COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY

Dr. Abdul K. Mohamed, Dean

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School of Engineering

- Department of Civil and Environmental Engineering
- Department of Computer Engineering
- Department of Computer Science

School of Science and Technology

- Department of Biology
- Department of Chemistry
- Department of Mathematics
- Department of Physics, Atmospheric Science and General Science
- Department of Technology

SCHOOL OF ENGINEERING

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Departments

- Civil and Environmental Engineering
- Computer Engineering
- Computer Science

GRADUATE ENGINEERING PROGRAM

Dr. William D. Blair, Professor and Director
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Program Mission

Jackson State University offers course work leading to the Master of Science in Engineering through the Graduate Engineering Program in collaboration with the Civil and Environmental Engineering Department and the Computer Engineering Department. The Department of Computer Science offers the Master of Science in Computer Science. Engineering students may pursue a MS degree with emphasis in Environmental Engineering, Geological Engineering, Computer Engineering, Electrical Engineering, or Telecommunications Engineering. It is anticipated an emphasis in Civil Engineering will be offered in the Fall of 2005, pending IHL approval. The Programs offers a non degree admission for engineers in the Jackson area who are only interested in continuing engineering education or desire preparation for the Professional Engineers (PE) Exam.

One objective of the Graduate Engineering Program is to meet the post graduate engineering educational needs of individuals in the greater Jackson metro area who are employed full time. The curriculum is designed not only to meet individual needs, but to provide courses that upgrade the technical skills of employees in private industry, and municipal, state and federal agencies. Classes are typically taught in the evenings to accommodate the working student.

The Graduate Engineering Program provides an environment that accommodates full time graduate engineering students who plan to pursue careers in engineering practice, research or academia.

Admission Requirements

Admission is open to applicants with an undergraduate degree in engineering. Applicants with an undergraduatedegree in a closely related field may be considered. Engineering applicants may be admitted to the Graduate School as Regular Graduate Students, Qualifying Students, Conditional Students or Non-Degree Students. Admission requirements for each of these categories are outlined in the JSU Graduate Catalog. Applicants may have

to satisfy undergraduate coursework prerequisites as determined by their Department Chairperson and/or Advisor.

Prior to admission as a Regular Graduate Student, each applicant must submit an official quantitative and verbal Graduate Record Exam (GRE) score. Applicants must meet all other admission requirements outlined in the JSU Graduate Catalog. In addition, international applicants must submit all documentation as outlined in the Graduate Catalog.

Transfer of Graduate Credit
Engineering Graduate students may transfer up to 9 semester hours of graduate credit from another institution upon the recommendation of their advisor and approval by the Department Chairperson.

Time Limit
All course work applied toward a Master of Science Degree in Engineering must be completed within an 8-calendar year period from the date of first entering the graduate program.

Degree Requirements
Thirty (30), or thirty-six (36), semester hours are required for the Master of Science Degree in Engineering depending upon which of the following three options the student selects with approval of his or her department chairperson and/or advisor:

Option 1-Twenty four (24) semester hours of coursework plus a six hour thesis
Option 2-Twenty seven (27) semester hours of coursework plus a three hour project
Option 3-Thirty six (36) semester hours of coursework

Option 1 requires a formal written thesis, formal ; presentation and oral exam.
Option 2 requires a written project report, formal presentation and oral exam.
Option 3 requires an oral exam

To remain in "good standing", students must maintain a minimum cumulative grade point average (GPA) of 3.0 ("B" average).

Core Courses
Each emphasis area typically has four core courses (12 semester hours). Electives are selected with approval of the student's graduate committee and/or graduate advisor.

Note: Please refer to the Department of Computer Science for admission and degree requirements, as well as emphasis areas, core courses and description of all courses for the Master of Science in Computer Science.

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

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Faculty
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Dr. P. N. Deliman, Adjunct Professor
Dr. J. Huey, Adjunct Professor
Dr. B. A. Kleiss, Adjunct Professor
Dr. Y. Li, Assistant Professor
Dr. S. Rahman, Assistant Professor
Dr. M. K. Sharp, Adjunct Professor
Dr. H. Shin, Assistant Professor
Dr. R. W. Whalin, Professor
Dr. M. Zakikhani, Adjunct Professor

Environmental Engineering Emphasis

Mission
To provide engineers and scientists with advanced graduate education in the broad areas of environmental engineering

Program Objectives

- Provide students an understanding of fundamental scientific and engineering principles necessary to manage and solve environmental challenges in natural and engineered systems
- Provide advanced course work and research programs in environmental engineering
- Enable students to develop increased professional competence in the broad areas of environmental engineering

Core Courses		**Semester**
Course	**Title**	**Hours**
CIV 561	Chemistry for Environmental Engineering	3
CIV 562	Hazardous Waste Engineering	3
CIV 660	Physicochemical Processes in Water and Wastewater	3
CIV 661	Biological Processes in Wastewater Engineering	3

Elective Courses		
CIV 520	Advanced Engineering Analysis I	3
CIV 521	Advanced Engineering Analysis II	3
CIV 550	Engineering Hydrology	3
CIV 551	Advanced Fluid Mechanics	3
CIV 552	GIS Applications in Civil and Environmental Engineering	3
CIV 560	Environmental Engineering II	3

CIV 563	Microbiology for Environmental Engineering	3
CIV 564	Surface Water	3
CIV 565	Wetland Management for Environmental Engineering	3
CIV 566	Air Pollution and Control	3
CIV 567	Environmental Remediation	3
CIV 568	Land Disposal of Waste	3
CIV 569	Environmental Systems Modeling	3
CIV 571	Principles of Geoenvironmental Engineering	3
CIV 573	Environmental Geology for Engineers	3
CIV 574	Engineering Hydrogeology	3
CIV 575	Applied Geological Engineering	3
CIV 631	Linear Theory of Ocean Waves	3
CIV 631L	Linear Theory of Ocean Waves' Laboratory	1
CIV 632	Tides and Long Waves	3
CIV 650	Small Watershed Hydrology	3
CIV 652	Hydraulic Engineering Design	3
CIV 653	Advanced Design of Hydraulic Structures	3
CIV 663	Design of Environmental Engineering Facilities	3
CIV 664	Limnology for Environmental Engineering	3
CIV 665	Environmental Law	3
CIV 666	Advanced Waste Treatment Processes in Environmental Engineering	3
CIV 667	Biological Process Engineering	3
CIV 668	Bioenvironmental Engineering	3
CIV 669	Advanced Topics in Environmental Engineering	1-4
CIV 695	Scientific Writing Seminar	1
CIV 696	Seminar	1
CIV 697	Internship	1-3
CIV 698	Independent Study	1-4
CIV 699	Thesis Research	1-6

Geological Engineering Emphasis

Mission

To provide a high quality graduate education in the traditional and emerging areas of geological engineering which is locally responsive; to contribute to the expansion of knowledge of geological engineering through programs of basic and applied research; and to provide professional and community service to the state, the nation, and the world.

Program Objectives

1. Provide a graduate education in the broad area of geological engineering fundamentals.
2. Provide academic education and real world design experiences to prepare students for practice in the geological engineering profession.
3. Make contributions to the advancement of knowledge in geological engineering; and engage in meaningful service activities.
4. Create and maintain an environment that promotes professional development, growth of the Intellect, character, and spirit of students, faculty and staff.

Core Courses

Course	Title	Semester Hours
CIV 570	Regional Geological Engineering	3
CIV 571	Principles of Geoenvironmental Engineering	3
CIV 672	Advanced Geomechanics	3
CIV 673	Advanced Foundation Engineering	3

Elective Courses

CIV 520	Advanced Engineering Analysis I	3
CIV 521	Advanced Engineering Analysis II	3
CIV 552	GIS Applications in Civil and Environmental Engineering	3
CIV 564	Surface Water	3
CIV 565	Wetland Management for Environmental Engineering	3
CIV 567	Environmental Remediation	3
CIV 568	Land Disposal of Waste	3
CIV 572	Applied Geotechnical Engineering Design	3
CIV 573	Environmental Geology for Engineers	3
CIV 574	Engineering Hydrogeology	3
CIV 575	Applied Geological Engineering	3
CIV 576	Geological Engineering Analysis	3
CIV 577	Airphoto Interpretation for Terrain Evaluation	3
CIV 578	Applied Geophysics	3
CIV 579	Engineering Seismology	3
CIV 670	Rock Mechanics	3
CIV 671	Advanced Topics in Geological Engineering	1-4
CIV 674	Soil Dynamics	3
CIV 675	Earth Dams and Slopes	3
CIV 676	Tunneling	3
CIV 677	Design and Construction with Geosynthetics	3
CIV 678	Soil Bioengineering	3
CIV 679	Advanced Topics in Geotechnical Engineering	1-4
CIV 695	Scientific Writing Seminar	1
CIV 696	Seminar	1
CIV 697	Internship	1-3
CIV 698	Independent Study	1-4
CIV 699	Thesis Research	1-6

DESCRIPTIONS OF COURSES

CIV 520 Advanced Engineering Analysis I. (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.

CIV 521 Advanced 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 the theoretical un of 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.

CIV 550 Engineering Hydrology. (3 Hours) Principles and theory of surface water and groundwater flow and quality; understanding and determination of water budget, hydrologic cycle, Darcy's law, and water resources management at the watershed scale. Water quality parameters including data analysis and interpretation, laboratory tests, and maintenance of water quality. Applications in engineering design, Prerequisite: CIV 370 or permission of Department.

CIV 551 Advanced Fluid Mechanics. (3 Hours) Kinematics of fluid flow; plane irrotational and incompressible fluid flow; Navier-Stokes equations; two-dimensional boundary layers in incompressible flow; dimensional analysis and dynamic similitude; hydrodynamic stability; turbulence; real life problems; Engineering applications and system approach. Prerequisite: CIV 330 or permission of Department.

CIV 552 GIS Applications in Civil and Environmental Engineering. (3 Hours) This course introduces students to the basic concepts and skills necessary to engage applied Geographic Information Systems (GIS) with the field of Civil and Environmental Engineering. Students will gain basic theoretical knowledge required for development and successful use of GIS and practical training on use of a GIS software. This course will consist of lecture sessions, lab exercises and GIS project. While the principles taught will be general in nature, the students will be taught how to use the ArcView GIS software program, and working through several exercises that emphasize its use in Civil and Environmental Engineering. Selected topics include: GIS analysis procedures, integration of survey control for data acquisition and rectification, hardware software selection criteria, and error propagation analyses, Global Positioning Systems (GPS) and their use with GIS. Prerequisite: permission of the Department.

CIV 560 Environmental Engineering II. (3 Hours) The physical, chemical, and biological environmental engineering systems that are used to protect health and the environment. Examples include drinking water treatment, wastewater treatment, hazardous waste treatment, and air pollution control. Prerequisite: permission of Department.

CIV 561 Chemistry for Environmental Engineering. (3 Hours) The principles of physical, equilibrium, inorganic, and organic chemistry as they apply to drinking water treatment, wastewater treatment, natural water quality, air quality, and air pollution control. Applications in engineering design. Prerequisite: CIV 340, or CIV 560, or permission of Department.

CIV 562 Hazardous Waste Engineering. (3 Hours) Comprehensive study of the complex, interdisciplinary engineering principles involved in hazardous waste handling, collection, transportation, treatment, and disposal. Also covered are waste minimization, site remediation, and regulations important for engineering applications. Design constraints, engineering judgment, and ethical responsibility are covered. Contemporary hazardous waste issues and urban issues are also addressed. Prerequisite: CHEM 241, CHML 241, CIV 340, CIVL 340, or permission of Department. (Cross reference: CIV 468)

CIV 563 Microbiology for Environmental Engineering. (3 Hours) The microbiological principles that apply to wastewater treatment, drinking water protection, water quality, and disease transmission. Applications in engineering design. Prerequisite: CIV 560 or permission of Department.

CIV 564 Surface Water. (3 Hours) Water quantity, water quality, regulation of, and management of rivers, lakes, and wetlands. Applications in engineering design. Prerequisite: permission of Department.

CIV 565 Wetland Management for Environmental Engineering. (3 Hours) The physical, chemical, biological, and regulatory aspects of wetland ecosystems. The impacts of engineered structures on wetland systems, and the factors involved with developing specifications for wetland creation and restoration. Prerequisite: permission of Department.

CIV 566 Air Pollution and Control. (3 Hours) The sources of and engineering principles to prevent or control air pollution and to design and operate processes. Topics include the risks of air pollution to which the public is exposed, the principle and factor underlying the generation of pollutants, physical principles describing how pollution affects the atmosphere and human well-being, regulations which engineers will be expected to understand and comply with. The engineering aspects including principles governing pollutant production from stationary and mobile combustion systems, modeling of the generation and transport of pollutants in the atmosphere, methods for separation and removal of gases and particulates from a process gas stream. Prerequisite: permission of Department.

CIV 567 Environmental Remediation. (3 Hours) The course covers current engineering solutions for the remediation of soils and waters contaminated by hazardous waste or spills. The technologies to be covered include bioremediation, oxidation, soil vapor extraction, soil washing, surfactant-enhanced remedy, thermal treatment,

air stripping, solidification/stabilization, electrokinetic decontamination, underground barriers, permeable reactive treatment walls, and other newly-emerging technologies. The engineering principles behind the remediation technologies are emphasized. Examples of successful applications of the remediation technologies are discussed. Prerequisite: permission of Department.

CIV 568 Land Disposal of Waste. (3 Hours) Theoretical, regulatory, and practical aspects of the disposal of waste on lands. Decontamination and reclamation of lands contaminated by industrial activities and spills of industrial chemicals. The usefulness and environmental impact of the disposal of municipal and industrial wastes via land treatment and land filling. (3 Hours) Design considerations and engineering problems associated with the land disposal of septic tank effluent, municipal garbage, sewage sludge, sewage effluent, industrial and hazardous waste, and radioactive wastes. Prerequisite: permission of Department.

CIV 569 Environmental Systems Modeling. (3 Hours) Mathematical modeling of environmental systems, including rivers, lakes, estuaries, and air. Prerequisite: permission of Department.

CIV 570 Regional Geological Engineering. (3 Hours) Geological engineering problems unique to specific geomorphic and physiographic regions based on terrain, rock type, and geologic structure will be addressed. Examples will be presented to show how site-specific conceptual geologic models are necessary for successful engineering design in unique geologic regions of the United States. Prerequisite: permission of Department.

CIV 571 Principles of Geoenvironmental Engineering. (3 Hours) Topics in geoenvironmental engineering in an urban environment. landfill design and incineration options. Stability of landfills, geotechnical characteristics of landfills, liner systems. Waste characterization, minimization, collection, treatment, transport and disposal. Leachate characteristics and potential groundwater contamination, design constraints. Legal and ethical considerations. Prerequisite: permission of Department. (Cross reference: CIV 471)

CIV 572 Applied Geotechnical Engineering Design. (3 Hours) Practical real life urban projects and advanced laboratory experience in geotechnical engineering, construction dewatering, construction issues, safety and economy, urban geotechnical engineering issues, preparation of subsurface investigation and geotechnical engineering reports, ethical considerations, oral presentation. Pre or co-requisite: CIV 430 or permission of Department. (Cross reference: CIV 472)

CIV 573 Environmental Geology for Engineers. (3 Hours) Defines the role of Environmental Geology in the engineering design of remedial activities dealing with a wide range of geotechnical engineering problems. Fundamental concepts of environmental unity and the rising human population will be addressed. Topics will range from earthquakes to coastal processes with particular emphasis on landslides and water problems. Prerequisite: permission of Department.

CIV 574 Engineering Hydrogeology. (3 Hours) Defines the role of Hydrogeology in the engineering design of activities dealing with the interaction of ground and surface water. The course will address a wide range of topics including the role of water in earthquakes and landslides, land subsidence, swelling clay foundations, geothermal energy, engineered wetlands, cave and karst formation, contaminant transport, and water resources with emphasis in engineering design. Prerequisite: permission of Department.

CIV 575 Applied Geological Engineering. (3 Hours) Applications of geological concepts including geomorphology and structural geology in solving geological engineering problems. Study of engineering principles and properties of earth materials. Exploration during engineering design and methods of site investigations. Applications of instrumentation and equipment used for soil, rock, and water analyses. Prerequisite: permission of Department.

CIV 576 Geological Engineering Analysis. (3 Hours) Computer applications to geological engineering, analysis, design, and use of computers for geological engineering projects. Computer-aided engineering facilities and use of general productivity and engineering software. Numerical methods in the solution of geological engineering and related problems. Case study of a complex project and a large-scale engineering analysis. Prerequisite: permission of Department.

CIV 577 Air-Photo Interpretation for Terrain Evaluation. (3 Hours) Determination of soil, bedrock, and drainage characteristics of land areas by air-photo interpretation and analysis; physical characteristics of landforms; application of air-photo interpretation for engineering soil surveys, land use suitability evaluation, and land use planning, applications in engineering design. Prerequisite: permission of Department.

CIV 578 Applied Geophysics. (3 Hours) Gravity and magnetic theory and methods. Gravitational field of earth and gravity measurements applications to geological engineering problems. Imaging subsurface features of earth using basic principles of physics, namely elastic, electric, magnetic, and density properties of earth material. Applications in engineering design. Prerequisite: permission of Department.

CIV 579 Engineering Seismology. (3 Hours) Theory and applications in earthquake seismology, earthquake mechanics, wave propagation, earth structure, instrumentation, interpretation of seismograms, focal mechanisms, faults, paleoseismology, seismotectonics, earthquake locations and magnitudes, selection of ground motion parameters. Applications in engineering design. Prerequisite: permission of Department.

CIV 631 Linear Theory of Ocean Waves. (3 Hours) A systematic theoretical development of the linear

theory of simple harmonic ocean gravity waves, water particle kinematics, shoaling, refraction, diffraction, and reflection.

CIV 631L Linear Theory of Ocean Waves' Laboratory. (1 Hour) Laboratory for linear ocean wave theory generation and propagation of linear waves, measurement of wave properties and observation of wave transformations in shallow water.

CIV 632 Tides and Long Waves. (3 Hours) A systematic development of the theory of ocean tides, tidal forcing functions, near shore tidal transformations and tidal propagation in harbors and estuaries. An introduction to the response of harbors to long waves and the study of the generation of long ocean waves.

CIV 650 Small Watershed Hydrology. (3 Hours) The role of land conditions in dealing with engineering problems of applied hydrology with emphasis on the small watershed, limited data, and land management situations Gain a physically-based understanding of hydrologic processes that define the functions of small watersheds; Effects of natural and human disturbances on the components of the hydrologic cycle; Investigate special characteristics of small watersheds; Approaches for dealing with limited data; Use the understanding of applied hydrology to predict the impacts of various land use activities on terrestrial and aquatic ecosystems; Develop analytic tools to integrate land use and catchment characteristics to predict catchment response and guide watershed management. Topics include stream flow generation, hill slope hydrology, stream channel hydraulics, hydrograph separation, evapotranspiration, hydrologic tracers, riparian zone hydrology, and hyporheic zone hydrology. Applications in engineering design. Prerequisite: CIV 550 or permission of Department.

CIV 652 Hydraulic Engineering Design. (3 Hours) Design of water supply and transport systems; Design and analysis of structures for controlling and conveying water in both the built and natural environment; Engineering applications of hydraulic and hydrologic engineering; Analytic methods and computer models for the design and evaluation of water resource projects such as flood control and river basin development; Common models, and typical applications for water resource systems; Reservoir design, flood routing; and design of water distribution and storm water management systems, and sanitary sewers. Prerequisite: CIV 370 or permission of Department.

CIV 653 Advanced Design of Hydraulic Structures. (3 Hours) Analysis and characteristics of flow in open channels (natural and artificial); channel design considerations including uniform flow (rivers, sewers), flow measuring devices (weirs, flumes), gradually varied flow (backwater and other flow profiles, flood routing), rapidly varied flow (hydraulic jump, spillways), and channel design problems (geometric considerations, scour, channel stabilization, sediment transport); analysis and design of hydraulic structures such as dams, spillways etc. based on economic, environmental, ethical, political, societal, health and safety considerations. Prerequisite: CIV 370 or permission of Department. (Cross-Reference: CIV 466)

CIV 660 Physicochemical Processes in Water and Wastewater Treatment. (3 Hours) Fundamental principles, analysis, modeling, and design considerations of physical and chemical processes for water and wastewater treatment processes and operations. Drinking water treatment processes will be focused on while parallel wastewater treatment schemes also being discussed. Relevant water quality characteristics, standards, and regulations in engineering design will be reviewed. Prerequisite: CIV 561 or permission of Department.

CIV 661 Biological Processes in Wastewater Treatment. (3 Hours) Theory and applications of the biological processes available for the treatment of wastewaters. Fundamentals of biological degradations and transformation of pollutants. Microbial growth kinetics and modeling. Wastewater treatment processes, both aerobic and anaerobic, including suspended growth biological processes and attached growth processes. Emphasis on engineering design considerations and parameters. Prerequisite: CIV 660.

CIV 663 Design of Environmental Engineering Facilities. (3 Hours) Analysis and design considerations and constraints for environmental engineering facilities such as water and wastewater treatment plants, solid and hazardous waste landfills, and resources recovery facilities. Design of municipal wastewater treatment plant including site selection, plant layout, hydraulic profile, preliminary treatment processes (screening, sedimentation, flow equalization, etc.), secondary treatment processes (activated sludge, trickling filter), waste stabilization ponds/constructed wetland), and sludge treatment and disposal (thickening, centrifugation, belt press, anaerobic digestion, thermal process and land disposal). Completion of one major design project and two minor design projects. Prerequisite: CIV 661 or permission of Department. (Cross reference: CIV 460)

CIV 664 Limnology for Environmental Engineering. (3 Hours) The study of aquatic ecosystems, with an emphasis on lakes. The physical characteristics of water and lakes; the chemical characteristics of aquatic systems; the dominant plants and animals in lakes, streams, and wetlands. The impacts of pollution, engineered structures, and man-made alterations of lakes and streams. Prerequisite: permission of Department.

CIV 665 Environmental Law. (3 Hours) The major federal statutes and regulations that govern environmental protection. Included are the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, Superfund, and others. Prerequisite: permission of Department.

CIV 666 Advanced Waste Treatment Processes in Environmental Engineering. (3 Hours) An in-depth study of the biological processes used to treat wastewater, with an emphasis on recently published information. Prerequisite: CIV 661 or permission of Department.

CIV 667 Biological Process Engineering. (3 Hours) Applications of the principles of microbial kinetics and heat transfer to the analysis and design of biological engineering processes. Emphasis on applications in environmental engineering processes or projects. Prerequisite: permission of Department.

CIV 668 Bioenvironmental Engineering. (3 Hours) Engineering principles for the design of systems for the biological treatment and utilization of organic by-products from animal and crop production and from industrial processes such as and food and crop processing industries. Design of best management practices to protect bioenvironmental resources by minimizing non-point pollution (off-site movement of sediment, nutrients and other constituents) and by minimizing nuisance odors associated with land applied organic residues, inorganic fertilizers and pesticides. Economic utilization of beneficial components of typical wastes. Prerequisite: permission of Department.

CIV 669 Advanced Topics in Environmental Engineering. (Variable 1-3 Hours) Course will focus on a variety of topics in the field of environmental engineering. May be repeated for credit. Prerequisite: permission of Department.

CIV 670 Rock Mechanics. (3 Hours) Classification of rock masses, stress and strain in rock, elastic and time-dependent behavior of rock, state of stress in rock masses, failure mechanisms, construction applications, geological and engineering applications. Prerequisite: permission of Department.

CIV 671 Advanced Topics in Geological Engineering. (Variable 1-4 Hours). Course will focus on a variety of topics in the field of geological engineering. May be repeated for credit. Prerequisite: permission of Department.

CIV 672 Advanced Geomechanics. (3 Hours) Theoretical and quasi-theoretical approaches for advanced soil mechanics including stress analysis, consolidation theory, immediate settlement, and saturated and partially saturated soils; problem idealization; introduction to rock mechanics; engineering judgment. Prerequisite: CIV 380 or permission of Department.

CIV 673 Advanced Foundation Engineering. (3 Hours**)** Advanced topics in foundations design, special cases of shallow foundations; horizontal load capacity of pile foundations; battered piles, load calculation of pile groups. Drilled caissons; design and construction of sheet piles including cantilever and anchored sheet piles; earth pressures and stability of retaining structures; design of braced supports, cofferdams; design examples. Prerequisite: CIV 430 or permission of Department.

CIV 674 Soil Dynamics. (3 Hours) Study of soil behavior under various dynamic loadings including earthquakes. Laboratory & field techniques for determining dynamic soil properties and liquefaction potential. Factors affecting liquefaction; dynamic soil-structure interaction. Engineering design examples. Prerequisite: CIV 380 or permission of Department.

CIV 675 Earth Dams and Slopes. (3 Hours) Stability of natural and man-made slopes under various loading conditions, slope protection. Selection and measurement of pertinent soil parameters. Engineering design and construction of earth dams and embankments. Practical aspects of seepage effects and ground water flow. Flow net and its use; wells; filters; total and effective stress methods of slope analysis. Prerequisite: CIV 380 or permission of Department.

CIV 676 Tunneling. (3 Hours) Overview of tunneling practice in rocks and soft ground. Underground construction techniques. Geological aspects and major technical problems in tunneling. Various tunneling methods and selections. Design and support of tunnels in soft ground and rock. Prerequisite: Permission of Department.

CIV 677 Design and Construction with Geosynthetics. (3 Hours) Properties and behavior of geosynthetics including geotextiles, geogrids and other fabrics; applications in geotechnical and geo-environmental engineering; quantify hydraulic behavior; applications in remediation, retaining structures, and foundations construction. Prerequisite: permission of Department.

CIV 678 Soil Bioengineering. (3 Hours) Engineering practices and ecological principles for the assessment, design, construction and maintenance of living vegetation systems. Slope stabilization against shallow mass movement and erosion through vegetated reinforcement. Root reinforcement, erosion control, aesthetics and environmental factors in engineering design are considered. Prerequisite: permission of Department.

CIV 679 Advanced Topics in Geotechnical Engineering. (Variable 1-4 Hours) Course will focus on a variety of topics in the field of geotechnical engineering. May be repeated for credit. Prerequisite: permission of Department.

CIV 695 Scientific Writing Seminar. (1 Hour) Exercises in scientific writing format and style, with particular emphasis on writing abstracts and manuscripts for publication in referred archival journals.

CIV 696 Seminar. (1 Hour) Presentation of papers, projects and reports by visiting lecturers, graduate students, engineers, and community leaders.

CIV 697 Internship. (Variable 1-3 Hours) Supervised graduate internship and externship in various areas. Prerequisite: permission of Department.

CIV 698 Independent Study. (Variable 1-3 Hours) Intensive study of a special engineering project including research and literature review selected in accordance with student interests and arranged in consultation with the adviser. Topics will vary. Student will make period reports, and will prepare a scholarly paper at the end of semester. Prerequisite: permission of Department.

CIV 699 Thesis Research. (Variable 1-6 Hours) Master's thesis representing an independent and original research. Prerequisite: permission of adviser.

DEPARTMENT OF COMPUTER ENGINEERING

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Dr. A. Eldek, Assistant Professor
Dr. T. Ghirmai, Assistant Professor
Dr. R. Chia-Pin Liu, Assistant Professor
Dr. G. W. Skelton, Associate Professor

Computer Engineering Emphasis

Mission

- Provide a solid foundation in the design and implementation of computer systems emphasizing the development of both software and hardware. Provide an outstanding educational program that enables graduates to have a solid background in both theoretical and practical aspects of Computer Engineering in order to prepare them to make meaningful contributions to their profession.
- Provide an outstanding educational program that enables our graduates to become leaders in their profession by imparting fundamental principles, skills, and tools necessary to innovate and excel in engineering practice, research or academia.

Program Objectives

1. Afford students the opportunity for in-depth study of Computer Engineering concepts and theories
2. Provide state-of-the-art applications and implementations in the design of computer-based systems
3. Provide graduates with effective communications skills required for career advancement
4. Endow students with a sense of professionalism, professional ethics and active participation in the affairs of the profession
5. Engage faculty and graduate students in meaningful Computer Engineering research
6. Promote professional development and growth of students and faculty

Core Courses		Semester
Course	**Title**	**Hours**
CPE 508	Operating Systems	3
CPE 512	Computer Architecture	3
CPE 515	Advanced Logic Design	3
CPE 541	Computer Networks	3

Elective Courses		
CPE 500	Software Engineering	3
CPE 505	Analysis of Algorithms	3
CPE 520	Advanced Engineering Analysis I	3
CPE 521	Advanced Engineering Analysis II	3
CPE 530	VLSI Design	3
CPE 531	VLSI Testing and Design for Testability	3
CPE 532	Digital Integrated Circuit Design	3
CPE 533	Fault-Tolerant Computing Systems	3
CPE 547	Modeling and Analysis of Computer and Communication Systems	3
CPE 552	Computer Vision	3
CPE 555	Control Systems	3
CPE 557	Robotics	3
CPE 560	Embedded Design with Microprocessors	3
CPE 601	Code Optimizations	3
CPE 610	Parallel Computing and Programming	3
CPE 611	Computer Arithmetic	3
CPE 630	Design Automation of VLSI Systems	3
CPE 640	Computer Security	3
CPE 641	Advanced Computer Networks	3
CPE 642	Computer Network Security	3
CPE 655	Advanced Control Systems	3
CPE 693	Advanced Topics in Engineering	1 to 4
CPE 695	Scientific Writing Seminar	1
CPE 696	Seminar	1
CPE 697	Internship	1-3
CPE 698	Independent Study	1-4
CPE 699	Thesis Research	1-6

Electrical Engineering Emphasis

Mission

Provide students with a solid foundation in electrical engineering, knowledge of technical specialty areas, and an appreciation for collaborative problem solving in order to make significant contributions to the profession.

Program Objectives

1. Provide students with a solid foundation in electrical engineering (EE), EE practices and major design skills to maintain high employability, adaptability to changing technologies, and an ability to conceive new technologies and innovative solutions to EE challenges
2. Graduates with effective communications skills required for career advancement
3. Endow students with a sense of professionalism, professional ethics and active participation in the affairs of the profession
4. Enable students to work effectively in a team environment

Core Courses		Semester
Course	**Title**	**Hours**
CPE 551	Digital Signal Processing	3
CPE 555	Control Systems	3
CPE 560	Embedded Design With Microprocessors	3
CPE 635	Advanced Circuit Theory	3
Elective Courses		
CPE 503	Computational Methods	3
CPE 515	Advanced Logic Design	3
CPE 520	Advanced Engineering Analysis I	3
CPE 521	Advanced Engineering Analysis II	3
CPE 530	VLSI Design	3
CPE 531	VLSI Testing and Design for Testability	3
CPE 532	Digital Integrated Circuit Design	3
CPE 536	Solid State Electronics	3
CPE 539	Lasers	3
CPE 544	Electromagnetic Field Analysis	3
CPE 556	Systems Theory	3
CPE 557	Robotics	3
CPE 571	Engineering Foundations of Biomedical Engineering	3
CPE 573	Biomedical Instrumentation	3
CPE 575	Biomaterials	3
CPE 655	Advanced Control Systems	3
CPE 693	Advanced Topics in Engineering	1 to 4
CPE 695	Scientific Writing Seminar	1
CPE 696	Seminar	1
CPE 697	Internship	1-3
CPE 698	Independent Study	1-4
CPE 699	Thesis Research	1-6

Telecommunications Engineering Emphasis

Mission

To provide quality education to prepare students to play a significant role in shaping the future telecommunication's environment, and to provide knowledge and skills necessary to foster life long learning.

Program Objectives

1. Provide students with both theoretical and practical foundations of telecommunications engineering
2. Engage faculty and students in research endeavors in telecommunications hardware, software, and systems
3. Promote professional development and growth of students and faculty
4. Produce graduates with effective communications skills required for career advancement
5. Endow students with a sense of professionalism, professional ethics and active participation in the affairs of the profession

Core Courses		Semester
Course	**Title**	**Hours**
CPE 540	Telecommunication Systems	3
CPE 541	Computer Networks	3
CPE 543	Wireless Communication Systems	3
CPE 551	Digital Signal Processing	3
Elective Courses		
CPE 500	Software Engineering	3
CPE 502	Telecommunication Software Design	3
CPE 520	Advanced Engineering Analysis I	3
CPE 521	Advanced Engineering Analysis II	3
CPE 534	Coding Theory	3
CPE 542	Computer and Network Security	3
CPE 545	Antennas	3
CPE 546	Digital Communication Systems	3
CPE 643	Wireless Networks	3
CPE 644	Optical Communication Systems	3
CPE 645	Microwave Circuits and Systems	3
CPE 646	Global Positioning Systems and Location Services	3
CPE 647	Mobile Computing Systems	3
CPE 648	Wireless Sensor Networks	3
CPE 649	Telecommunications Network Management	3
CPE 670	Wireless Design Laboratory	3
CPE 671	3G and 4G Wireless Networks	3
CPE 672	Network Quality Assurance and Simulation	3
CPE 673	Wireless Internet Application Development	3
CPE 693	Advanced Topics in Engineering	1 to 4
CPE 695	Scientific Writing Seminar	1
CPE 696	Seminar	1
CPE 697	Internship	1-3
CPE 698	Independent Study	1-4
CPE 699	Thesis Research	1-6

DESCRIPTION OF COURSES

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 502 Telecommunication Software Design. (3 Hours) Comprehensive course to familiarize telecommunication professionals with the state of the art in software concepts and technologies in modern telecommunications applications; examination of state-of-the-art software concepts and technology in modern telecommunications applications; focus on software process modeling as applied to telecommunications; application of software engineering concepts and processes; user interface design; reusability; reuse; reliability; distributed computing; real-time operating systems; interfacing with Optical/IP Networks; Personal Communication Service (PCS); switch control; heavy emphasis on real world application topics including

Optical/IP Network, Intelligent Network (IN) Service Creation, and Cellular/Personal Communication Service (PCS).

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 I. (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 Advanced 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 the theoretical un of 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 531 VLSI Testing and Design for Testability. (3 Hours) Introduction to testing of digital electronic circuits and systems; faults and fault modeling, test equipment, test generation for combinational and sequential circuits, fault simulation, memory and microprocessor testing, design for testability, built-in self-test techniques, and fault location.

CPE 532 Digital Integrated Circuit Design. (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 533 Fault-Tolerant Computing Systems. (3 Hours) Analysis and design of very high reliability and availability systems; fault types, reliability techniques, and maintenance techniques; case studies of high-availability long-life, life-critical systems; both hardware and software techniques for achieving fault-tolerance will be studied.

CPE 534 Coding Theory. (3 Hours) Introduction to linear codes; error detection and correction; bounds on the error correction capabilities of codes; Hamming distance code; linear block codes; syndrome decoding of linear block codes; cyclic codes; error trapping; decoding; burst error correcting codes; convolutional codes with threshold, sequential and viterbi decoding; cyclic random error correcting codes; P-N sequences; cyclic and convolutional burst error correction codes; other coding conceptions and implementations.

CPE 536 Solid State Electronics. (3 Hours) This course explores the electronic properties of semiconductor and related materials used in modern day devices. For common semiconductor devices, operation, electrical characteristic, manufacturing and applications are covered.

CPE 539 Lasers. (3 Hours) Review of electromagnetic theory; ray tracing in an optical system; Gaussian beam propagation; resonant optical cavities; study of excitation and laser mechanisms in gas and semiconductor lasers.

CPE 540 Telecommunication Systems. (3 Hours) Preparatory course for all subsequent graduate work in telecommunications; theoretical and technical foundation for the analysis and design of communications systems; use of classical and modern mathematical analysis techniques, including Fourier Series and Fourier Transform; classical modulations techniques (amplitude, frequency, phase).

CPE 541 Computer Networks. (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 542 Computer and Network Security. (3 Hours) In-depth examination of computer and network security; coverage of encryption, public/private keys, certificates, security of wired and wireless communication systems; invasion and intrusion techniques and detection; security architectures; network and computer risk analysis; biometrics and their application to computer security will be examined.

CPE 543 Wireless Communication Systems. (3 Hours) Principles of mobile communication systems; models of wave propagation; compensation for fading; modulation, demodulations; coding, encoding; multiple-access techniques; performance characteristics of mobile systems; wireless device characteristics; low-power mobile devices; wireless communication system design; mobile and cell antenna designs.

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 546 Digital Communication Systems. (3 Hours) Maxwell's equations; numerical propagation of scalar waves; numerical implementation of boundary conditions; absorbing boundary conditions for free space and waveguides; selected applications in telecommunications, antennas, microelectronics, digital systems.

CPE 547 Modeling and Analysis of Computer and Communication Systems. (3 Hours) Modeling of single and multiprocessor systems, single and multi-stage interconnection networks, computer networks; analysis using Stochastic processes, Markov and Queuing techniques; modeling using Petri Nets and Finite State models.

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 computer vision; algorithms and architectures for artificial intelligence 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 556 Systems Theory. (3 Hours) Linear operators; impulse response including convolution; transition matrices; fundamental matrix; linear dynamical system; definition; representation; diagramming principles; signal flow diagramming; analog and digital modeling; controllability and observability; eigenstructure; similarity transformations.

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

CPE 560 Embedded Design with Microprocessors. (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 571 Engineering Foundations of Biomedical Engineering. (3 Hours) This course is designed for engineering graduate students who come from traditional engineering disciplines and provides a comprehensive survey of the multi-disciplinary field of biomedical engineering. This course is intended to provide a broad perspective of the role that biomedical engineers play and to serve as an engineering foundation for subsequent, more advanced courses in biomedical engineering. Prerequisite: permission of Department

CPE 573 Biomedical Instrumentation. (3 Hours) Origins and characteristics of bioelectric signals, recording electrodes, amplifiers, chemical, pressure and flow transducers, noninvasive monitoring techniques, and electrical safety. Prerequisite: CPE 571

CPE 575 Biomaterials. (3 Hours) Introductory course in biomaterials. Topics include structure property relationships for synthetic and natural biomaterials, biocompatibility, and uses of materials to replace body parts. Perquisite: CPE 571

CPE 601 Code Optimizations. (3 Hours) Discussion of methods to improve the performance of code generated by compilers; data-flow and dependence analysis, peep-hole optimization, instruction scheduling, and parallelism enhancing transformations; techniques to improve the utilization of registers, instruction level parallelism, and memory hierarchies in modern computer systems.

CPE 610 Parallel Computing and Programming. (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; performance analysis of parallel algorithms; parallel programming environments: P threads for shared memory multiprocessor systems and PVM/MPI for distributed networks computers.

CPE 611 Computer Arithmetic. (3 Hours) Theory and application of computer arithmetic, design, and analysis of computer arithmetic units: fast adders, fast multipliers, shifters, dividers, and floating-point arithmetic units.

CPE 630 Design Automation of VLSI Systems. (3 Hours) Theory and algorithms for design automation, design automation tools in VLSI systems, Advanced VSLI design principles, Verilog and VHDL hardware description languages; timing-driven physical design and synthesis, circuit simulation and validation, formal verification, design for reuse and System on Chip (SOC) design methodology.

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 640 Computer Security. (3 Hours) Comprehensive introduction to field of computer security; security architectures; physical security; communications security; system security; operational security; network and computer risk analysis; invasion and intruder techniques; case studies; in-depth examination of cryptography; biometrics and their application to computer security will be examined.

CPE 641 Advanced Computer Networks. (3 Hours) Concepts and fundamental design principles of computer networks and Internet that have contributed to modern network implementations; survey of new trends in networks and Internet/intranet with design of real networks; topics include discussion of fundamental aspects of Internet application layer (HTTP, FPT, DNS), TCP/UDP socket programming, reliable data transfer, congestion control; network layer (IPv4 and IPv6) and routing; link layer and Local Area Networks (LAN); multimedia networking (RTSP, RPT, RSVP, DiffServ); security in computer networks.

CPE 642 Computer Network Security. (3 Hours) Principles and concepts in computer network security; introduction to cryptography, confidentiality, authentication, digital signatures, E-mail security, IP security, Web security, intruders, intruder detection, malicious software, firewalls, biometrics as applied to security, and other network security-related issues.

CPE 643 Wireless Networks. (3 Hours) Wireless architectures and networking; examination of both wireless LANs and mobile wireless networks; wireless network protocols; channel and resource allocation; mobile IP; wireless data management; Quality of Service (QoS); performance modeling; related wireless networking topics; examination of various architectures and standards (802.11, 802.15, 802.16), IR, and other related protocols.

CPE 644 Optical Communication Systems. (3 Hours) Principles of optical communication systems and fiber optic communication technology; characteristics of optical fibers, laser diodes, and laser modulation; laser and fiber amplifiers; detection; demodulation; dispersion compensation; system typologies.

CPE 645 Microwave Circuits and Systems. (3 Hours) Operating principles of devices at microwave and millimeter wave frequencies; sources; detectors; waveguide; cavities; antennas; scattering parameters; impedance matching; system design.

CPE 646 Global Positioning Systems and Location Services. (3 Hours) Examination of satellite navigation systems; overview of transition from radio navigation systems to modern satellite-based systems; examination of satellite signal propagation, clock accuracy, and injected errors and their effect on accuracy; application of GPS and location services as related to autonomous mobile vehicles and public safety; examination of alternative location services and their comparison to GPS.

CPE 647 Mobile Computing Systems. (3 Hours) Overview of the emerging field of mobile computing; land mobile vs. satellite vs. in-building communications systems; RF vs. IR; cellular telephony; mobility support in cellular teleTelephone networks; Personal Communications Systems/Personal Communications Networks; wireless local area networks; direct broadcast satellite; low earth orbiting satellites; examination of data

management, reliability issues; mobile IP; end-to-end communication; channel and other resource allocation; routing protocols; 2G and 3G standards and protocols such as TDAM, CDMA, GMS, PCS will be discussed.

CPE 648 Wireless Sensor Networks. (3 Hours) Survey of the field of wireless communications as related to low-power embedded sensor networks including communications standards and protocols, e.g. 802.11, Bluetooth, 802.15.4/Zigbee; examination of network services including reliable delivery, routing, naming, and security; examination of system architectures, operating systems and language support, distributed algorithms, and applications for wireless sensor networks; target tracking, data collection and analysis, power and resource management; a sensor network is implemented during the course.

CPE 649 Telecommunications Network Management. (3 Hours) Systematic examination of standards, basic concepts, current practices in telecom system management; Telecommunications Network Management (TNM) and OSI coverage; coverage of major telecom management standards; examination of management issues relating to both wireless mobile networks and traditional telecom systems, coverage of essential features of TNM architectures; examination of management of telecommunication network equipment and services; interoperability in a multi-supplier environment.

CPE 655 Advanced Control Systems. (3 Hours) Linearization of nonlinear systems; phase-plane analysis; Lyapunov stability analysis; adaptive estimation; stability of adaptive control systems.

CPE 670 Wireless Design Laboratory. (3 Hours) Laboratory experiments directed towards in-depth understanding of the implementation of components used in wireless communications; practical experience in the use of Bluetooth, WiFi, 802.11, and RF related components and networks.

CPE 671 3G and 4G Wireless Networks. (3 Hours) Examination of the technical, business, and regulatory issues surrounding third and fourth generation (3G and 4G) wireless communication systems; examination of the evolution of the various generation of wireless communications; focus on CDMA, Wideband CDMA, 3G, GSM, 4G designs and applications; extensive use of case studies; examination of both protocols and physical implementations.

CPE 672 Network Quality Assurance and Simulation. (3 Hours) Focus on the theoretical and practical aspects of network simulation and quality assurance; fundamentals of simulation and statistical modeling; random variable distributions; random number generation; wireless network performance; distributed systems; distributed and parallel systems and services; resolution in simulation; modeling and abstraction in multilevel simulation; distributed simulation consideration; implementation of actual network simulation and modeling project.

CPE 673 Wireless Internet Applications Development. (3 Hours) Course focuses on the Wireless Application Protocol (WAP) and the Wireless Markup Language (WML), Microsoft Mobile .Net framework, Java Server Pages, Active Server Pages, CGI, and related protocols; attention is directed to development of applications using both thin and thick client models; course is composed of development of applications using both simulators and actual application servers and wireless devices such as WAP enabled Telephones, PDAs, and personal communication devices.

CPE 693 Advanced Topics in Engineering. (Variable 1 to 4 Hours) Pre-requisites: 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 695 Scientific Writing Seminar. (1 Hour) Exercises in scientific writing format and style, with particular emphasis on writing abstracts and manuscripts for publication in referred archival journals.

CPE 696 Seminar. (1 Hour) Presentation of papers, projects and reports by visiting lecturers, graduate students, engineers, and community leaders.

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

CPE 698 Independent Study. (Variable 1-4 Hours) 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. Prerequisite: permission of Department.

CPE 699 Thesis Research. (Variable 1-6 hrs) Master's thesis representing independent and original research. Prerequisite: permission of advisor.

DEPARTMENT OF COMPUTER SCIENCE

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Faculty

Dr. C. Bland, Assistant Professor
Dr. W. Brown, Associate Professor
Dr. T. Haile, Associate Professor
Dr. S. Hong, Assistant Professor
Dr. H. Kettani, Assistant Professor
Dr. H. Kim, Assistant Professor
Dr. X. Liang, Assistant Professor
Dr. Q. Malluhi, Professor
Dr. T. Pei, Assistant Professor

The Department of Computer Science offers the Master of Science in Computer Science. The curriculum can be geared to 1) provide training for those preparing to enter fields where a substantial working knowledge of computing is required, 2) provide additional training to people already working in the field, and/or 3) prepare students for study at the doctoral level.

Program Objectives

1. To afford students the opportunity for in-depth study of Computer Science concepts and theories.
2. To keep abreast of, and expose students to, state-of-the-art, as well as state-of-the-practice, computer applications and technologies.
3. To engage faculty and students in meaningful computer science research, and computer science applications research and development.
4. To promote professional development and growth o f students and faculty.

Admission Requirements

In addition to satisfying the university requirements to enter the graduate school, students must meet other specific requirements in order to be formally admitted to the Department of Computer Science program. Ideally, students will have a B.S. in Computer Science, or a related field, and at least the equivalent of the following courses:

CSC 118	Programming Fundamentals
CSCL 118	Programming Fundamentals Lab
CSC 119	Object-Oriented Programming
CSCL 119	Object-Oriented Programming Lab
CSC 216	Computer Architecture and Organization
CSC 216L	Computer Architecture and Organization Lab
CSC 225	Discrete Structures
CSC 228	Data Structures and Algorithms
CSC 228L	Data Structures and Algorithms Lab
CSC 312	Advanced Computer Achitecture
CSC 325	Operating Systems
BIO 111	General Biology
CHEM 141	General Chemistry
MATH 231	Calculus I
MATH 232	Calculus II
MATH 355	Probability and Statistics
PHY 211	General Physics I
PHY 212	General Physics II

Students who do not have the required background may be admitted as special students. These students must take specified courses to make up deficiencies and no credit toward the degree is awarded for courses prescribed to satisfy entrance requirements.

Degree Requirements

The Department offers courses on a semester basis. Thirty-six credit hours are required for a master's degree. All students are required to pass the departmental Graduate Comprehensive Examination. A thesis or project option may be chosen.

Areas of Emphasis

Software Engineering	Artificial Intelligence
Computer Architecture	Numerical Analysis
Parallel/Distributed Processing	Simulation
Database Management Systems	Operating Systems
Programming Languages	Information Systems

Core Courses

Course	Title	Semester Hours
CSC 512	Computer Architecture	3
CSC 515	Data Structures and Algorithm Analysis	3
CSC 518	Operating Systems	3
CSC 519	Principles of Programming Languages	3
	Total Hours	12

Major Courses

(Students must choose four major courses for a total of 12 hours)

CSC 520	Database Systems	3
CSC 524	Comp. Com. Netwks and Distrib. Processing	3
CSC 529	Compiler Construction	3
CSC 530	Theory of Computation	3
CSC 532	Numerical Methods	3
CSC 535	Information Systems Analysis and Design	3
CSC 545	Artificial Intelligence	3
CSC 560	Software Engineering	3

ELECTIVES

(Students must choose two electives)	6
OPTION A: THESIS	6
OPTION B: PROJECT	3
ONE ADDITIONAL COURSE	3

TOTAL REQUIRED FOR DEGREE:

(either option)	36

DESCRIPTION OF COURSES

CSC 505 Computer Mathematics. (3 Hours) Elements of set theory, functions and relations nondecimal numbers, data representation, boolean algebra. Review of elementary differential and integral calculus with applications to the problems in computer science.

CSC 508 Legal and Economic Issues in Computing. (3 Hours) A presentation of the interactions between users of computers and the law and a consideration of the economic impacts of computers. Includes discussion of computer crime, privacy, electronic fund transfer, and automation.

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 514 Statistical Methods for Research Workers. (3 Hours) Estimation and tests of hypotheses; regression and correlation; analysis of variance; non-parametric statistics; chi-square. SAS programming for data analysis.

CSC 515 Data Structures and Algorithm Analysis. (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 Operating Systems. (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 Principles of Programming Languages. (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 520 Data Base Management Systems. (3 Hours) Introduction to data base concepts including data independence; relations; logical and physical organizations; schema and subschema. Hierarchical, network, and relational models with description of logical and physical data structure representation of the database system. Normalization: first, second, and third normal forms of data relations. Relational algebra and relational calculus; data structures for establishing relations; query functions.

CSC 521 Linear Algebra and Finite Mathematics. (3 Hours) Matrices and determinants; ranks of matrix; inverse of matrix; solving systems of linear equations; bases of a vector space; probability; permutations and combinations; Gaussian vector space; probability; elimination, Gauss-Seidel iteration.

CSC 523 Probability and Statistical Inference. (3 Hours) Elements of probability; combinatorial methods; discrete and continuous distributions; cumulative distribution functions; moment generating functions; distribution associated with normal distributions derived distributions.

CSC 524 Computer Networks and Distributed Processing. (3 Hours) Topologies, media selection, medium access control for local area networks (LANs) including highspeed and bridged LANs; circuit switched, ISDN wide area networks (WANs) internetworking issues and standards, 150/051, TCP/IP protocols.

CSC 526 Automata Theory. (3 Hours) Definition and representation of finite state automata and sequential machines. Equivalence of states and machines, congruence, reduced machines, and analysis and synthesis of machines. Decision problems of finite automata, partitions with the substitution property, generalized and complete machines, probabilistic automata, and other topics.

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 529 Compiler Construction. (3 Hours) An introduction to the major methods used in compiler implementation. The parsing methods of LL(k) and LR(k) are covered as well as finite state methods for lexical analysis, symbol table construction, internal forms for a program, run time storage management for block structured languages, and an introduction to code optimization.

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 531 Computer Simulation Methods and Models. (3 Hours) A study and construction of discrete-system simulation models. Use of discrete-system simulation language (GPSS/H), advance programming techniques, random number generation, generation of various random variate, and statistical validation procedure.

CSC 532 Numerical Methods. (3 Hours) Applying principles and techniques for computing methods. Solution of linear and nonlinear equations. Matrix methods for systems of equations. Polynomial approximation. Numerical integration. Solution of ordinary differential equations using various methods.

CSC 533 Distributed Database System. (3 Hours) Prerequisites: CSC 520, 524. A consideration of the problems and opportunities inherent in distributed database on a networked computer system. Includes file allocation; directory systems; deadlock detection and prevention; synchronization; query optimization; and fault tolerance.

CSC 535 Information System Analysis and Design. (3 Hours) Prerequisite: 519. A practical guide to information systems programming and design. Theories relating to module design, coupling, and module strength are discussed. Techniques for reducing a system's complexity are emphasized. The topics are oriented toward the experienced programmer or systems analyst.

CSC 539 Special Topics in Computer Science. (Variable 1-9 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 540 Microcomputer Local Area Networks. (3 Hours) Prerequisites: 518. This course describes various criteria for selecting and implementing local area networks (LANs) consisting of microcomputers.

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 549 Applied Combinatorics and Graph Theory. (3 Hours) A study of combinatorial and graphical techniques for complexity analysis including generating functions, recurrence relations, Polyal's theory of counting, planar directed graphs, and NP-complete problems. Applications of the techniques to the analysis of algorithms in graph theory, sorting, and searching.

CSC 555 Information Storage and Retrieval: (3 Hours) Advanced data structures, databases, and processing systems for access and maintenance. For explicitly structured data, interactions among these structures, access patterns and design of processing/access systems. Data administration, processing system life cycle, system security.

CSC 560 Software Engineering: (3 Hours) Formal approach to techniques and software design and development. Software cycle emcompassed 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 595 Information Systems Development Project: (Variable 1-6 Hours) Prerequisites: 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 599 Thesis Research. (Variable 1-6 Hours) Prerequisites: Pass comprehensive examination and consent of advisor. An independent study course for the preparation of a Master's thesis.