; maintenance; software project management; team building.

CPE 503 COMPUTATIONAL METHODS (3 Hours)
Computational methods for solving problems in engineering analysis; variational methods; finite-difference analysis; optimization methods; finite-difference analysis; matrix methods; focus is on real-world engineering problems; techniques and algorithms for simulating large-scale digital and analog circuits.

CPE 505 ANALYSIS OF ALGORITHMS (3 Hours)
Mathematical foundations of algorithms and algorithm analysis; sorting and searching algorithms, graph algorithms, algorithm design techniques, lower bound theory, fast Fourier transforms, NP-completeness.

CPE 508 OPERATING SYSTEMS (3 Hours)
Examination of concepts of process communication and synchronization; protection; performance measurement; study of mutual exclusion; concurrent processes; device and memory management; I/O and interrupt structures.

CPE 512 COMPUTER ARCHITECTURE (3 Hours)
Study of architectural features of modern processors, including cache memories and memory systems, pipeline designs, branch prediction techniques; design of superscalar, multithreaded VLIW processors, code optimization for such systems will be studied; quantitative evaluation of architectural features.

CPE 515 ADVANCED LOGIC DESIGN (3 Hours)
Advanced concepts in Boolean algebra; use of hardware description languages as a practical means to implement hybrid sequential and combinational designs; digital logic simulation; rapid prototyping techniques; design for stability concepts; focuses upon the actual design and implementation of sizeable digital design problems using a representative set of Computer Aided Design (CAD) tools.

CPE 520 ADVANCED ENGINEERING ANALYSIS (3 Hours)
A comprehensive course to familiarize engineering professionals with advanced applied mathematics as it relates to solving practical engineering problems. The course of intensive study blends the theoretical underpinnings of advanced applied mathematics with an understanding of how these powerful tools can be used to solve practical engineering problems. The material covered includes Ordinary Differential Equations; Linear Algebra, Vector Calculus; Fourier Analysis and Partial Differential Equations.

CPE 521 ADVD ENGINEERING ANALYSIS II (3 Hours)
A comprehensive course to familiarize engineering professions with advanced applied mathematics as it relates to solving practical engineering problems. The course of intensive study blends theoretical and advanced applied mathematics with an understanding of how these powerful tools can be used to solve practical engineering problems. The material covered includes Complex Analysis; Numerical Methods; Optimization; Graphs; and Probability and Statistics.

CPE 530 VLSI DESIGN (3 Hours)
Theory of MOS transistors: fabrication, layout, characterization; CMOS circuit and logic design; circuit and logic simulation, fully complementary CMOS logic, pseudo-NMOS logic, dynamic CMOS logic, pass-transistor logic, clocking strategies; sub system design; ALUs, multipliers, memories, PLAs; architecture design: data path, floor planning, iterative cellular arrays, systolic arrays; VLSI algorithms; chip design and test; full custom design of chips, possible chip fabrication by MOSIS and subsequent chip testing.

CPE 532 DIGITAL INTEGRATED CIRCUITS (3 Hours)
Design methodologies for digital systems using a modern hardware description language; algorithmic, architectural and implementation aspects of arithmetic processing elements; design of Complex Instruction Set (CISC), Reduced Instruction Set (RISC), and floating point processors; synthesis, simulation and testing of processors with computer-aided design tools.

CPE 541 COMPUTER NETWORK (3 Hours)
Study of computer network architectures, protocols, and interfaces; OSI reference model; Internet architecture; networking techniques (multiple access, packet/cell switching, and internetworking); end-to-end protocols; congestion control; high-speed networking; network management.

CPE 544 ELECTROMAGNETIC FIELD ANALYSIS (3 Hours)
Maxwell¿s equations; solutions of Laplace¿s equation; Green¿s Function; scalar and vector potentials; energy and momentum in electromagnetic fields; interaction of fields and material media.

CPE 545 ANTENNAS (3 Hours)
Examine the theory and properties of various communication antennas covering the range from RF frequencies to millimeter wavelengths; examine actual antennas and their characteristics.

CPE 551 DIGITAL SIGNAL PROCESSING (3 Hours)
Signals and systems; sampling continuous-time signals and reconstructions of continuous-time signals from samples; spectral analysis of signal using the discrete Fourier transform; the fast Fourier transform and fast convolution methods; z-transforms; finite and infinite impulse response filter design techniques; signal flow graphs and introduction to filter implementation.

CPE 552 COMPUTER VISION (3 Hours)
Examination of information processing approaches to computervision; algorithmsand architectures for artificial intelligence and robotic systems capable of vision; inference and robotic systems capable of vision; inference of three-dimensional properties of a scene from its images, such as distance, orientation, motion, size and shape, acquisition and representation of spatial information for navigation and manipulation in robotics.

CPE 555 CONTROL SYSTEMS (3 Hours)
Analysis and design of control systems with emphasis on modeling and dynamic response; transform and time domain methods for linear control systems; stability theory; root locus, bode diagrams and Nyquist plots; design specification in time and frequency domains; state-space design with computer solutions; compensation design in the time and frequency domain; modern design principles.

CPE 557 ROBOTICS (3 Hours)
Fundamentals of robotics; rigid motions; homogenous transformation; forward and inverse kinematics; velocity kinematics; motion planning; trajectory generation; sensing; vision; and control.

CPE 560 EMBEDDED DESIGN W/MICHROPROCES (3 Hours)
Microcomputer system design and use of microprocessors and single chip microcomputers as basic system components; basic microcomputer design and the interface between microprocessor and external devices; course examines the software aspects of microcomputers using assembly language and C programming; single chip microcomputers for embedded and power efficient applications; direct memory access, memory design and management, cache memory, fault tolerance issues, parallel processing with emphasis on hardware issues.

CPE 610 PARALLEL COMPUTING AND PROGRAM (3 Hours)
Introduction to processing in parallel and distributed computing environments, general concepts of parallel machine models, processes, mutual exclusion, process synchronization, messing, passing, and programming languages for parallel computing and scheduling; design and analysis of parallel algorithms, parallel programming environments: P threads for shared memory multiprocessor systems and PVM/MPI for distributed networks computers.

CPE 618 HIGH PERFORMANCE COMPUTING (3 Hours)
The class will study a variety of algorithms, their applications, and tradeoffs between different solutions. Issues such as performance analysis, evaluation and prediction will be addressed. There will also be discussions on topics such as parallel computer architectures (memory hierachy, interconnection networks, latency and bandwidth, parallel I/O), and software systems, with the aim of understanding their capabilities, costs and limitations. Students will make use of recent technology through a number of software packages and programming environments appropriate to the topics addressed. High performance computing tools will be used to compare and evaluate the performance of different implementations through a variety of criteria. Students will draw conclusions regarding preferred algorithms, methods, programming paradigms, and programming environments and tools for parallel distributed computing.

CPE 635 ADVANCED CIRCUIT THEORY (3 Hours)
CMOS technology; structured digital circuits; VSLI systems; computer-aided design automation tools and theory for design automation; chip design and integration; microelectronic systems architecture; VLSI circuit testing methods; advanced high-speed circuit design and integration.

CPE 693 ADVANCED TOPICS-IC DESIGN (3 Hours)
Graduate standing in engineering. Lectures on advanced topics of special interest to students in various areas of computer engineering are introduced. This course number is used to offer and test new courses.

CPE 697 INTERNSHIP (1-3 Hours)
Prerequisite: permission of Department.
Supervised graduate internship or externship in selected areas.

CPE 698 INDEPENDENT STUDY (1-4 Hours)
Prerequisite: permission of Department.
Intensive study of a special engineering project including research and literature review selected in accordance with the student¿s interests and arranged in consultations with the advisor. Topics will vary. Student will make periodic reports as well as a paper at the end of the semester.

CPE 699 THESIS (1-6 Hours)
Prerequisite: permission of advisor.
Master's thesis representing independent and original research.

CPE 899 DISSERTATION RESEARCH (1-6 Hours)
Dissertation representing independent and original research.

CSC 506 Graduate Seminar (3 Hours)
Reports on recent advances and problems in computer science by guest speakers, faculty, and students; student participation, presentations, general discussion; exercises in scientific writing format and style, with particular emphasis on writing abstracts and manuscripts for publication in referred archival journals; discussion of program requirements; introductory programming project exercises.

CSC 509 COMPUTERS AND SOCIETY (3 Hours)
History of computing and technology; place of computers in modern society; the computer and individual; survey of computer applications, legal issues; computers in decision making processes; the computer scientist as a professional; futurist¿s view of computing; public perception of computers and computer scientists.

CSC 511 OBJECT-ORIENTED PROGRAMMING (3 Hours)
Discussion of object-oriented languages. Object-Oriented techniques using the C++ language, classes, objects, constructors, destructors, friend functions, operator overloading, inheritance, multiple inheritance, and polymorphism. Reusability is emphasized.

CSC 512 COMPUTER ARCHITECTURE (3 Hours)
An advanced introduction to computer design and architecture. Topics include instruction set architecture, RISC computers, control unit design, pipelining, vector processing, memory system architecture, and classification of computers.

CSC 515 DATA STRU ALGORITH ANALY (3 Hours)
Mathematical foundations for complexity theory, asymptotic notation, recurrence relations. Strategies for development of algorithms like divide and conquer, greedy, dynamic programming, backtracking. Exposure to some typical and important algorithms in computer science. Introduction to the theory of NP-completeness.

CSC 518 PRIN OPRTNG SYST CMP ARC (3 Hours)
Emphasizes the concepts of process communication and synchronization, protection, performance measurement, and evaluation. Problems associated with mutual exclusion and synchronization, concurrent processes, information, process, device, and memory management are examined. Implementation of I/0 and interrupt structure is also considered.

CSC 519 PRIN PROG SYSTEMS & LANG (3 Hours)
Important programming language concepts including, representation of data and sequence control, data abstraction and encapsulation; procedural and non-procedural paradigms: functional, logic, and object-oriented languages; distributed and parallel programming issues.

CSC 524 COMP COMM NETWK DIST PRO (3 Hours)
Topologies, media selection, medium access control for local area networks (LANs) including high speed and bridged LANs; circuit switched, ISDN wide area networks (WANs) internetworking issues and standards, 150/051, TCP/IP protocols.

CSC 527 REAL TIME SYSTEMS (3 Hours)
An introduction to the problems, concepts, and techniques involved in computer systems which must interface with external devices. These include process control systems, computer systems embedded within aircraft or automobiles, and graphics systems. The course concentrates on operating system software for these systems.

CSC 530 THEORY OF COMPUTATION (3 Hours)
A survey of formal models for computation. Includes Turing Machines, partial recursive functions, recursive and recursively enumerable sets, abstract complexity theory, program schemes, and concrete complexity.

CSC 537 CLOUD COMPUTING (3 Hours)
The course will present the state of the art in cloud computing technologies and applications as well as providing hands-on project opportunities and experiment with different technologies. Topics will include: telecommunications needs; architectural models for cloud computing; cloud computing platforms and services; security, privacy, and trust management; resource allocation and quality of service; cloud economics and business models; pricing and risk management; interoperability and internetworking; legal issues; and novel applications.

CSC 539 SPECIAL TOPICS (3 Hours)
Prerequisite: Consent of instructor.
Topics and problems of information systems that are of practical importance and current interest. New developments in system concepts, techniques, and equipment.

CSC 541 CRYPTO AND NETWORK SECURITY (3 Hours)
Cryptography and Network Security. This course will focus on graduate-level topics in cryptography and network security, including: Symmetric Key and Public Key encryption algorithms, Digital Signature, Certificates, Cryptanalysis, Key management and distribution, Classical network attacks and their solutions, User authentication protocols, Transport-level security, Wireless network security, g-mail security, Web security, IP security, Distributed system security, Firewalls and Intrusion detection systems.

CSC 542 Digital Forensics (3 Hours)
Digital forensics is a new and emerging field that is becoming increasingly important and visible. The ease with which one can access the internet and commit crimes with and against computers has led to an increase in the need for online protection. As a result, there is a need for computer science graduates with skills needed to investigate these crimes. In this course, topics of computer crimes, system and computer forensics will be introduced. Students will be required to learn the different aspects of computer crime and ways to uncover, protect, and exploit digital evidence. In addition, the lab projects will expose students to different types of tools, both hardware and software, and will enable them to perform fundamental investigations.

CSC 545 ARTIFICIAL INTELLIGENCE (3 Hours)
Efficient and intelligent search techniques. Knowledge representation e.g., logic, and semantic nets. Reasoning techniques including reasoning under uncertainty, e.g., fuzzy reasoning. Exposure to different artificial intelligence systems like planning and learning (including neural networks).

CSC 547 Computer Security (3 Hours)
This course provides an overview of security challenges and strategies of countermeasures in the information systems environment. Topics include definition of terms, concepts, elements, and goals incorporating industry standards and practices with a focus on confidentiality, availability, and integrity aspects of information systems.

CSC 551 PARALLEL & DISTRIBUTED COMPUTI (3 Hours)
The course introduces the concepts and design of parallel and distributed computing systems. Topics covered include: Data versus control parallelism (SIMD/Vector, Pipelines, MIMD, Multi-core, GPU); Shared versus distributed memory (SMP and NUMA), Message passing Interface (MPI) and Topologies; Parallel and distributed algorithms: Paradigms, Models and Complexity, Scheduling, Synchronization, Deadlock detection, Fault tolerance and Load balancing.

CSC 552 APPLIED PROGRAMMING (3 Hours)
Department and advisor approval. This course focuses on the fundamentals of computing and is geared toward non-CS majors going into computational sciences. The course will cover key concepts of data strudtures, data manipulation, algorithms and efficiency, and how they apply to the various application domains specific to computational fields. The course will also provide an introduction to Python for computational sciences. Topics include: an introduction to computational complexity, data structures (arrays, lists, stacks, queues, trees, and graphs), elementary algorithms and their complexity.

CSC 560 SOFTWARE ENGINEERING (3 Hours)
Formal approach to techniques and software design and development. Software cycle encompassed from initial ideas through code design and implementation with emphasis on object-oriented design techniques will be included. Software testing and maintenance will be discussed.

CSC 571 PROGRAMMING FOR BIG DATA (3 Hours)
The course will expose students to three programming paradigms for big dat analytics to cover the three Vs: Velocity, Volume, and Variety. The course will focus on design and development of programs based on the: (1) Supervised and unsupervised machine learning algorithms to perform predictive analytics of Big Data dn implement them using a high-level algorithms such as Octave; (2) Map-reduce parallel programming paradigm for selected data-intensive computational problems; (3) Functional programming paradigm using languages such as OCaml to analyze big data in a recursive fashion. In addition, the course will enable students to be able to configure a distributed file system based on the Hadoop architecture for reliable share storage and develop programs that interface with it, as well as manage large datasets using SQL-like access to unstructured data (Hive) and NoSQL storage solutions (HBase).

CSC 582 SOCIAL NETWORK ANALYSIS (3 Hours)
This course will cover the structure and analysis of large social networks on models and algorithms that abstract their properties. Topics covered include: Nodes, edges, and network measures, structure, and visualization and tools, the tie strength of networks, trust in social media, analyzing and classifying user roles, attributes and behavior, link prediction and entity resolution, epidemic models, location-based social media analysis, social sharing and filtering, aggregation and data mining, and network strategies for the individual and for the government.

CSC 595 INFO SYST & DEVELOP PROJ (1-3 Hours)
Prerequisite: Pass comprehensive examination and consent of advisor.
Provide the student with the experience in analyzing, designing, implementing, and evaluating information systems. Students are assigned one or more system development projects. The project involves part or all of the system development cycle.

CSC 597 Internship (1-3 Hours)
Prerequisite: Permission of department.
Supervised graduate internship or externship in selected areas of computer science.

CSC 599 THESIS RESEARCH (1-6 Hours)
Prerequisite: Pass comprehensive examination and consent of advisor.
An independent study course for the preparation of a Master's thesis.

CSC 601 COMPUTER ALGORITHMS (3 Hours)
The course focuses on algorithms of different design strategies, and the mathematical concepts used in describing the complexity of an algorithm. Topics covered include: Asymptotic notations; Time complexity analysis of iterative and recursive algorithms; design strategies like Bruite force, Diviide and Conquer, Transform and Conquer,Greedy and Dynamic programming; Space-time tradeoffs in algorithms and NP-completeness - Heuristics and Approximation algorithms. The course will also cover graph theory algorithms and string matching algorithms with respect to the application of the above design strategies for specific problems.

CSC 620 DATABASE MANAGEMENT SYSTEMS (3 Hours)
This course is designed for non-computer science majors entering the Ph.D. in Computational and Data Enabled Sciences and Engineering. It introduces students to the concepts and theories of database systems, necessary in the CDS&E fields. Topics include: information models and systems; the database environment; data modeling; conceptual modeling using the entitiy-relationship approach and mapping to relational tables; the relational model including the relational data structure, integrity rules, relational algebra and relational calculus; normalizaation; data definition and data manipulation in SQL; conceptual, logical, and physical database design; security; transaction management; query processing; and advanced topics in database systems, and how this applies to computational and data enabled sciences and engineering.

CSC 621 MACHINE LEARNING (3 Hours)
This course will deal enable students to understand the underlying algorithms used in varioius learning systems. Topics covered include: Inductive classification, Decision-tree learning, Ensembles, Experimental evaluation, Computational learning theory, Rule learning, Neural network learning, Support vector machines, Bayesian learning, Instance-based learning and Text categorization.

CSC 634 BIG DATA MINING (3 Hours)
This course will focus on data mining of very large amounts of data that is so large enough not to fit in main memory, characteristic of data retrieved from the web. Topics to be covered include: Distributed file systems and Map Reduce, Similarly search techniques, Real-time data-stream processing algorithms, Technology of search engines (PageRank, Link-spam detection, hubs-and-authorities approach) and Frequent-itemset mininig. The course will also expose students to algorithms for clustering very large, high-dimensional datasets.

CSC 641 NETWORK SCIENCE (3 Hours)
Topics covered include the measurement and structure of networks, methods for analyzing network data, including methods developed in physics, and statistics, and sociology, graph theory, computer algorithms, mathematical models of networks, including random graph models and generative models, and theories of dynamical processes taking place on networks.

CSC 651 FNDS OF PROGRAMMING & COMP SYS (3 Hours)
Prerequisite: experience in any object-oriented language.
This course will focus on graduate-levle central concepts in modern programming languages, impact on software development, language design trade-offs, and implementation considerations. Functional, imperative, and object-oriented paradigms. Formal semantic methods and program analysis. Modern type systems, higher order functions and closures, exceptions and continuationsl Modurlarity, object-oriented languages, and concurrency. Runtime support for language features, interoperability, and security issues.

CSC 899 DISSERTATION RESEARCH (1-9 Hours)
Prerequisite: permission of advisor.
Dissertation representing Independent and original research in the area of Computational Science and Engineering.

MATH 501 TOPICS IN GEOMETRY (3 Hours)
Prerequisite: Approval of department.
A survey of geometries and their structures. Emphasis is on both synthetic and analytic methods.

MATH 503 FOUNDATIONS OF MATH I (3 Hours)
The fundamental elements of set theory and finite mathematical structures; cardinals and ordinals; logical deduction, elements of probability; vectors and matrices, linear programming, theory of games and applications.

MATH 504 FOUNDATIONS OF MATH II (3 Hours)
The fundamental elements of set theory and finite mathematical structures; cardinals and ordinals; logical deduction, elements of probability; vectors and matrices, linear programming, theory of games and applications.

MATH 506 BASIC CONCPTS FOR TCHR I (3 Hours)
Prerequisite: Approval of department.
Higher mathematics for teachers, reviewing the fundamental areas of algebra, geometry and analysis, with stress on rigor and validity of ideas.

MATH 507 BASIC CONCPTS FOR TCH II (0.5-3 Hours)
Prerequisite: Approval of department.
Higher mathematics for teachers, reviewing the fundamental areas of algebra, geometry and analysis, with stress on rigor and validity of ideas.

MATH 510 TOPICS & ISSUES IN MATH (3 Hours)
This course is designed for in-service teachers who are interested in the renewal of teaching licenses and the pursuit of graduate studies in the teaching of mathematics. Emphasis is on individualized research dealing with the stages of development of mathematics, new trends in the teaching of mathematics, and the exploration of teaching theories resulting from the work of experimental psychologists such as Piaget, Aushel and Bruner. Because of the individualized nature of the course, students with diverse backgrounds in mathematics can be accommodated.

MATH 511 BASIC ABSTRACT ALGEBRA I (3 Hours)
Groups, (homomorphisms), rings, integral domains, modules and fields, elementary linear algebra, number theory.

MATH 513 LINEAR ALGEBRA I (3 Hours)
Vector spaces, matrices, linear transformations, determinants and linear equations. Selected topics on eigenvalues, canonical forms, inner products, inner product spaces, bilinear and quadratic forms.

MATH 531 BASIC REAL ANALYSIS I (3 Hours)
Prerequisite: Math 511 or approval of department.
Metric spaces, regulated functions and integrals; integrals of Riemann and Lebesgue; trigonometrical and Fourier series; differentiation and Stieltjes Integrals.

MATH 532 BASIC REAL ANALYSIS II (3 Hours)
Prerequisite: Math 511 or approval of department.
Metric spaces, regulated functions and integrals; integrals of Riemann and Lebesgue; trigonometrical and Fourier series; differentiation and Stieltjes Integrals.

MATH 535 INTRO MEAS & INTEGRTN I (3 Hours)
Prerequisite: Mathematics 531 or approval of department.
Lebesgue measure of linear sets, measurable functions, definite integral, convergence, integration and differentiation, spaces of functions, orthogonal expansions, multiple integrals and the Stieltjes Integral.

MATH 536 INTRO MEAS & INTEGRTN II (3 Hours)
Prerequisite: Mathematics 531 or approval of department.
Lebesgue measure of linear sets, measurable functions, definite integral, convergence, integration and differentiation, spaces of functions, orthogonal expansions, multiple integrals and the Stieltjes Integral.

MATH 541 BASIC COMPLEX ANALYSIS I (3 Hours)
Complex numbers, sets and functions; limits and continuity; analytic functions of a complex variable, elementary functions; integration; power and Laurent series, calculus of residues, conformal representation, special topics.

MATH 542 BASIC COMPLEX ANALYS II (3 Hours)
Complex numbers, sets and functions; limits and continuity; analytic functions of a complex variable, elementary functions; integration; power and Laurent series, calculus of residues, conformal representation, special topics.

MATH 543 NUMERICAL ANALYSIS (3 Hours)
This is an introductory course on Numerical Analysis. It is made of five related modules: M1) floating-point arithmetic, M2) root-finding algorithms, M3) numerical solution of systems of equations, M4) interpolation problems and M5) numerical integration.

MATH 551 BASIC GENERAL TOPOLOGY I (3 Hours)
Prerequisite: Mathematics 223 and approval of department.
Elementary set theory, ordinals and cardinals; topological spaces; cartesian products; connectedness; special topologies; separation axioms; covering axioms, metric spaces; convergence; compactness; function spaces; spaces of continuous functions and complete spaces; homotopy; maps into spheres; topology of En; homotopy type; introduction to algebraic topological ideas.

MATH 563 EXPERIMENTAL DESIGN I (3 Hours)
Prerequisite: Mathematics 272.
Experimental Design: Completely randomize design; randomize block designs, factorial experiments split plot design. confounding.

MATH 567 NON-PARAMETRIC STATS I (3 Hours)
Prerequisite: Mathematics 562 and approval of department.
Problems of estimating testing hypotheses when the functional form of the underlying distribution is unknown. Robust methods; sign test, rank test and confidence procedures based on these tests; tests based on permutations of observations. Non-parametric tolerance limits; large sample properties of the tests, multi sample problems; ranking methods in analysis of variance; Bivariate and multivariate procedures, efficiency comparisons.

MATH 571 NUMERICAL ANALYSIS I (3 Hours)
Prerequisite: Approval of department.
Introduction to Matlab, approximate differentiation, local truncation error and order, Euler¿s method, Runge-Kutta methods, embedded Runge-Kutta methods, stiff equations and implicit methods, explicit multi-step methods, implicit multi-step methods, shooting method, finite element method, finite difference methods for partial differential equations.

MATH 577 ORDINARY DIF EQUATIONS I (3 Hours)
Ordinary differential equations: basic theorems of existence, uniqueness, and continuous dependence of the solutions; linear differential equations and systems; stability theory; topology of integral curves; differential equations in the complex domain, asymptotic integration; boundary value problems. Partial differential equations; equations of first order method of characteristics, Hamilton-Jacobi theory; equations of second order-classification according to type; elliptic equations-potential equation, maximum principle, characteristics, and other topics of interest.

MATH 578 ORDINARY DIF EQUATION II (3 Hours)
Ordinary differential equations: basic theorems of existence, uniqueness, and continuous dependence of the solutions; linear differential equations and systems; stability theory; topology of integral curves; differential equations in the complex domain, asymptotic integration; boundary value problems. Partial differential equations; equations of first order method of characteristics, Hamilton-Jacobi theory; equations of second order-classification according to type; elliptic equations-potential equation, maximum principle, characteristics, and other topics of interest.

MATH 579 PARTIAL DIFF EQUATIONS I (3 Hours)
Prerequisite: Mathematics 577 or departmental approval.
Linear equations with constant coefficients in two independent variables, applications, eigenfunction expansions, homogeneous and nonhomogeneous equations. Fourier series, existence, solution uniqueness and representation, Initial boundary value problems, Laplace's equation, and special topics.

MATH 584 INDEPENDENT STUDY (3 Hours)
Prerequisite: Departmental consent.
Intensive study and research of a subject selected in accordance with student needs and arranged in consultation with the staff. Topics will vary. Student will make periodic reports on his/her reading and will-prepare a scholarly paper on a problem.

MATH 599 THESIS (3 Hours)
The candidate for the Master's degree must present a Thesis embodying the results of his research. The candidate chooses his problem, but approval by his adviser is required.

MATH 628 ADVD PARTIAL DIFF EQUATIONS I (3 Hours)
This course covers representation formulas for Laplace's equation, heat equation, and wave equation' theory of general nonlinear first-order partial differential equations; solvability of uniformly second order ellipitc, parabolic, and hyperbolic equations; theory of Sobolev spaces.

MATH 629 ADVND PARTIAL DIF EQUATIONS II (3 Hours)
This course is a continuation of MATH 628 and covers the theory and qualitative analysis techniques for nonlinear higher-order partial differential equations including calculus of variations, monotonicity methods, fixed point methods, methods of sub-solutions and super-solutions, nonexistence, geometric properties of solutions, gradient flows, Hamilton-Jacobi equations, and system of conservation laws.

MATH 670 COMPUTATIONAL METHODS N MATH I (3 Hours)
This course is designed to give an overview of the design, analysis and implementation of the most fundamental numerical techniques of MATH 543 in numerical linear algebra, the interpolation of functions, and the evaluation of integrals. This course in most part will depend on programming with MATLAB and/or C++. While we present many MATLAB examples throughout the course, students are strongly advised to have some previous programming experience in any computer programming language.

MATH 671 COMPUTATNL METHODS IN MATH II (3 Hours)
This course is a continuation of MATH 670. Topics covered includes introduction to mathematical and computational problems arising in the context of molecular biology. Theory and applications of combinatories, probability, statistics, geometry, and topology to problems ranging from sequence determination to structure analysis. The course depends on parallel and distributed programming.

MATH 673 QUANTITATIVE EXPLORATN OF DATA (3 Hours)
This course covers how to analyze and mine data with the Structured Query Language (SQL). Understand SQL fundamentals, and then advance into the uses of SQL data analysis and data mining with real applications. Learn to use Microsoft Excel to further analyze, manipulate and present your data exploration and data-mining findings in tabular and graphical formats. Students will be exposed to Extreme Science and Engineering Discovery Environment (XSEDE).

MATH 700 TPCS N MATH & STATS A N CDS&E (3-6 Hours)
The course may be repeated for credit. It covers current trends and challenges of mathematical and statistical applications in CDS&E.

MATH 827 NUMERICAL SOLUTN OF DIF EQUATI (3 Hours)
Ordinary differential equations:Runga-Kutta and predictor-corrector methods; stability theory, Richardson extrapolation, sitff equations, boundary value problems. Partial equations, boundary value problems. Partial differential equations: stablity, accuracy and convergence, Von Neumann and CFL conditions, finite difference solutions of hyperbolic and parabolic equations. Finite differences and finite element solution of elliptic equations.

STAT 661 PROBABILITY AND STATISTICS (3 Hours)
This course covers multivariate discrete probability distributions, biavriate normal distribution, maximum likelihood estimation, confidence interval, the Dirichlet distribution, Whishartn expectation identities, Hotelling's T2 and distribution of quadratic forms, quintile transformations and moments, Laws of large number, convergence of moments, characteristics functions of standard distributions, error of the Central Limit Theorem, central order statistics, extremes, markov chains, and random walks.

STAT 672 COMPUTATIONAL STATISTICS (3 Hours)
This course covers R, SAS, SPSS, S-Plus, Mathematics, computational statistics packages and other big data statistical computational packages with emphasis on reading, manipulating, summarizing and modeling data and implementations of simulation through random number generating, Monte Carlo method and bootstrapping.

STAT 680 CMPTNL DATA ANLYSIS & VISUAL I (3 Hours)
This course covers basic descriptive statistics, basic probability distributions, simple linear regression, point estimation, comparison of data sets and how to use mathematical and statistical software and packages as well as program to conduct analysis and provide visualized representations.