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

Dr. Loretta A. Moore, Associate Professor and Chair

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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.

SCHOOL OF SCIENCE AND TECHNOLOGY

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Departments

- Biology
- Chemistry
- Mathematics
- Physics, Atmospheric Sciences & General Science
- Technology

The School of Science and Technology resulted from the merger of the School of Industrial and Technical Studies and the Division of Natural Sciences, previously in the School of Liberal Studies. This reorganization was authorized July 1, 1983 for the purpose of consolidating the scientific and technical resources of the University into an efficiently focused endeavor capable of meeting the demands of new technology.

The departments comprising the School of Science and Technology are: (1) Department of Biology, (2) Department of Chemistry, (3) Department of Mathematics, 4) Department of Physics, Atmospheric Science and General Science, and (5) Department of Technology. The school offers graduate programs in various areas leading to the M.S., M.S.T., and Ph. D. degrees.

Active research programs in all departments are consistently maintained. The School of Science and Technology is also actively involved in a number of cooperative external programs with national and international institutions designed to enhance student and faculty development. The cooperative programs serve to broaden faculty and student exposure as well as give national and international visibility to Jackson State University.

DEPARTMENT OF BIOLOGY

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Faculty

Dr. G. Begonia, Professor
Dr. M. Begonia, Associate Professor
Dr. J. Cameron, Professor
Dr. P. Chigbu, Associate Professor
Dr. S. Ekunwe, Associate Professor
Dr. I. Farah, Associate Professor
Dr. K. Goldman, Assistant Professor
Dr. M. Hardy, Professor
Dr. E. Hamadain, Associate Professor
Dr. C. Howard, Assistant Professor
Dr. H. Hwang, Professor
Dr. E. Izevbigie, Associate Professor
Dr. R. Kafoury, Assistant Professor
Dr. A. Mohamed, Professor
Dr. J. Stevens, Assistant Professor
Dr. B. Wilson, Associate Professor

The Department of Biology offers graduate study leading toward the following advanced degrees: Master of Science (M.S.), Master of Science in Environmental Science (M.S.), and Master of Science in Teaching (M.S.T.).

Program Objectives

1. To provide academic and practical training of high quality at the master's degree level,
2. To contribute to the pool of biologists qualified to undertake doctoral degree programs, and to obtain employment in industry, government and academic institutions, and
3. To offer a program that will enable environmental science majors to obtain the necessary classroom, laboratory and field experiences required for entering areas in and related to environmental science directly upon graduation.

Degree Programs

The M.S. is research-oriented; the M.S.T. is generally a course-oriented degree. All are designed to satisfy academic requirements for those students intending eventually to seek degree(s) beyond master's or specialist's level.

Admissions Requirements

All applicants seeking admission to the Master of Science program in Biology must meet the following minimum admission requirements:

1. An undergraduate degree in biology or related field.
2. A passing grade (C or better) in undergraduate biology courses with a grade point average of 3.00 or higher as evidenced by an official transcript
3. Three letters of recommendation from former college professors sent directly to the department.
4. Satisfactory score on the GRE, sent directly to the department.
5. Applicants must also meet all the requirements as set forth by the Graduate School

Transfer of Credits

Course for which transfer credit are sought must have been completed with a grade of "B" or better. Approval is required by the Chair of the Department and Director of the MS program.

Time Limit

No student will be granted an MS degree unless all requirements are completed within a period of eight (8) consecutive calendar years from the time of admission to the program.

Residence

Students are required to spend one academic year in resident study on the campus. One academic year may include two adjacent regular semesters or one regular semester and one adjacent summer session. To satisfy the continuous residence requirement, the student must complete a minimum of eighteen (18) hours for the required period.

Master of Science in Biology

Courses available for the M.S. degree in Biology provide appropriate preparation for:

1. Biological, marine and environmental sciences.
2. Advanced professional degrees elsewhere in zoology, plant science, marine science, environmental biology, environmental health, toxicology and meteorology, physiology, microbiology, biochemistry, anatomy and other associated areas.
3. Research careers in industry, government and academic institutions.
4. Professional degrees in medicine, dentistry, veterinary medicine, pharmacy and related health fields.

Degree Requirements

A student is required to complete a minimum of thirty (30) semester hours with a "B" or better average and submit an acceptable thesis. Six (6) of the required credits must be in "Thesis Research".

Required Courses

Course	Title	Semester Hours
BIO 511	Biostatistics	3
BIO 515	Molecular Biology, or	
BIO 540	Cell Biology, or	
CHEM 531	Biochemistry	4
BIO 589	Graduate Seminar	1
BIO 599	Thesis Research	6
	Total Hours	14

Elective Concentration Courses

A student in consultation with his/her advisor and guidance committee must select a minimum of sixteen (16) semester hours from departmental course offerings to complete degree requirements with emphasis in one of the following areas.

Molecular and Developmental Biology
Genetics and Microbiology
Anatomy and Physiology
Plant Science
Environmental and Marine Biology
Invertebrate Zoology

Master of Science in Teaching Degree

The Master of Science in Teaching degree provides: (1) M.S.T. at Jackson State University, (2) Advanced certification for teacher education in the biological sciences, (3) Careers in educational administration, and (4) Advanced degrees in science education and related fields.

Degree Requirements

A student seeking the M.S.T. degree may select from one of three programs options, i .e.

1. Thirty (30) semester hours plus an acceptable thesis. Six (6) of the required credits must be in BIO 599-Thesis Research.
2. Thirty-three (33) semester hours plus an acceptable research project. Three of the required credits must be in BIO 587-Independent Study.
3. Thirty-six (36) semester hours.

Required Core

Course	Title	Semester Hours
EDFL 511	History and Philosophy of Education	3
PSY 566	Advanced Educational Psychology	3
EDFL 568	Curriculum Methods	3
EDFL 515	Methods of Educational Psychology	3
EDFL 514	Elementary Statistics	3
	Total hours	15
BIO 509	General Genetics	4
BIO 515	Molecular Biology	4
BIO 523	Ecology	4
BIO 589	Graduate Seminar	1
	Total hours	13

*Any student who does not have a Class "A" teaching certificate must also complete the following course requirements for certification.

PSY 305	Adolescent Psychology	3
BIO 401	Biology in Secondary Schools or	4
BIO 505	Biology for Teachers	
EDCI 591	Practicum and Student Teaching	9
	Total Hours	16

Elective and Concentration Courses

A student selecting program options No. 2 or 3 in consultation with his/her advisor and guidance committee must select sufficient electives (see below) from departmental courses to complete degree requirements with emphasis in one of the following areas.

Molecular and Developmental Biology
Plant Science
Genetics and Microbiology
Environmental and Marine Biology
Invertebrate Zoology
Anatomy and Physiology

Total Required Hours Brought Forward (All Options)		21
Option 1:		
BIO 599	Thesis Research	6
	Elective in biology, environment or general sciences	3
	Total Hours	30
Option 2:		
Bio 587	Independent Study	2
	Electives in biology, environment or general sciences	10
	Total Hours	33
Option 3:		
	Electives in biology, environment or general sciences	15
	Total Hours	36

Master of Science
ENVIRONMENTAL SCIENCE

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Dr. E. Hamadain, Associate Professor
Dr. M. Hardy, Professor
Dr. R. Kafoury, Assistant Professor
Dr. E. Izevbigie, Associate Professor
Dr. P. Tchounwou, Distinguished Professor
Dr. B. Wilson, Associate Professor

Program Objectives

More than ever, responsible decision making in an age of global awareness requires more information on the consequences of our actions. Decisions based on new information need to be global, cooperative and interdisciplinary if we are to chart a course toward a sustainable world. The MS Environmental Science Program helps provide the student with the tools and knowledge to ask the proper questions and help provide acceptable answers. Research is needed in the federal, state and private sectors to raise consciousness, arouse curiosity, and provide information for environmental evaluation. Qualified professionals are required by government agencies to carry out and enforce mandated laws in the protection of the environment. The Environmental Science Masters program is located academically in the Department of Biology and serves students in the School of Science and Technology.

Objectives of this program are:

- to provide an education that allows for greater opportunities in employment and further education in the diverse field of environmental science, particularly as the need relates to minorities and women.
- to provide a cadre of trained individuals committed to using their environmental literacy toward the betterment of the environment and mankind.

Admission Requirements

Admission is open to persons holding an undergraduate degree in a science with the following prerequisites:

1. An undergraduate science degree from an accredited institution with a grade point average of 3.00 or higher as evidenced by an official transcript.
2. Demonstrated satisfactory performance on the Graduate Record Examination (GRE) taken preferably before entrance into the program.
3. Three letters of recommendation.
4. A career goals essay.
5. A personal and/or telephone interview may be required
6. Other considerations such as work or life experiences which are directly related to potential success for completion of the program may be factored into the admission criteria.

Degree Requirements

The student will be required to complete a minimum of 30 semester hours, 24 of these hours will include course work whereby a B of higher will be maintained. A minimum of 6 semester hours will be taken in Thesis Research leading toward the completion of an acceptable thesis. The student will follow a testing schedule consisting of written graduate comprehensive and the thesis defense.

The student in consultation with her/his advisor and committee will select elective courses from those areas and departments offering appropriate instruction. It is the student's responsibility to fill out and return all forms at the appropriate times during the student's tenure in the department.

Core Course Requirements

Course	Title	Semester Hours
BIO 506	Human Environments and Natural Systems	4
BIO 511	Biostatistics	3
BIO 523	Ecology	4
BIO 589	Graduate Seminar	1
	Total Hours	12

Elective Courses

BIO 514	Methods in Environmental Analysis	4
BIO 515	Molecular Biology	4
BIO 516	Marine Botany	4
BIO 512	Natural Resources and Conservation	4
BIO 531	Invertebrate Zoology	4
BIO 533	Biology of Water Pollution	4
BIO 534	Ichthyology	4
BIO 540	Cell Biology	4
BIO 546	Selected Topics in Marine/Env Sc	1
BIO 547	Introduction to Oceanography	4
BIO 553	Tropical Marine Ecology	4
BIO 580	Limnology	4
BIO 602	Special Problems in Env Science	1-4
BIO 610	Environmental Microbiology	4
BIO 615	Principles of Bioremediation	3
CHEM 515	Environmental Chemistry	4
ITHM 520-531	Industrial/Technical Hazardous Materials Management courses	3-6
BIO 599	Thesis Research	6

DESCRIPTION OF COURSES

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 Environments and Natural Systems (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.

BIOL 506 Human Environments and Natural Systems Lab. (1 Hour) Selected laboratory exercises, visiting lectures and field trips are designed to provide a broad view of applications and concepts in environmental science.

BIO 507 Biology for Elementary Teachers. (3 Hours) Prerequisites: None. The application of biological procedures and techniques at the elementary school level with emphasis on selected topics in biology.

BIOL 507 Biology for Elementary Teachers Laboratory. (1 hour) Prerequisite: Bio 101. Laboratory designed to expand and illustrate subject-matter areas stressed in Bio 507.

BIO 508 Fundamentals of Electron Microscopy. (4 hours) Prerequisites: Senior, graduate level, and consent of instructor. To introduce the students to the techniques of electron microscopy so that they may be able to initiate their own biological investigations. Emphasis will be placed on laboratory work.

BIO 509 General Genetics. (4 Hours) Prerequisite: Bio 318. A study of the principal concepts of heredity to include the application of classical and modern 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 and Conservation (3 hours) A study of our natural resources with emphasis on their origin, properties, use and misuse and good conservation practices.

BIOL 512 Natural Resources and Conservation Lab. (1 hour) Students are involved in the collection of data concerning the use and the analysis of conservation practices for both domestic and public waste, water, and energy resources.

BIO 513 Advanced Human Nutrition. (3 Hours) Prerequisites: 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 514 Methods of Environmental Analysis. (3 Hours) Theory, methods and techniques for identifying and qualifying environmental contaminants. Sampling methods are discussed and some coverage is provided on methods for separation and concentration.

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

BIOL 515 Molecular Biology Laboratory. (1 Hour) Prerequisite: Must be taken concurrently with Bio 515. Laboratory techniques used to purify proteins, DNA, and RNA and the methods used to analyze these macromolecules.

***BIO 516 Marine Botany.** (3 Hours) Prerequisites: Bio 119, Biol 119, Bio 416; open to qualified undergraduates. Survey of seaweeds (marine algae), marine phytoplankton and maritime vascular plants, treating structure, reproduction, life histories, distribution and ecology. Lecture and laboratory to be taken during same semester.

***BIOL 516 Marine Botany Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 516. Collection, preservation and preparation and microscopic examination with purpose of emphasizing identification of seaweeds.

BIO 520 Biological Photography. (3 Hours) Prerequisite: Consent of instructor. The course is designed to equip students with the knowledge and expertise to produce high quality prints and slides. Emphasis is placed on laboratory work (darkroom).

BIOL 520 Biological Photography Laboratory. (1 Hour) Laboratory activities give the student experience in exposing and developing black and white films and making prints with various print papers. Must be taken concurrently with Bio 520.

BIO 521 Plant Morphology. (3 Hours) Prerequisite: Bio 119. Study of anatomical, reproductive, ontogenetic and phylogenetic aspects of vascular and non-vascular plants.

BIOL 521 Plant Morphology Laboratory. (1 Hour) Selection of exercises involving the structures, developments and relationships of nonvascular and vascular plants.

BIO 522 Plant Taxonomy. (3 Hours) Prerequisite: Bio 119. Classification and nomenclature of flowering plants; introductory method of collection; laboratory and field studies of representative plant families.

BIOL 522 Plant Taxonomy Laboratory. (1 Hour) Prerequisites: Botany 118, 119. Exercises on collection, classification and nomenclature of flowering plants.

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

BIOL 523 Ecology Lab. (1 Hour) This lab course is designed to be, and should be, taken concurrently with the Ecology lecture course (BIO 523). The ecology laboratory sesions are structured to reinforce topics discussed in lecture and provide a treatment of technical topics not covered in the lecture. Methods common to the laboratory and field will be taught. Students will 1) gain a deeper understanding of the main concepts of ecology and ecological processes and 2) develop critical and analytical thinking skills along with reasoning and logical thinking skills, and apply them to ecological concepts.

BIO 524 Plant Physiology. (3 Hours) Prerequisite: Bio 119. Principal physiological processes of plants including water relation, synthesis, and use of foods and growth phenomena are discussed.

BIOL 524 Plant Physiology Laboratory. (1 Hour) Laboratory exercises will be continued to verify the principles of Plant Physiology.

***BIO 525 Introduction to Marine Geology. (1 Hour)** Prerequisites: Bio 408, 408A, or permission of instructor; open to advanced undergraduates. Introductory geology from the marine viewpoint; morphology and origin of ocean basins, plate tectonics, marine sedimentation, coastal features and marine georesources. Lecture and laboratory to be taken during same semester.

***BIOL 525 Introduction to Marine Geology Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 525. Field and laboratory exercises in recognition of geological features and specimens, study of techniques, core samples, mapping and marine topographic profiles.

BIO 526 Mycology. (3 Hours) Prerequisite: Bio 119. A survey of the principal fungal classes. Morphology and cytology of fungi and their relation to industry and agriculture.

BIO 528 Evolution. (3 Hours) Prerequisite: Bio 409 or the equivalent. A study of the processes of organic change. Historical developments of the major concepts and mechanisms. (S)

BIO 529 Plant Anatomy. (3 Hours) An introduction to cell division, development, and maturation of the structures of the vascular plants.

BIOL 529 Plant Anatomy Laboratory. (1 Hour) Selection of exercises involving cell division, development and maturation of the structures of vascular plants.

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

BIOL 530 Advanced Microbiology Laboratory. (1 Hour) Teaches the student special methods in isolating, culturing, and identifying certain microorganisms of medical and industrial importance. Must be taken concurrently with Bio 530.

BIO 531 Invertebrate Zoology. (3 Hours) Prerequisites: Bio 114, CHEM 142. Intended for students who wish to obtain a comprehensive knowledge of the invertebrates.

BIOL 531 Invertebrate Zoology Laboratory. (1 Hour) Prerequisite: Must be taken concurrently with Bio 531 . A taxonomy consideration of the invertebrate fauna. Students are also introduced to empirical observation in such areas as ecology, physiology and behavior.

BIO 532 Advanced Parasitology. (3 Hours) Prerequisites: 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.

BIOL 532 Advanced Parasitology Laboratory. (1 Hour) Prerequisite: Bio 331 and/or consent of the instructor. The course will emphasize the experimental approach to Parasitology. Important parasites of man and other animals will be studied from clinical specimens. Must be taken with Bio 532.

BIO 533 The Biology of Water Pollution (3 hours) Biological approaches to water pollution problems are discussed. The effect of pollution on life in aquatic environments is emphasized.

BIOL 533 The Biology of Water Pollution Lab. (1 hour) Selected laboratory exercises, instrument use, and field trips are designed to further enhance the student's awareness in water pollution effects, analysis and problem solving.

BIO 534 Ichthyology. (3 Hours) Prerequisites: Bio 115, Biol 115; open to advanced undergraduates. Biology and classification of marine and freshwater fish; emphasis on identification and collecting. Lecture and laboratory to be taken during same semester.

BIOL 534 Ichthyology Laboratory. (1 Hour) Prerequisites: Bio 115, Biol 115. Must be taken with lecture in Bio 534. Field collecting, sorting, preserving, classification of marine fish; emphasis on identification.

***BIO 539 Marine Microbiology.** (3 Hours) Prerequisites: Bio 313, Biol 313, 416, Biol 416. Open to advanced undergraduates. A survey of the most important marine microorganisms; emphasis on bacteria, sampling techniques, enumeration of indicator organisms, isolation of pathogenic organisms from seafood. Lecture and laboratory to be taken during same semester.

***BIOL 539 Marine Microbiology Laboratory.** (1 Hour) Prerequisites: 313, 416. Must be taken with lectures in Bio 539. Techniques in sampling, isolation, culture and enumeration of pathogenic and nonpathogenic marine microorganisms.

BIO 540 Cell Biology. (3 Hours) Prerequisites: 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.

BIOL 540 Cell Biology Laboratory. (1 Hour) Prerequisites: Bio 112,119, 313. Must be taken concurrently with Bio 540. Laboratory activities which develop techniques for isolation of cellular organelles and quantitative analyses of biomolecules.

BIO 544 Arthropod Disease. (3 Hours) Prerequisites: Bio 115, 427. Emphasis is given to the control and prevention of insect and other arthropod borne diseases, the physiology, taxonomy, life-cycles and ecology of important vectors.

BIOL 544 Arthropod Disease Laboratory. (1 Hour) Study the external structure and make outline sketches to indicate the characteristics used in classification of representative forms and unknown specimens of organisms important to medicine and veterinary science.

BIO 546 Selected Topics in Marine and Environmental Studies. (1-2 Hours) Prerequisites: None; open to advanced undergraduates or others on consent of instructor. Lectures on a broad range of marine and environmental topics of general interest having special application to students in both marine sciences program. No separate laboratory.

***BIO 547 Introduction to Oceanography.** (3 Hours) Prerequisites: Bio 407, Biol 407. CHEM 254 and CHML 254, or consent of instructor; open to advanced undergraduates. Broad view of the marine world, geological, geographical, chemical, physical and biological; field trips aboard research vessels and laboratories introducing applied uses of oceanographic gear, instruments and sampling techniques. Lecture and laboratory to be taken during same semester.

***BIOL 547 Introduction to Oceanography Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 547. Introduction to oceanographic gear, its application methodology and sampling techniques; field work in practical applications.

BIO 550 Immunology and 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.

BIOL 550 Immunology and Serology Laboratory. (1 hour) Prerequisite: Bio 313 Experimental application of immunology and serology in diagnosis of microbial diseases In vitro and in vivo techniques in immune response will be investigated.

BIO 553 Tropical Marine Ecology (3 hours) Opportunity for practical field exercises in selected tropical environments.

BIO 570 Human Physiology. (3 Hours) Prerequisites: 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.

BIOL 570 Human Physiology Laboratory. (1 Hour) Selected studies of the physiological processes of mammals with emphasis on man. Must be taken concurrently with Bio 570.

BIO 575 Endocrinology. (3 Hours) Prerequisites: 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.

BIOL 575 Endocrinology Laboratory. (1 Hour) Prerequisites: Bio 115, 218; CHEM 142, 242. Must be taken concurrently with Bio 575, or with the consent of instructor. Experimental analysis of normal and abnormal endocrine functions. Emphasis is placed on basic laboratory techniques employed in the study of endocrine function.

BIO 576 Histopathology. (3 Hours) Prerequisites: 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.

BIOL 576 Histopathology Laboratory. (1 Hour) Exercises studying gross and microscopic diseased tissues and clinical cases.

BIO 580 Limnology (3 hours) Physical and chemical factors affecting the biology of ponds, reservoirs, and streams is presented. A research project in limnology will be required.

BIOL 580 Limnology Lab. (1 hour) Both chemical and biological monitoring of aquatic systems will be explored. Hack kits, conductivity meters, oxygen probes, BOD's, COD's and map surveys will be utilized.

BIO 587 Independent Study. (2 for M.S. students) 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 for M.S. students) 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 590 Reproductive Physiology. (3 Hours) Prerequisites: Bio 115, CHEM 142, 242. Some prerequisites may be waived with approval of instructor. An advanced assessment of the physiology metabolism and histology of the reproductive system. The etiology of abnormal functions will be presented.

BIOL 590 Reproductive Physiology Laboratory. (1 Hour) Prerequisites: Bio 112, 218, CHEM 142, 242. Must be taken concurrently with Bio 590 or with consent of instructor. Experimental analyses of the mammalian reproductive system. Emphasis is placed on basic methodologies employed in anatomical and physiological studies of the reproductive system.

BIO 591 Advanced Developmental Biology. (3 Hours) Prerequisites: Bio 112, CHEM 242. Current experimental findings in the field of developmental biology will be presented. Theories on the mechanisms regulating differentiation and abnormal growth pattern will be discussed.

BIOL 591 Advanced Developmental Biology Laboratory. (1 Hour) Advanced laboratory techniques in the field of developmental biology will be presented and analyzed.

BIO 599 Thesis Research. (required for M.S. students) (6 Hours) Thesis representing original research.

BIO 600 Graduate Seminar Advanced topics investigated are presented by students. The student will be required to prepare and present reports and assigned projects. Required of all students.

BIO 601 Environmental Science Seminar Advanced topics of special interest, current research, field trips, demonstrations, and guest lectures in the areas of environmental science, limnology, ecology, water and air pollution, populations, solar energy, earth resources, and others.

BIO 602 Environmental Science Special Problems (4 hours) Each student will select an aspect of the environment beyond the limits of the campus. The student will define the problem, analyze it, and report on his findings and possible solutions. This problem will sometimes include on the job training with an environmental agency.

BIO 609 Advanced Genetics. (4 Hours) Prerequisite: Bio 509. Provides detailed considerations of genetic analysis, quantitative inheritance, chromosomal engineering and some concepts in genetics.

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.

BIOL 610 Environmental Microbiology Lab. (1 hour) Laboratory is designed to acquaint students with modern techniques for measuring microbial biomass and microbial degradative activities of natural and xenobiotic chemicals in natural environments. Specific projects of microbial analysis will be assigned to students.

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, 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.

BIOL 615 Principles of Bioremediation (1 Hour) Laboratory and field experiments conducted to familiarize students and methodologies. Identification and classification of microorganisms, use of bacteria in toxicity assessment, biodegradation of organic contaminants, and phytoremediation ot toxic metals are dicussed.

BIO 620 Independent Study 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 621 Advanced Plant Morphology. (4 Hours) Prerequisite: Bio 521. Analysis and morphology of vascular plants ranging from pteridophyta through angiosperms with phylogenetic considerations.

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 630 Thesis Research. Thesis representing original research.

*These courses (or close equivalents) also may be taken during summers at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi; Dauphin Island Sea Laboratory, Alabama, or other coastal teaching/research laboratory for credit at JSU subject to approval on individual basis by JSU administration and coastal laboratory administrators.

Doctor of Philosophy
ENVIRONMENTAL SCIENCE

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Faculty

(Interdisciplinary, listed by their Primary Department)

Biology:
Dr. M. T. Begonia, Assoicate Professor
Dr. P. Chigbu, Associate Professor
Dr. I. Farah, Associate Professor
Dr. E. Hamadain, Associate Professor
Dr. M. Hardy, Professor
Dr. H. Hwang, Professor
Dr. R. Isokpehi, Assistant Professor
Dr. R. Kafoury, Assistant Professor
Dr. A. Mohamed, Professor
Dr. A. Patolla, Assistant Professor
Dr. D. Sutton, Assistant Professor

Chemistry:
Dr. Z. Arslan, Assistant Professor
Dr. A. Hamme, Assistant Professor
Dr. J. Leszczynski, Distinguished Professor
Dr. Y. Liu, Associate Professor
Dr. H. Tachikawa, Professor
Dr. H. Yu, Associate Professor

Civil and Environemtal Engineering
Dr. F. Amini, Professor
Dr. Y. Li, Assistant Professor

Computer Engineering
Dr. M. Manzoul, Professor
Dr. R. Whalin, Professor

Computer Science
Dr. W. Brown, Associate Professor
Dr. Q. Malluhi, Professor
Dr. L. Moore, Associate Professor

Mathematics
Dr. T. Kwembe, Professor
Dr. R. Gompa, Professor

Physics, Atmospheric Sciences and General Science
Dr. Y. Li, Assistant Professor
Dr. S. Reddy, Associate Professor
Dr. Q. Williams, Associate Professor

Technology
Dr. I. Mosley, Associate Professor
Dr. P. C. Yuan, Professor

Program Mission

To produce highly skilled environmental scholars who in turn will provide for policy makers and the general public, scientific and factual information derived from laboratory and field applied research encompassing basic sciences, engineering and technology. As such, it is related to the assessment of water contamination, food contamination, air pollution, global warming, toxic and hazardous substances releases and associated environmental issues; and the development of cost-effective methodologies and strategies to protect the environment and human health.

Program Objectives

1. To provide graduate students with essential knowledge, skills and aptitudes needed for successful careers in environmental science related jobs at various institutions including government agencies, academia and the environmental industry.
2. To protect the environment and human health by educating and training students on the interactions between the various components/systems of the environment, the complex and fragile nature of the environment, and how to sustain ecosystem integrity and protect human health.
3. To establish applied environmental science research initiatives that will lead to an authoritative base of knowledge concerning the State of Mississippi's environment and natural resources; by assessing and understanding the mechanisms by which physical, chemical, and biological agents generated by nature many cause alterations of ecosystem integrity, disability and diseases in man and other life forms.
4. To develop and understand cost-effective methodologies and means whereby the impact of various environmental pollutants may be prevented and/or controlled, and to integrate important knowledge and technologies in the physical, chemical, biological and social sciences needed to set policies and guidelines for appropriate utilization and management of vital resources.
5. To render services to the community through outreach programs, technology transfer for the protection of natural resources and the development of the economy, and communication to convey environmental science education to the public.

Admission Requirements

Admission to the doctoral program in Environmental Science is open to persons holding the master's degree in science, technology, engineering, or agriculture; demonstrated satisfactory performance on the Graduate Record Examination (GRE), and the Test of English as Foreign Language (TOEFL) for international students; and acceptable academic records.

All students seeking admission to this Ph.D. Program must meet the following criteria:

1. A Master's degree in natural sciences or related sciences from an accredited university. *An applicant with a Bachelor's degree only may be admitted when that student shows exceptional potential as determined by a GPA of 3.5 or better, a satisfactory GRE, and extraordinary work experience*,
2. A completed program application submitted to the Graduate School,
3. An official score on the Graduate Record Examination (GRE),
4. An overall GPA of 3.25 or above (on a 4.0 scale) on the highest earned degree,
5. Transcripts for all post secondary and graduate work attempted prior to a program application,
6. Recommendations from three major graduate professors knowledgeable of the applicant's professional academic ability, job experiences, and leadership and research potential,
7. Acceptable evidence of a student's writing ability as determined by a writing sample,
8. A satisfactory TOEFL score for international students,
9. A successful interview with the program screening committee, and
10. Recommendation for admission by the program screening committee.

All applications received are reviewed by a standing Environmental Science Doctoral Advisory Committee which recommends acceptance or denial of admission to the Graduate School. The Graduate School officially informs the prospective student of its decision for the University.

Transfer Credits

A maximum number of nine credit hours can be transferred into the Program. Courses for which transfer credits are sought must be at least 700-Level; must have been completed with a grade of B or better; and must be approved by the student's Advisory Committee, the Environmental Science Advisory Committee, the Dean of the School of Science and Technology, and the Dean of the Division of Graduate Studies. Credit for thesis or dissertation research as well as "internship" course work in any form is not transferable.

Time Limit

No student will be granted a doctoral degree unless all requirements are completed within a period of ten (10) consecutive calendar years from the time of admission to the program.

Financial Aid

Graduate research and teaching assistantships are available on a competitive basis to highly qualified students.

Residence

Students are required to spend one academic year in resident

study on the campus. One academic year may include two adjacent regular semesters or one regular semester and one adjacent summer session. To satisfy the continuous residence requirement, the student must complete a minimum of eighteen (18) hours for the required period.

Candidacy Requirements

To be admitted to candidacy for the doctoral degree, a student must have:

1. Completed the formal coursework with a GPA of 3.0 or better.
2. Passed the Comprehensive Examination.
3. Filed with the Dean of the Graduate School, the dissertation proposal approved by the student's Advisory Committee, the Program Director and the Academic School Dean.

Degree Requirements

The program requires approximately two years of course work (40 semester hours) and a minimum of twenty (20) semester hours of dissertation research credit beyond the MS degree. The exact program of study will be determined by the student's graduate committee. Additional requirements include:

1. Satisfactory performance on the Comprehensive Examination administered after the student has completed all course work; and
2. Successful defense of the dissertation research. The final basis for granting the degree shall be the candidate's grasp of the subject matter in a specialized area of environmental science, and a demonstrated ability to express thoughts clearly and forcefully in both oral and written languages.

Required Courses		**Semester**
Course	**Title**	**Hours**
ENV 700	Environmental Systems	3
ENV 701	Environmental Chemistry	4
ENV 702	Environmental Health	3
ENV 711	Applied Environmental Biostatistics	3
ENV 751	Water Quality Management	3
ENV 755	Air Quality Management	3
ENV 800	Environmental Toxicology	4
ENV 801	Risk Assessment and Management	3
ENV 900	Environmental Science Seminar	2
ENV 999	Dissertation Research	20
	Total Hours	48

In addition to the required courses shown above, the student must complete a minimum of 12 semester hours selected from the elective courses listed below. Other electives in biological sciences, physical sciences, engineering, technology, and public policy will be added as developed.

Elective Courses		**Semester**
Course	**Title**	**Hours**
CSC 700	Computer modeling	3
CSC 800	Image Interpretation	3
MATH 700	Statistics and Experimental Design	3
MET 800	Environmental Meteorology	3
ENV 715	Principles of Bioremediation	4
ENV 721	Solid Waste Management	3
ENV 780	Environmental Epidemiology	3
ENV 802	Environmental Physiology	4
ENV 803	Wetland Ecology	4
ENV 830	Environmental Microbiology	4

The minimum total semester hours required for the doctoral degree is 60.

DESCRIPTION OF COURSES

ENV 700 Environmental Systems. (3 hours). A groundwork of environmental science, environmental awareness and ecological literacy for the incoming Ph.D. students is presented. The environment and its living and non living components, and the interactions of these component areas studied. The course is set in a thermodynamic perspective and is based on a nested hierarchy of systems. Key concepts and principles that govern how we think the environment works are presented while learning how to apply these concepts to possible solutions of various environmental degradation, pollution and resource problems.

ENV 701 Environmental Chemistry. (3 hours). Prerequisites: One year of general Chemistry and one year of organic chemistry. Studies of the basic concepts of environmental chemistry; the nature of chemical compounds; organic and inorganic; chemical reactions; their effects, and fate of chemical species, in aquatic systems. This include: Studies of equilibrium phenomena of acids, bases, salts, complex compounds, and oxidation/reduction reactions. Studies of water pollution, environmental chemistry of water and its properties.

ENVL 701 Environmental Chemistry (1 hour). Experiments done for the purpose of water quality control and assessment, such as the determination of alkalinity, acidity, water hardness, biochemical oxygen demand (BOD), and other important parameters. The laboratory is coordinated to go with the lecture material.

ENV 702. Environmental Health. (3 hours). This course focuses on the impact of environmental problems on human health. Health issues related to water pollution/contamination by physical, chemical and biological agents; wastewater discharges; radiations; air pollution; municipal, and industrial wastes; food contamination; pesticides; occupational hazards; and vector-borne diseases are discussed.

ENV 711 Applied Environmental Biostatistics. (3 hours) Prerequisite: Biostatistics (Bio 511) or equivalent. This course is designed as an applied, advanced biostatistics course for students in the Environmental Science Ph.D. Program. Students will learn how to apply important concepts and principles of environmental biostatistics in the conduct of their research, from the initial designing of experiments to proper data collection and analysis, inferences, interpretation of results in applied terms, reporting and presentation of the results. The statistical computer software (SAS) will be used to analyze and interpret results.

ENV 751 Water Quality Management. (3 hours). This course provides students with basic concepts and principles in Water Quality Management. The effects of organic, inorganic, biological and thermal pollutants/contaminants in various systems of the hydrologic cycle including streams, reservoirs, and estuaries; eutrophication; water quality criteria and standards; monitoring concepts; methods in water quality management; regulatory considerations; and non point source pollution control, are discussed.

ENV 755 Air Quality Management. (3 hours). This course provides students with basic concepts and principles of air quality management. Contaminant classification, pollutant sources, criteria pollutants, health effects, exposure and risk assessment are discussed. Pollutant measurements and air quality assessment techniques are considered with regard to atmospheric effects on dispersion and transport. Identification of, and control strategies for, stationary and mobile sources, and environmental regulations are studied, and indoor air quality considered.

ENV 800 Environmental Toxicology. (3 hours). Prerequisites: ENV 701, ENV 702. This course is designed to provide an overview of the basic principles and concepts of toxicology including : exposure characterization, dose-response relationship, kinetics and distribution of toxicants in a biological system; to understand the fate, behavior and toxicities of xenobiotic chemicals, and the mechanisms by which they affect cells and organs; and to identify the sources and discuss the effects of various groups of environmental toxicants including heavy metals, pesticides and other industrial byproducts.

ENVL 800 Environmental Toxicology. (1 hour). This course is designed to familiarize the students with important laboratory and field procedures and methods used in toxicological testing of environmental toxicants; and to discuss the strengths and weaknesses of major methodologies including acute, subacute, subchronic and chronic bioassays.

ENV 801 Risk Assessment and Management. (3 hours). Prerequisites: ENV 800, MATH 700. This course is designed to provide students with qualitative and quantitative skills necessary to evaluate the probability of injury, disease and death in humans and other life forms, from exposure to various environmental contaminants. Hazard identification, exposure assessment, dose-response evaluation and risk characterization are emphasized. Regulatory and technical aspects of risk assessment in the promulgation of public and environmental safety standards are discussed.

ENV 900 Seminar. (0.5 hr x 4 semesters =2) (Lecture). This course focuses on contemporary issues in environmental health science. The student is expected to review, discuss, and present orally a report on a topic related to contemporary environmental issues. Topic areas for selection include (but not limited to): environmental biology, environmental chemistry, environmental microbiology, environmental toxicology, atmospheric science, water quality management, solid and hazardous waste management, computer modeling and remote sensing. Students are required to attend all scheduled seminars.

ENV 999 Dissertation Research. (20 hours). Original research in one of several subdisciplines in Environmental Science. Credit per academic session allowable is 1-6 hours. Student must produce, present and defend a document of publication quality.

Elective Courses

CSC 700 Computer Modeling. (3 hours). The purpose of this course is to provide the student with the fundamental knowledge of simulation models, writing programs to generate random numbers from various probability distributions using differential methods, and testing the statistical properties of random number generators. The student will also be trained to write simple programs to simulate real life situation models using GPSS language.

CSC 800 Image Interpretation. (3 hours). This course presents a broad overview of various image processing concepts and techniques. Topics include the history of remote sensing, image digitation, data formats, hardware and software functions, commercial and public available digital processing systems, image preprocessing (radiometric and geometric correction), image enhancement, image classification, change detection, interfaces of remote sensing and geographical information system (GIS), and the future of digital image processing.

MATH 700 Statistics and Experimental Design. (3 hours) Prerequisite: MATH 272. Or 2 semesters of Introductory Statistics. Probability; random variables; expectation of a function of random variables; sampling distribution; estimation; hypothesis testing; designed experiments; completely randomized design; randomized complete block design; Latin square design; factorial experiments; statistical software application to statistical analysis, are discussed.

MET 801 Environmental Meteorology. (3 hours). Principles of atmospheric science as applied to gaussian modeling of pollutants. Includes source review and receptor identification and modeling, National Ambient Air Quality Standards and human health and welfare impacts, plume

behavior, and access of EPA models, running of EPASCREEN, and web site information. Special topics covered include: scavenging; acid precipitation; weather modification, green house enhancement; stratospheric ozone; scrubbers; and indoor air quality.

ENV 715 Principles of Bioremediation. (3 hours). This course uses modern knowledges 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, 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.

ENVL 715 Principles of Bioremediation. (1 hour). Laboratory and field experiments conducted to familiarize students with relevant bioremediation techniques and methodologies. Identification and classification of microorganisms, use of bacteria in toxicity assessment, biodegradation of organic contaminants, and phytoremediation of toxic metals are discussed.

ENV 721 Solid Waste Management. (3 hours). This course emphasizes on waste control methodologies for both municipal and industrial wastes including hazardous and nonhazardous waste under the Resource Conservation and Recovery Act (RCRA). The students are familiarized with environmental legislation regulating these wastes at state and federal levels. A thorough review is done on waste handling, transport, treatment technologies including chemical, physical, biological and thermal treatments, and disposal options such as land disposal of wastes. Waste minimization techniques such as source reduction and recycling are also discussed.

ENV 780 Environmental Epidemiology. (3 hours) This course is designed to provide students with the basic knowledge and skills required to develop and apply epidemiologic principles and concepts to the study of adverse effects of various environmental factors on both human and ecological health. Emphasis is put on the study of the health effects of physical, chemical and biologic factors in the external environment, broadly conceived from the epidemiologic point of view. As such, it enables students to interpret epidemiological data and understand the approaches used in the epidemiologic investigations of acute and chronic diseases. The course also covers the basic methods and issues involved in epidemiologic investigation of disease conditions in human populations.

ENV 802 Environmental Physiology. (3 hours). This course provides students the basic concepts of homeostasis and adaptation to the environment. Discussions are designed to provide an understanding of the physiological responses to various types of pollutants in The different environmental systems including aerospace, hyperbaric, marine and terrestrial environments. Emphasis is placed on homeostatic responses at cellular, organ and organ system levels to various environmental stresses.

ENVL 802 Environmental Physiology. (1 hour). Laboratory exercises are performed to introduce students to instrumental techniques necessary in the understanding of homeostatic regulatory mechanisms that permit adaptation of organisms to varied and peculiar habitats.

ENV 803 Wetland Ecology. (3 hours). This course is designed to provide scientific knowledge for a better understanding of interactions between biological, physical and chemical components of wetlands. The structure and function of various types of wetlands; their biodiversity, biogeochemistry, and the impact of pollution on their ecological characteristics are discussed. Discussions are also done on how constructed wetlands can be used as water quality enhancers.

ENVL 803 Wetland Ecology. (1 hour). Emphasis is placed on field works designed to evaluate the physical, chemical and biological characteristics of wetlands.

ENV 830 Environmental Microbiology. (3 hours). The general objective of this course is to study the roles of microorganisms in natural ecosystems. Attention is given to the examination of nutrient cycles, methods of analysis of microbial biomass and activities, and the functional roles of microorganisms. In addition, this course offers in-depth examination of the role of microbial processes related to environmental deterioration, its control and remediation, and ultimately its prevention.

ENVL 830 Environmental Microbiology. (1 hour). Laboratory designed to acquaint students with modern techniques for measuring microbial biomass and microbial degradative activities of natural and xenobiotic chemicals in natural environments. Specific projects of microbial analysis will be assigned to students.

DEPARTMENT OF CHEMISTRY

Dr. Hongtao Yu, Associate Professor and Chair

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Faculty

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Dr. N. Campbell, Associate Professor
Dr. A. Hamme, Assistant Professor
Dr. G. Hill, Assistant Professor
Dr. M. Huang, Assistant Professor
Dr. K. Lee, Professor
Dr. J. Leszczynski, Distinguished Professor
Dr. Y. Liu, Asociate Professor
Dr. E. Noe, Professor
Dr. P. Ray, Assistant Professor
Dr. H. Tachikawa, Professor
Dr. R. Venkatraman, Associate Professor
Dr. J. Watts, Professor
Dr. J. Zubkowski, Professor

The Department of Chemistry offers the Doctor of Philosophy degree and the Master of Science degree in Chemistry. The Ph.D. degree program in chemistry requires the existence of high quality scientific research and teaching in the department. It covers all modern areas of chemistry including analytical, biochemistry, computational, organic, inorganic, and physical.

Program Mission

The Department of Chemistry seeks to provide comprehensive graduate programs in chemistry that aim for national distinction. The Department offers M.S. and Ph.D. degrees in all field of chemistry. These aim for intense graduate training through courses, hands-on experience of research methods, and development of an independent research thesis and dissertation. Graduates will be trained and capable of independent research in an academic or industrial setting.

Program Objectives

- To provide students with an environment that is conducive to learning and scholarly activities.
- To provide opportunities in which students can develop methods of independent and systematic investigation.
- To prepare students to develop a successful career in chemistry.
- To promote the professional growth and development of the faculty.

Doctoral Program in Chemistry

Admission Requirements

In addition to the requirements of the Graduate School, applicants must:

1. The minimum requirement for admission is a B.S. degree in chemistry or related field. The student must have passed the following courses, with labs, with a passing grade, 'C' or better:
   - 2 semesters of General Chemistry
   - 2 semesters of Organic Chemistry
   - 1 semester of Analytical Chemistry
   - 1 semester of Physical Chemistry
   - 1 semester of Inorganic Chemistry
2. Submit an official GRE Score.
3. The M.S. degree is not a prerequisite for the Ph.D. degree.

Degree Candidacy Requirements

The comprehensive examination and the independent research proposal are required for a student to be an official Ph.D. candidate. The comprehensive examination of 3 subjects must be taken and passed during the second year. The independent research proposal must be prepared and defended during the first semester of the third year.

Graduation Requirements

The minimum number of credit hours for the Ph.D. in Chemistry is 60 credit hours.

1. 18 credit hours from graduate Chemistry lecture courses
2. 2 credit hours for Seminars
3. 40 credit hours for Dissertation

The 60 credit hours must include three out of five possible core courses for a total of 9 credit hours required in core courses. The core courses are:

CHEM 723	Advanced Analytical Chemistry
CHEM 731	Advanced Biochemistry I
CHEM 736	Physical Organic Chemistry
CHEM 741	Advanced Inorganic Chemistry
CHEM 758	Quantum Chemistry

The student will be required to teach at least one undergraduate laboratory course and must have a dissertation in chemistry, which has to be defended in public.

Masters' Program in Chemistry

The M.S. degree is offered by the Department in the areas of analytical, biological, computational, inorganic, organic, and physical chemistry.

Admission Requirements

Applicants for the Master's Degree Program must meet the requirements of the Graduate School.

Retention Requirements

The student must satisfy the basic requirements of the Graduate School and must maintain GPA 3.00 or higher every semester. The chemistry department will calculate the GPA based on the 500 level chemistry lecture courses. Grades from the Thesis Research are excluded from calculating the GPA.

Degree Requirements

A student pursuing a M.S. degree in Chemistry is required to complete a minimum of 30 hours and a thesis in chemistry.

1. Within the 30 hours, the student must complete three (3) out of five (5) possible core courses for a total of nine (9) hours required in the core courses, and two semesters of seminar. The core courses are:

CHEM 523	Advanced Analytical Chemistry
CHEM 541	Advanced Inorganic Chemistry
CHEM 531	Biochemistry
CHEM 558	Quantum Chemistry
CHEM 536	Physical Organic Chemistry

2. The student will fulfill the remaining 20 hours from Chemistry electives with no more than 11 hours in CHEM 580 - Thesis Research. It is possible to take some courses in related fields upon recommendation of the advisor.
3. Pass the Graduate Area Comphrensive Examination in three core areas.
4. The student must participate as a teaching assistant in the chemistry department for at least one semester.

Non-Thesis Masters' Degree

Graduate students who fulfill the following requirments will be awarded a non-thesis masters' degree in Chemistry.

1. A minimum of 36 credit hours, including at least 18 hours of graduate level lecture courses and two hours of seminar with a GPA of 3.0 or better. The graduate lecture courses should include at least three of the five core courses: Advanced Analytical Chemistry, Advance Inorganic Chemistry, Biochemisty, Quantum Chemistry, and Physical Organic Chemistry.
2. Pass the Graduate Area Comphrensive Examination in three core areas.
3. Pass an oral defense covering the student's research before a committee of four faculty members.

DESCRIPTION OF COURSES

Master-level Courses

CHEM 511 Chemistry Seminar. (1 Hour) Presentation and discussion of current chemical topics and research by students, faculty and visiting speakers. Prerequisite: Permission of instructor.

CHEM 523 Advanced Analytical Chemistry. (3 Hours) Prerequisites: Courses in Analytical Chemistry and Physical Chemistry. Principles and application of selected analytical methods including electrochemistry, spectroscopy and selected topics of unusual current interest.

CHEM 526 Electroanalytical Chemistry. (3 Hours) Prerequisite: Advanced Analytical Chemistry. Discussion of potentiometric, conductometric, polarographic, amperometric, coulometric, controlled potential and stepping analysis and related techniques. Emphasis is also placed on theoretical considerations and applications to studies of chemical and charge transfer equilibria and kinetics.

CHEM 531, 532 Biochemistry. (3 Hours) Prerequisite: One year of Organic Chemistry. The chemical composition of living matter and the chemical mechanics of life processes.

CHML 531, 532 Biochemistry Laboratory. (1 Hour) Prerequisite: Chemistry 531 and 532. Basic purification and characterization techniques in Biochemistry.

CHEM 536 Physical Organic Chemistry. (3 Hours) Prerequisites: Physical Chemistry and Organic Chemistry. A study of organic molecular structure, Woodward Hoffmann Rules, substituents effects, intra- and intermolecular forces, kinetics and stereochemistry.

CHEM 541 Advanced Inorganic Chemistry. (3 Hours) Prerequisite: An undergraduate course in Physical Chemistry. A study of inorganic compounds with the application of Physical Chemistry principles to thermodynamic, kinetic and structural problems.

CHEM 553 Thermodynamics. (3 Hours) Prerequisite: Physical Chemistry. Principles of thermodynamics and their application to chemical and phase equilibria.

CHEM 558 Quantum Chemistry. (3 Hours) Prerequisite: Physical Chemistry. Principles and applications of quantum theory.

CHEM 580 Thesis Research. (Variable 1-6 Hours) Prerequisite: Permission of adviser. Selected topics arranged in consultation with the staff; includes literature, research, and laboratory investigation of a problem.

Doctoral-level Courses

CHEM 711 Seminar (0.5 Hour) Presentation and discussion of current chemical topics and research by visiting speakers, faculty and students.

CHEM 721 Advanced Instrumental Analysis (3 Hours). Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Theoretical principles and laboratory techniques involved in characterization of chemical systems using instrumental methods. This one semester course will present the following topics of interest: absorption and emission spectrometry, mass spectrometry, liquid and gas chromatography, and

electrophoresis. A laboratory series on spectro-photometry, fluorometry, atomic absorption spectrometry, inductively coupled plasma atomic emission spectrometry, FT-IR, gas chromatography-mass spectroscopy, and high performance liquid chromatography are included in this

CHEM 723 Advanced Analytical Chemistry (3 hours) Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Principles and application of analytical methods including acid-base titrations, redox titrations, titrations which involve metal-ligand complexes, gravimetric analysis, separation methods (chromatography), and electroanalytical chemistry.

CHEM 726 Electroanalytical Chemistry (4 hours) Prerequisite: Advanced Analytical Chemistry. Principles and application of all modern electrochemical methods such as voltammetrics, chronoamperometry, spectroelectrochemistry, and thin layer electrochemistry etc. Electrode kinetics and mass transfer are discussed in detail.

CHEM 729 Spectroscopic Methods (3 hours) Prerequisite: Analytical Chemistry. Study of the theoretical principles of advanced spectroscopic topics used in analytical chemistry. Some examples of the topics to be covered are: X-ray methods (absorption, fluorescence, diffraction), surface spectroscopy and chemical analysis of surfaces, (Ion Scattering Spectroscopy, ISS), Auger Emission Spectroscopy (AES), electron Spectroscopy for chemical analysis (ESCA), Secondary Ion Mass Spectrometry (SIMS), Electron Spin Spectroscopy (ESR), Nuclear Magnetic Resonance Spectroscopy (NMR).

CHEM 731 Advanced Biochemistry I (3 hours) Prerequisite: Organic Chemistry (two semesters). Comprehensive coverage of major areas of biochemistry. Topics covered include proteins, enzymology, bioenergetics, the chemistry and intermediary metabolism of carbohydrates, lipids, proteins and nucleic acids.

CHEM 732 Advanced Biochemistry II (3 hours) Prerequisite: Advanced Biochemistry I. Comprehensive coverage of major areas of biochemistry. Topics covered include storage, transmission, and expression of genetic information, molecular immunology, membrane transport and hormone action.

CHML 731 Advanced Biochemistry Laboratory (1 hour) Corequisite: Advanced Biochemistry I. Selected techniques in areas covered in CHEM 731.

CHML 732 Advanced Biochemistry Laboratory (1 hour) Corequisite: Advanced Biochemistry II. Selected techniques in areas covered in CHEM 732.

CHEM 733 Advanced Molecular Biology (3 hours) Molecular mechanisms involved in replication, expression and regulation of prokaryotic genes. Topics include: DNA replication, repair, recombination, restriction-modification, recombinant DNA technology, plasmids and transposons, RNA transcription, processing and message splicing.

CHEM 734 Physical Biochemistry (3 hours) Characterization of macromolecules, hydrodynamic methods, multiple equilibria, maromolecule-ligand interactions.

CHEM 736 Physical Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of organic molecular structure, Woodward Hoffmann Rules, substituents effects, intra- and intermolecular forces, kinetics and stereochemistry.

CHEM 738 Organic Synthesis (3 hours) Prerequisite: Organic Chemistry (two semesters). The course covers the formation of carbon-carbon and carbon-heteroatom bonds, functionalization and interconversion of functional groups, reactions of organic reagents, protective groups, total synthesis and asymmetric synthesis in organic synthesis.

CHEM 741 Advanced Inorganic Chemistry (3 hours) Prerequisite: Advanced Inorganic Chemistry (CHEM 441). A study of symmetry and group theory, bonding and structures of inorganic compounds, coordination chemistry and acid-base chemistry.

CHEM 743 Structural Inorganic Chemistry (3 hours) Prerequisite: Any 700 level course. A study included concepts of the solid state as explored by crystallography. It covers symmetry, polyhedra, sphere packing, tetrahedral and octahedral structures of inorganic compounds.

CHEM 747 Inorganic Reaction Mechanisms (3 hours) Prerequisite: Any 700 level course. The topics include mechanism of reactions of certain inorganic compounds, stereochemical changes in complexes, redox reactions, homogeneous and heterogeneous catalysts.

CHEM 749 Organometallic Chemistry (3 hours) Prerequisite: Physical Organic Chemistry (CHEM 736) or equivalent. A study of formation, stability, and reactivity of metal-carbon bond of main group and transition metal. It will covers the usage of organometallics in organic synthesis and catalysis.

CHEM 752 Atomic and Molecular Spectroscopy (3 hours) Prerequisite: Physical Chemistry (two semesters). A comprehensive course covering concepts and methods of modern atomic and molecular spectroscopy. Subjects covered include electric phenomena, absorption and emission of radiation, atomic spectroscopy, rotational spectroscopy, vibrational spectroscopy, electronic spectroscopy, and magnetic resonance spectroscopy.

CHEM 753 Thermodynamics (3 hours) Prerequisite: Physical Chemistry (two semesters). Laws of thermodynamics and their chemical applications. Introduction to chemical kinetics and statistical mechanics.

CHEM 754 Kinetics (3 hours) Prerequisite: Physical Chemistry (two semesters). Mechanics of chemical reactions, cross sections, and rate constants. Elastic, inelastic, and rearrangement channels are discussed, using quantum and semiclassical techniques.

CHEM 755 Mechanisms of Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of mechanistic aspects of organic reactions included the rate theory, and reaction mechanism, experimental methods and treatment of data.

CHEM 758 Quantum Chemistry (3 hours) Prerequisite: Physical Chemistry (two semesters). (Computational Chemistry) Important concepts of quantum chemistry at the intermediate level, including angular momentum, perturbation theory, electronic structure of molecules, and radiation matter interaction. Applications will vary from year to year.

CHEM 763 Statistical Mechanics (3 hours) Prerequisite: Physical Chemistry (two semesters) A study of statistical mechanical ensembles, partition functions and their relationship to thermodynamics, lattice statistics, molecular distribution and correlation functions, the theories of liquids and solutions, phase transitions, and cluster theory.

CHEM 780 Dissertation - (1 - 9 hours)

CHEM 782 Special Topics in Analytical Chemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in analytical chemistry.

CHEM 783 Special Topics in Biochemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in biochemistry.

CHEM 784 Special Topics in Organic Chemistry - (3 hours) A course in a specific area of organic chemistry such as structure determination in organic chemistry, or current research subject not covered in regularly scheduled courses presented to fit the interests of advanced students.

CHEM 785 Special Topics in Inorganic Chemistry - (3 hours) Topics include subjects of current research in inorganic chemistry, but not covered in regularly scheduled courses.

CHEM 786 Special Topics in Physical Chemistry - (3 hours) Topics vary from year to year will include subjects such as photochemistry, solid state, surface chemistry, and radiation chemistry.

DEPARTMENT OF MATHEMATICS

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Dr. M. R. Khadivi, Professor
Dr. Y. Pan, Professor

The Department of Mathematics in the School of Science and Technology in cooperation with the School of Education offers a program leading to the Master of Science in Teaching (MST) degree, in mathematics. This department also offers a master of Science (MS) degree in pure mathematics for students who seek careers in college or university teaching, government, industry, business, etc.

Based on the certification requirements of the State of Mississippi as stated in *Bulletin 130,* and upon the stated principles and guidelines of The National Council of Teachers of Mathematics, The Mathematics Association of America, and The Mississippi Council of Teachers-Mathematics, the successful candidate for graduation with the MST degree should be able to perform the following competencies:

1. Expose students to various teaching aids in teaching and learning of mathematics at the junior high, high school, and college levels.
2. Show the basic structure of an idea by means of displays and examples.
3. Explain abstract ideas and relate them to concrete models by using the most modern techniques.
4. Bring ideas together to form new concepts in mathematics.
5. Turn ideas into words by means of displays, diagrams, and examples. Improve the oral and written expression of students in mathematics.
6. Stimulate a greater interest in mathematics to improve the performance of students. Share the idea of teaching and learning with other teachers in the field of mathematics by being active in professional organizations.
7. Properly counsel students in the field of mathematics.
8. Supervise programs in mathematics education.
9. Provide the kind of experiences in mathematics that will be relevant to the needs of today's youth.

10. Construct programs in mathematics that meet the needs of students in modern schools.
11. Demonstrate the nature of problem solving , proofs and processes involved in the solution of problems, and proofs of theorems in general.

These degree programs are designed for persons with an adequate background in mathematics and who wish additional preparation for mathematics teaching or mathematics supervision.

Admission Requirements

Admission to a graduate program in mathematics requires at least 15 semester hours of undergraduate mathematics above the regular calculus sequence.

Master of Science in Teaching Degree

Retention Requirements

By the end of the first semester, students should have taken the Graduate Record Exam (G.R.E.) and the Graduate English Competency Exam

Degree Requirements

1. Thirty six (36) hours are required with a thesis, i.e. ten (10) courses plus six (6) hours for a thesis.
2. Thirty six (36) are required with a project, i.e. eleven (11) courses plus three (3) hours for a project.
3. Thirty six (36) hours are required if neither a thesis nor a project is done.
4. A "B" average is required for graduation.

Core Educational

Courses	Titles	Semester Hours
EDFL 511	History and Philosophy of Education (R)	3
EDFL 515	Methods of Educational Research (R)	3
EDFL 514	Elementary Statistics (R*)	3
EDFL 568	Curriculum Methods (R)*	3
	Total Hours	*15*

(R)- Required
(R*) -Required for students without an undergraduate Statistics course, and it is a prerequisite for EDSE 515.

Required Courses

Math 501	Topics in Geometry	3
Math 510	Topics & Issues	3
Math 511	Basic Algebra I	3
Math 513	Linear Algebra I	3
Math 531	Basic Real Analysis I	3
	Total Hours	15

Other Requirements

Math elective		3
Math 590	Thesis or	
Math 584	Independent Study (Project)	3
	(and 3 hrs. from List I), or	
Six hours from List I and three hours		
	from List II or List III	9
	Total Hours	36

List I

Math 503	Foundations of Mathematics I	3
Math 504	Foundations of Mathematics II	3
Math 512	Basic Algebra II	3
Math 513	Linear Algebra I	3
Math 514	Linear Algebra II	3
Math 532	Basic Real Analysis II	3
Math 541	Basic Complex Analysis I	3
Math 542	Basic Complex Analysis II	3
Math 561	Basic Probability and Statistics I	3
Math 562	Basic Probability and Statistics II	3
Math 551	Basic General Topology I	3
Math 552	Basic General Topology I-II	3
Math 581	Number Theory I	3
Math 582	Number Theory II	3

List II

Math 505	Mathematics for Secondary Teachers	3
Math 506	Basic Concepts for Teachers	3
Math 507	Basic Concepts for Teachers	3
Math 509	Mathematical Structures	3
Math 519	Topic in Mathematics Education I	3
Math 520	Topics in Mathematics Education II	3

List III

CSC 511	Computers and Programming	3
CSC 512	Intro. to Computer Systems and Organ.	3
CSC 515	Data Structures and File Management	3
CSC 518	Principles of Operating Systems	3
CSC 531	Com.Simulation Methods and Models	3
CSC 561	Probability and Statistical Inference I	3

MASTER OF SCIENCE

Retention Requirements

By the end of the first semester, students should have taken the Graduate Record Exam (G.R.E.) and the Graduate English Competency Exam

Degree Requirements

1. Thirty six (36) hours are required with a thesis, i.e. ten (10) courses plus six (6) hours for a thesis.
2. A "B" average is required for graduation.

Core Courses

Course	Title	Hours
Math 511	Basic Algebra I	3
Math 513	Basic Abstract Algebra I	3
Math 531	Basic Real Analysis I	3

Math 541	Basic Complex Analysis I	3
Math 551	Basic General Topology I	3
Math 599	Thesis	6
Electives- Three (3) courses from the list below:		
Math 501	Topics in Geometry	3
Math 503	Foundations of Mathematics I	3
Math 512	Basic Algebra II	3
Math 514	Linear Algebra II	3
Math 542	Basic Complex Analysis II	3
Math 552	Basic General Topology II	3
	Elective	3
	Total Hours	36

A student may concentrate in Applied Mathematics by taking the four (4) elective courses from this list: Math 513, 514, 541, 542, CSC 511, 512, 515, 518, 531, 561.

A concentration in Foundations of Mathematics consists of four (4) courses from this list: Math 501, 503, 513, 541, CSC 511, 512, 515, 518, 531, 561.

Notes

1. The Class 'A' Certificate must be held before receiving the Class 'AA' Certificate.
2. Math courses should be taken first because of their sequential nature, and the fact that they are not offered every term. However, Core Educational Courses are offered every term.
3. File Form II—Petition for Graduate Degree Candidacy if at least 15 semester hours have been completed.
4. File Form III—Application for Degree before the dates listed in the Graduate Calander for May and August graduations.
5. File Form IV—Application for Clearance following the completion of all work.

DESCRIPTION OF COURSES

MATH 500 Mathematics for Elementary Teachers. (3 Hours) Prerequisite:Approval of department. A course emphasizing content and techniques employed in the teaching of mathematics in the elementary school . Stress is placed on current trends and philosophy, content and methodologies.

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 502 Topics in Algebra. (3 Hours) Prerequisite: Approval of department. An amalgamation of classical and modern theory, stressing the synthesis of ideas in areas from equation solvability, special algebraic forms (permutations, combinations, arrangements, binomial and multinomial theorems, partial fractions, progressions, groups, rings, domains of integrity, and ideas of interest).

MATH 503-504 Foundations of Mathematics I-II. (3-3 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 505 Mathematics for Secondary Teachers. (3 Hours) Prerequisite: Approval of department. The basis of the content, philosophy and methodology employed in the teaching of secondary school mathematics is of prime interest here.

MATH 506-507 Basic Concepts for Teachers I-II. (3-3 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 508 Elementary School Topics. (3 Hours) Special topics and problems of elementary school mathematics and its teaching.

MATH 509 Mathematical Structures. (3 Hours) A course surveying the ideas of algebras, geometries, topology, set theory and other areas of interest. The course serves to strengthen the foundations of the learner, as well as to provide a rigorous basis for the areas under discussion.

MATH 510 Topics and Issues in Mathematics. (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 511-512 Basic Algebra I-II. (3-3 Hours) Groups, (homomorphisms), rings, integral domains, modules and fields, elementary linear algebra, number theory.

MATH 513-514 Linear Algebra I-II. (3-3 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 515-516 Abstract Algebra III-IV. (3-3 Hours) Prerequisite: Mathematics 512. Special topics in groups, rings and fields, factorization theory, extensions of rings and fields, modules, elementary theory of fields.

MATH 517-518 Topics in Mathematics Education I-II. (3-3 Hours) Elementary. Counting and numerical concepts, problem solving, equipment, achievement, examinations.

MATH 519-520 Topics in Mathematics Education I-II. (3-3 Hours) Secondary. Aims and problems, techniques, arousing and maintaining interest, aids and trends, tests and measurements, traditional and non-traditional courses, operation, geometry.

MATH 521-522 Basic Geometry I-II. (3-3 Hours) Prerequisite: Mathematics 511, concurrent enrollment or approval of department. Historical development; sets and projective planes and geometries; vectors, transformations, axiomatic affine, projective and plane geometry.

MATH 523-524 Modern Geometry III-IV. (3-3 Hours) Prerequisite: Mathematics 523 or approval of department. Motions and transformations, projective and topological transformations, projective plane, analytic projective geometry; absolute, ordered, affine and hyperbolic geometries; elementary differential geometry, topology of surfaces.

MATH 525-526 Introduction to Differential Geometry I-II. (3-3 Hours) Prerequisite: Mathematics 523 or approval of department. Curves and surfaces in three dimensions by classical methods, introduction to corresponding problems in n-dimensions involving tensor methods.

MATH 527-528 Projective Geometry I-II. (3-3 Hours) Prerequisite: Mathematics 512 or approval of department. The projective plane, polarities and conic sections, affine geometry, projective metrics, non-Euclidean Geometry, spatial geometry.

MATH 529-530 Systems Analysis I-II. (3-3 Hours) Prerequisite: Approval of department. An analysis of the numerical and abstract systems of mensuration. Stress is placed on the metric and English systems, conversion analysis and other systems of interest.

MATH 531-532 Basic Real Analysis I-II. (3-3 Hours) Prerequisite: Mathe 511 or approval of department. Metric spaces, regulated functions and integrals; integrals of Riemann and Lebesque; trigonometrical and Fourier Series; differentiation and Stieltjes Integrals.

MATH 533-534 Advanced Analysis I-II. (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. Further treatment of limits, continuity, differentiability and integrability of functions of one and more variables. Infinite series and products, power and trigonometric series; selected topics.

MATH 535-536 Introduction to Measure and Integration I-II. (3-3 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 537-538 Introduction to Functional Analysis I-II. (3-3 Hours) Prerequisites: Mathematics 512, 531, or approval of department. Fundamentals of the theory of vector spaces; Banach spaces; Hilbert spaces. Linear functionals and operators in such spaces; spectral resolution of operators, applications.

MATH 539-540 Infinite Series I-II. (3-3 Hours) Prerequisites: Mathematics 511 and approval of department. 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 541-542 Basic Complex Analysis I-II. (3-3 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 544 Entire Functions. (3 Hours) Prerequisite: Mathematics 541. Entire functions, maximum absolute value and order, zeroes of entire functions, fundamental theorem of algebra, Picard's Little Theorem, algebraic relationships and addition theorem; special theorems and functions.

MATH 545 Laplace Transforms. (3 Hours) Prerequisites: Math 534 and approval of department. The Stieltjes Integral; fundamental formulae; moment problem, Tauberian theorems, bilateral Laplace Transform, inversion and representation problems, the Stieltjes Transform.

MATH 546 Special Functions. (3 Hours) Prerequisites: Math 535 and approval of department. Infinite products, Gamma and Beta functions, series, polynomials, functions, relations and sets of analysis and differential equations.

MATH 547-548 Integral Equations I-II. (3-3 Hours) Prerequisites: Math 534, 542, and approval of department. Theory of Fredholm and Volterra equations; Hilbert-Schmidt theory; singular integral equations and some applications.

MATH 549-550 Methods In Applied Mathematics I-II. (3-3 Hours) Prerequisite: Approval of department. Elements of linear algebra; applications to systems of linear variables; function spaces; tensor analysis, applications to geometry, electromagnetic theory, Lagrangian and Hamiltonian formulations of mechanics; other topics of interest.

MATH 551-552 Basic General Topology I-II. (3-3 Hours) Prerequisites: 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 553-554 Introductory Algebraic Topology I-II. (3-3 Hours) Prerequisites: Mathematics 552 and approval of department. Complexes, simplicial,

singular and Cech Homology Theory. Homotopy groups and basic theorems of algebraic topology.

MATH 555-556 Combinatorial Topology I-II. (3-3 Hours) Prerequisites: Mathematics 553 and approval of department. Properties of topological spaces; Jordan's theorem, surfaces, complexes, coverings, dimension; the Betti Groups, homology theory, manifolds, the duality theorems, cohomology groups of compacta, introduction to theory of continuous mappings of polyhedra.

MATH 557-558 Introduction to Algebraic Geometry I-II. (3-3 Hours) Prerequisites: Mathematics 512, 521, or approval of the department. Algebraic preliminaries, local rings valuation theory, power series, rings, geometry of algebraic varieties with emphasis on curves and surfaces.

MATH 559-560 Linear Programming I-II. (3-3 Hours) Basic Concepts, graph theory, theory of games, Markov Chains, Leontief Economic Models, Optimizing linear functions of variables subject to constraints, a geometric approach, simplex method, convex sets duality, applications.

MATH 561-562 Basic Probability and Statistics I-II. (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. Basic concepts of measure theory and integration axiomatic foundations of probability theory, distribution functions and characteristics functions, central limit problem, modern statistical inference, analysis, variance, decision functions.

MATH 563-573 Design I-II. (3-3 Hours) Prerequisite: Mathematics 272. Experimental Design: Completely randomize design, randomize block designs, factorial experiments split plot design. confounding.

MATH 564 Linear Models. (3 Hours) Prerequisite: Mathematics 562 or departmental approval. Linear statistical models, some noise-reducing experimental designs, an example-of a volume-increasing design, fitting the general linear model, inference making, multiparameter hypothesis: the analysis of variance, the effect of coding on the analysis, seeking a maximum or minimum response, fractional factorial experiments and incomplete block designs, an example of a completely random model, mixed models.

MATH 565 Multivariate Analysis. (3 Hours) Prerequisites: Mathematics 562 and approval of department. General linear hypothesis; least square estimation; confidence regions, multiple comparison; analysis of complete layouts; effects of departures from underlying assumptions. Analysis of convariance.

MATH 566-566W Operations Research. (3-3 Hours) Prerequisite: Math 232, 355. Linear programming, network analysis, PERT-CPM, dynamic programming, queuing theory and decision analysis.

MATH 567-568 Nonparametric Statistics I-II. (3-3 Hours) Prerequisites: 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, multisample problems; ranking methods in analysis of variance; Bivariate and multivariate procedures, efficience comparisons.

MATH 569-570 Functions of Several Real Variables I-II. (3-3 Hours) Prerequisites: Mathematics 533 and approval of department. Euclidean spaces, Mapping and differentials, manifolds, differential forms, vector analysis.

MATH 571-572 Numerical Analysis I-II. (3-3 Hours) Prerequisite: Approval of department. Approximation and interpolations; numerical differentiation, quadrature and summation; numerical solutions of ordinary differential equations; functional approximation techniques; solutions of equations; eigenvalues and eigenvectors.

MATH 573 Fractal Geometry. (3 Hours) Prerequisite: Math 511 or departmental approval. Metric spaces, equivalent spaces, classification of subsets, and the Space of Fractals. Transformations on metric spaces, contraction mappings, and the Construction of Fractals. Chaotic Dynamics of Fractals, Fractal Dimension. Fractal Interpolation. Julia Sets. Parameter Spaces and Mandelbort Sets. Measures on Fractals.

MATH 574 Numerical Linear Algebra. (3 Hours) Prerequisite: Approval of department. Elementary numerical analysis; matrix algebra; elimination and compact elimination methods; orthogonalization methods; condition, accuracy, and precision; comparison of methods; iterative and gradient methods; iterative and transformation methods for latent roots and vectors; error analysis for latent roots and vectors.

MATH 575-576 Approximation and Interpolation I-II. (3-3 Hours) Prerequisite: Approval of department. Interpolation, remainder theory; convergence theorems; infinite interpolation; uniform approximation; best approximation; least squares approximation; Hilbert space; orthogonal polynomials; closure and completeness.

MATH 577-578 Ordinary Differential Equation I-II. (3-3 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 579-580 Partial Differential Equations I-II. (3-3 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, special topics.

MATH 581-582 Number Theory I-II. (3-3 Hours) Prerequisites: Approval of department. Diophantine analysis, primes, residue classes, theorems of Euler, Fermat, and Wilson, Continued Fractions, Chinese Remainder Theorem, quadratic reciprocity, valuations, extensions of valuations, local and global fields, discriminant.

MATH 583 Advanced Number Theory. (3 Hours) Prerequisite: Mathematics 581 or departmental approval. Quadratic and Cyclotomic extensions, elementary class field theory, and selected 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 585-586 Introductory Algebraic Number Theory I-II. (3-3 Hours) Prerequisites: Mathematics 512, 582, and approval of department. Valuations, fields of algebraic functions, cohomology of groans, local and global class field theory are introduced as topics.

MATH 586A Special Projects: Mathematics Curriculum Planning. (3 Hours) Prerequisite: Departmental consent. This course is designed primarily for inservice personnel in education desiring enrichment activities in mathematics curriculum planning K-12. Students taking this course will be engaged in activities directed toward planning, developing, and evaluating curricular materials that may be used for teaching grades K-12.

MATH 587 Introductory Analytic Number Theory. (3 Hours) Elements from prime number theory,prime number theory for arithmetic progressions,additive number theory, density theorems.

MATH 588-589 Sampling Methods I-II. (3-3 Hours) Prerequisite: Mathematics 272. Sampling methods: Simple random sampling, sampling for proportions and percentages, estimation of sample size, stratified random sampling ratio estimates.

MATH 590 Thesis. (3 Hours) The candidate for the Master of Science in Teaching degree must present a Thesis embodying the results of his research. The candidate chooses his problem, but approval by his adviser is required.

MATH 591-592 Basic Modern Logic I-II. (3-3 Hours) Prerequisite: Approval of department. Elementary introduction to classical first order theory (completeness, deduction theorem, Godel completeness, Herbrand's Theorem), presentation of basic model theory; axiomatic set theory, cardinal and ordinal numbers to the consistency results of Godel and the independence results of Cohen, Incompleteness Results (Godel's, Rossi's and Church's Theorem).

MATH 593 Theory of Models. (3 Hours) Prerequisites: Mathematics 592 and approval of department. Infinitary languages, ultraproducts, compactness, saturated structures, applications to mathematical theories; other topics as time permits.

MATH 594 Decidability and Undecidability. (3 Hours) Prerequisites: Mathematics 592 and approval of department. Godel's incompleteness theorem for arithmetic, recursive nonaxiomatizability of second-order logic, Church's Undecidability Theorem for first-order logic, decidable first-order theories; other topics as time permits.

MATH 595-596 Foundations of Set Theory I-II. (3-3 Hours) Prerequisite: Mathematics 591 or approval of department. Axiom systems, ordinal and cardinal arithmetic, model theory of set theory, constructible sets, relative consistency and independence of Axiom and Choice and generalized continuum hypothesis.

MATH 597-598 Theory of Recursive Functions I-II. (3-3 Hours) Prerequisites: Mathematics 592 and approval of department. Turing machines, recursive functions, recursive and recursively enumerable sets, Post's Problem and degrees of unsolvability, recursion theorem, lattice of r.e. sets, hierarchies.

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 600 Research. (3 Hours) Prerequisite: Department approval. Mathematics research.

MATH 611-612 Algebra I-II. (3-3 Hours) Prerequisite: Approval of department. Groups and operator groups; basic constructions; isomorphism theorems; Jordan-Holder theorem. Rings and ideals, polynomial rings and group rings; integral domains, factorization theory. Modules and vector spaces, linear mappings; theory of fields and field extensions; normal extensions; separability, Galois theory, finite fields, algebraic closure. Advanced topics.

MATH 613-614 Homological Algebra I-II. (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Categories, functions, spectral sequences, cohomology of groups. Abstract category theory.

MATH 615-616 Finite Groups I-II. (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Permutation representations. Sylow's theorems, commutator calculus, nilpotent groups; p-groups. Finiteness conditions; Burnside problem. Solvable groups; theorems of Hall and Cunihin. Special topics.

MATH 617-618 Ring Theory I-II. (3-3 Hours) Prerequisite: Mathematics 511 or departmental approval. Definition and examples of rings, some special classes of rings, homomorphisms, ideals and quotient rings, more ideals and quotient rings. The field of quotients and integral domains, Euclidean Rings, polynomial rings, polynomials over the rational field, polynomial rings over commutative rings, localization, principal rings, selected topics.

MATH 619-620 Universal Algebra I-II. (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Basic definitions. Subalgebras, congruences and homomorphisms. Direct products, lattices, Boolean algebras, Stone's representation theorem; varieties of algebras, free algebras; special topics.

MATH 621-622 Modern Geometry I-II. (3-3 Hours) Prerequisite: Approval of department. Geometries and their properties. Emphasis on properties and comparisons with systems. Analytic and synthetic projective geometry; structural systems. Advanced topics.

MATH 623-624 Differential Geometry I-II. (3-3 Hours) Survey of minimal surfaces, submanifolds, plateau's problem, Bernstein's problem; complex manifolds, Kahler metric. The Charn class. Albanese and Picard varieties. Holomorphic vector fields, automorphism group. Hodge manifolds.

MATH 625-626 Algebraic Geometry I-II. (3-3 Hours) A study in the plane, based on homogeneous point and line coordinates; a study of algebraic curves and envelopes, including such topics as invariants, singularities, reducibility, genus polar properties, Pascal and Brianchon theorems, and Jacobian, Hessian and Pluker Formulas.

MATH 629-630 Theory of Fields I-II. (3-3 Hours) Prerequisites: Mathematics 511, 512 or departmental approval. Extension fields, the transcendence of e, roots of polynomials, construction with straight-edge and compass, Galois Theory, solvability by radicals, real fields, absolute values, applications, selected topics.

MATH 631-632 Real Variables I-II. (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. The Lebesgue integral, Function Spaces and Banach Spaces, Differentiation, integration of Product Spaces, Lebesgue Stieltjes Integral, linear functionals, implicit and inverse function theorems, Fubini's Theorem, Stokes' Theorem Lp classes; applications to Fourier Series.

MATH 633-634 Functional Analysis I-II. (3-3 Hours) Prerequisite: Mathematics 541 or departmental approval. Advanced Topics. Fundamentals of the theory of vector spaces, Banach Spaces; Functional equations; applications to fields of analysis. Non-linear problems. Schauder-Leray fixed-point theorem and its applications to fundamental existence theorems of analysis, convex sets and weak topologies, operators and their adjoints, semi-norms. Orthogonal projection and Liesz's Representation Theorem, the Hahn-Banach Theorems, normed ring, Ergodic and diffusion theory.

MATH 635-636 Ordinary Differential Equations I-II (3-3 Hours) Prerequisite: Mathematics 541. Approval of department. Existence theorem; linear systems; regular and irregular singular points; special topics.

MATH 637-638 Partial Differential Equations I-II. (3-3 Hours) Prerequisite: Mathematics 541. Approval of department. Classical theory of partial differential equations, together with an introduction to the modern theory based on functional analysis.

MATH 639-640 Theory of Integration I-II. (3-3 Hours) Prerequisite: Mathematics 632 or approval of department. Differentiation and integration, classical Banach spaces, abstract spaces, compact spaces, Banach spaces, measure and integration, measure and outer measure, the Daniell Integral, measure and topology, mappings and measurable spaces.

MATH 641-642 Complex Variables I-II. (3-3 Hours) Prerequisite: Approval of department. The plane and sphere of complex numbers, Differentiability and Cauchy-Riemann differential equations; Cauchy's integral theorem and integral formula. Series of analytic functions. Expansion in power series. Laurent expansion. Singularities, residue theorem, conformal mapping, Riemann mapping theorem, complex manifolds. Reflection principles, theorem of Mittag-Leffler product theorem of Weierstrass theorems of Runge and Poincare. Poisson's Integral Formula, other topics of interest.

MATH 643-644 Functions of Several Complex Variables I-II. (3-3 Hours) Prerequisites: Mathematics 642 and approval of department. Definition of homomorphic and meromorphic functions. Sequences of holomorphic functions. Analytic sets. Theorems of Cousin I, II, and Poincare. Kneser-Weierstrass integral. Functions of finite order, Jacobian Functions, Analytical continuation. Singularities of function and analytic sets on analytic sets. Integral representations of holomorphic functions. Envelopes of holomorphy. Complex manifolds and complex spaces; special topics.

MATH 645-646 Several Complex Variables I-II. (3-3 Hours) Prerequisites: Mathematics 644 and approval of department. Elementary properties of holomorphic functions. Local theory of homorphic functions and analytic sets. Analytic continuation. Coherent analytic sheaves. Cohomology with coefficients in sheaves. Stein spaces. Theorems A and B of Cartan. Theorems of Poincare and Cousin. Embedding theorems. Theorem of Runge. Envelopes of holomorphy, Levi's problem. Holomorphic maps. Compact complex spaces.

MATH 647 Entire Functions. (3 Hours) Prerequisites: Mathematics 642 and approval of department. First and Second Main Theorem of Nevanlinna. Functions of finite order. Hadamard's Theorem, functions of the exponential type. Functions of regular growth. Functions in the unit disk, Blasche Product. First and Second Main Theorem of Nevanlinna for functions for several variables, special topics.

MATH 649-650 Several Real Variables I-II. (3-3 Hours) Prerequisite: Mathematics 641 or approval of department. Necessary and sufficient conditions for an extremum, variations of Hamilton's Principle, the nonparametric problem of Bolza, parametric problems, direct methods, measure, integrals and derivatives, Lebesgue Integrals, Hamilton-Jacobi Theory, applications, nonclassical problems, selected topics.

MATH 651-652 General Topology I-II. (3-3 Hours) Prerequisite: Approval of department. Fundamentals of set theory, topological spaces, metric spaces, Function spaces and separation axioms. Complexes, homotopy and basic theorems in algebraic topology.

MATH 653-654 Algebraic Topology I-II. (3-3 Hours) Prerequisite: Mathematics 652 or 554. Approval of department. Fibre spaces, extension problems, obstruction theory.

MATH 655-656 Combinatorial Topology I-II. (3-3 Hours) Prerequisite: Mathematics 553 or departmental approval. Advanced properties of topological spaces, homology theory, cohomology groups of compacta, selected topics.

MATH 657-658 Differential Topology I-II. (3-3 Hours) Prerequisites: Mathematics 652 and 525 or 623. Study of differential manifolds from a viewpoint approximately midway between topology and differential geometry. Embedding manifolds in Euclidean spaces, transverse regularity of mappings, vector space bundles, universal bundles, characteristic classes, and the Thom Theory of Cobordism. Morse Theory of non-degenerate functions on a manifold, Morse Theory of geodesics, spherical modifications, theory of differentiable homotopy spheres, theory of handlebodies.

MATH 659-660 Algebraic Topology III-IV. (3-3 Hours) Prerequisite: Mathematics 654 or departmental approval. Sheaves and extraordinary cohomology theories, selected topics.

MATH 668 Topics in Statistics. (3 Hours) Prerequisite: Mathematics 562 or departmental approval. Topics in the advanced theory of statistics.

MATH 671-672 Advanced Numerical Analysis I-II. (3-3 Hours) Prerequisite: Mathematics 572 or departmental approval. Selected topics in advanced numerical analysis.

MATH 673-674 Approximation and Interpolation I-II. (3-3 Hours) Prerequisite: Mathematics 576 or departmental approval. Expansion theorems, degree of approximation of linear functions, selected topics.

MATH 677-678 Advanced Set Theory I-II. (3-3 Hours) Prerequisite: Mathematics 596 or departmental approval. Many equivalencies of the Axiom of Choice, selected topics.

MATH 681-682 Infinite Series I-II. (3-3 Hours) Prerequisite: Mathematics 540 or departmental approval. Selected topics are covered.

MATH 683-684 Theory of Summability I-II. (3-3 Hours) Prerequisite: Mathematics 539 or departmental approval. Advanced summability theory of series such as the Karamata-Lototsky-Jakimovski types, selected topics.

MATH 687-688-689 Research I-II-III. (3-3-3 Hours) Research in Mathematics.

MATH 690 Topics in Mathematics Education. (3 Hours) Prerequisite: Departmental approval. Selected topics are covered.

MATH 691 Topics in Algebra. (3 Hours) Prerequisite: Departmental approval.

MATH 692 Topics in Geometry. (3 Hours) Prerequisite: Departmental approval.

MATH 693 Topics in Real Analysis. (3 Hours) Prerequisite: Departmental approval.

MATH 694 Topics in Complex Analysis. (3 Hours) Prerequisite: Departmental approval.

MATH 695 Topics in Probability and Statistics. (3 Hours) Prerequisite: Departmental approval.

MATH 696 Topics in Number Theory. (3 Hours) Prerequisite: Departmental approval.

MATH 697 Topics in Numerical Analysis. (3 Hours) Prerequisite: Departmental approval.

MATH 698 Topics in Logic and Foundations. (3 Hours) Prerequisite: Departmental approval.

MATH 699 Dissertation. (3 Hours) Prerequisite: Departmental approval. Research in Mathematics.

DEPARTMENT OF PHYSICS, ATMOSPHERIC SCIENCE AND GENERAL SCIENCE

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Faculty

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Dr. E. Heydari, Assistant Professor
Dr. M. Longmire, Associate Professor

The Department of Physics, Atmospheric Sciences and General Science has the major teacher training responsibility in the School of Science and Technology. This program leads to the (MST) degree in Science Education with a concentration in one of the following areas: (Astronomy, Biology, Chemistry, General Science, Physics and Physical Science). The Department also offers for credit graduate science education and science content courses for graduate students of other programs. Several courses are offered for inservice teachers and other educators for professional development. These courses are often used toward certification and further degrees.

Accreditation

This program is accredited by the National Council for Accreditation of Teacher Education (NCATE).

Program Objectives

1. To provide additional preparation for science teachers and science supervisors in scientific content and supervision techniques.
2. To enable teachers of science to gain insight into the kinds of science experiences that are relevant to the needs of today's youth.
3. To develop in science teachers an awareness of the modern trends and problems in science teaching.
4. To enrich current and potential science teachers and educators with content and pedagogy in science and science education areas.
5. To offer courses of use to different non-departmental graduate degree programs.

Admission Requirement

Hold a baccalaureate degree with a major or minor in one of the natural sciences from an accredited college or university. Student maybe admitted conditionally if the Graduate Record Examination (GRE) is not taken.

Degree Requirements

A total of 30 semester hours plus a thesis (6 hours), 33 semester hours plus a project (3 hours), or 36 semester hours with neither a thesis or project.

By the end of the first year, the student should complete the Graduate English Competency Examination (GECE). Students should take the Gradsuate Area Comprehensive Examination in all core science courses.

Master of Science in Teaching

Core Courses

Course	Title	Semester Hours
EDFL 515	Methods of Educational Research	3
EDFL 514	Elementary Statistics	3
EDFL 568	Curriculum Methods	3
	Hours	9

Science Education Core Courses

SCI 502	General Science for Teachers	3
SCI 507	Earth Science	3
SCI 513	Computer Applications in the Teaching of Science	3
SCI 522	Environmental Science	3
SCI 563	Problems and Issues in Science	3
SCI 581	Operation Physic I	3
	Hours	21
SCI 599	Thesis, *or*	6
SCI 587	Independent Study	3
	Science Elective, *or*	3
	Two Science Electives	6
	Total Hours	36

DESCRIPTION OF COURSES

SCI 502 General Science for Teachers. (3 Hours) A study of topics in astronomy, chemistry, geology, meteorology and physics.

SCI 507 Earth Science. (3 Hours) An exploratory course dealing with basic concepts in geology, meteorology, and astronomy.

SCIL 507 Earth Science for Teachers Lab. (1 Hour) Laboratory experiments designed to expand subject matter taught in SCi 507.

SCI 508 Cosmology for Non-Scientists. (3 Hours) A study of the structure, makeup origin, and evolution of the universe and objects in it.

SCI 509 Earth History (3 Hours) The course studies history of the continents and oceans and the changes to the atmosphere through time.

SCI 513 Computer Applications in the Teaching of Science. (3 Hours) This course includes computer concepts; programming in the Basic language;

building modules for computer assisted instruction and computer aided instruction; problem solving on a microcomputer system.

SCI 515 Earth and Space Science (3 Hours) This course is the study of Earth Science, Geology, and Meteorology.

SCI 516 Physical Science I for Middle School Teachers (3 Hours) This course is the study of properties and reactions of matter.

SCI 517 Physical Science II for Middle School Teachers (3 Hours) This course is the study of Physics, Astronomy and Technology that includes: (in Physics) measurment, force, motion, energy, simple and compound machines, electricity and magnetism, sound, light and heat; (in Astronomy) stars in the night sky, solar system, lunar phases, eclipses, earth seasons, galaxies and universe.

SCI 518 Life Science for Teachers (3 Hours) This course is the study of biochemistry, the cell, genetics, organ systems, natural selection, diversity, ecology and the property and reaction of matter.

SCI 519 Environmental Science and Chemistry for Teachers (3 Hours).

SCI 520 Methodology for Science Teaching (3 Hours) This course includes exemplary teaching strategies and research-based methods, i.e. Inquiry-based learning, cooperative learning, and the use of technology.

SCI 522 Environmental Science. (3 Hours) A general study of environmental problems created by various kinds of pollution and the effects of man's bio-physical environment.

SCI 523 Seminar in Science (3 Hours) Provides the opportunity to discuss the most pertinent trends in science and to become familiar with current research.

SCI 524 Elements of Astronomy (3 Hours) Survey of solar and stellar systems, with emphasis on the historical and scientific development of astronomy.

SCI 525 Hands-on Activity in Astronomy (3 Hours) This course is support for instructional competency in astronomy in Mississippi.

SCI 551 Hands-on Universe in Mississippi I. (3 Hours) This course integrates mathematics, science and technology in the context of exciting astronomical explorations. This course addresses many of the goals set by the National Council of Teachers of Mathematics and the National Research Council for Math and Science Education.

SCI 563 Problems and Issues in Science. (3 Hours) Content in elementary science; aims and methods of instruction, new curricular developments.

SCI 581 Operation Physics I . (3 Hours) This course is the study of mechanics that includes: measurement, force and motion, simple machines and forces, and fluids.

SCI 552 Hands-on Universe in Mississippi II. (3 Hours) Prerequisite: SCI 551. This course integrates mathematics, science and technology in the context of exciting astronomical explorations. This course addresses many of the goals set by the National Council of Teachers of Mathematics and the National Research Council for Math and Science Education.

SCI 580 Science Technology and Environment (3 Hours) An overview of contemporary topics in science and technology. The scientific and technical materials will be covered in detail, then the social consequences of applying or misapplying that knowledge will be examined.

SCI 582 Operation Physics II. (3 Hours) This course is the study of sound and light that include: measurement, sound, behavior of light, color and vision.

SCI 583 Operation Physics III. (3 Hours) This course is the study of electricity and magnetism that include: measurement, electricity, magnets, and magnetism.

SCI 584 Operation Physics IV. (3 Hours) This Course is the study of modern physics that include: measurement, structure of matter, atoms, molecules, nuclei, elementary particles, and special and general relativity.

SCI 587 Independent Study. (1-3 Hours) For students who are actively working on special projects and consulting with their major professor.

SCI 592-592W Seminar in Meteorology. (3 Hours) Presentation and discussion of special topics and research in meteorology by staff members, students and guest lecturers.

SCI 599 Thesis (6 Hours). A minimum of 40 hours of research for the thesis must be scheduled. The thesis must show (a) mastery of the techniques of research, and (b) a very distinct contribution to the field under investigation and study.

SCI 601W Seminar in Environmental Science. (3 Hours) Advanced topics of special interest, current research, field trips, demonstrations and guest lecturers.

SCI 602 Construction of Teaching Materials for Secondary Science Instruction. (3 Hours) Special work in models, charts, graphs, photography, electrical apparatus, mechanical equipment, etc.

SCI 603 Special Topics in Science. (3 Hours) Topics of current interest, both theoretical and experimental.

SCI 604 Advanced Methods—Secondary School Science. (3 Hours) Experience with science teaching. Major trends in the new science courses and methodology programs.

SCI 605 Analysis of Science Curriculum. (3 Hours) A critical examination of contemporary and potential science curricular projects.

DEPARTMENT OF TECHNOLOGY

Dr. J. Ejiwale , Associate Professor and Acting Chair
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Faculty

Dr. I. T. Mosley, Sr., Associate Professor
Dr. P. C. Yuan, Professor

The Department of Technology offers the Master of Science in Education and the Master of Science in Hazardous Materials Management. The Master of Science in Education degree with a concentration in technology education is designed to improve the competencies of technology educators and administrators in secondary and post-secondary schools.

Admission Requirements

Admission to the graduate degree program in Hazardous Materials Management and Technology Education is governed by the regulations of the Graduate School.

Hazardous Materials Management

Degree Requirements

The degree options are 30 semester hours plus a thesis; 33 semester hours plus a project; or 36 semester hours of course credit.

Course	Title	Semester Hours
ITHM 520	Introduction of Hazardous Materials Management	3
ITHM 523	Statistics/Data Analysis	3
ITHM 524	Public Issues in Hazardous Materials	3
ITHM 525	Natural Resources and Conservation	3
ITHM 529	Env Toxicology and Risk Assessment	3
	Hours	15

Elective Courses

ITHM 521	System Modeling	3
ITHM 522	Chemistry of Hazardous Materials	3
ITHM 526	Environmental Regulations	3
ITHM 527	Water and Wastewater Treatment	3
ITHM 528	Waste Minimization	3
ITHM 530	Industrial Waste Treatment and Tech.	3
	Total Hours	30, 33 or 36

Technology Education

Degree Requirements

The degree options are 30 semester hours plus a thesis; 33 semester hours plus a project; or 36 semester hours of course credit.

Course	Title	Semester Hours
TE 501	Current Literature, Issues and Research	3
TE 504	Laboratory Planning and Management	3
TE 505	History and Philosophy of Technology Education	3
TE 512	Administration and Funding	3
TE 513	Instructional Aids	3
	Hours	15

Courses in Education

PSY 531	Elementary Statistics	3
EDFL 515	Methods of Educational Research	3
EDFL 568	Curriculum Methods	3
	Hours	9

Elective Courses

TE 511	Technical Education	3
TE 515	Career Education	3
TE 516	Curriculum Development	3
TE 521	Problems in Electronics	3
TE 522	Problems in Drafting	3
TE 523	Problems in Metals	3
TE 524	Problems in Woods	3
	Total Hours	30, 33 or 36

DESCRIPTION OF COURSES

Hazardous Materials Management

ITHM 500 Graduate Research/Thesis. (1-4 hours) The student is required to select an appropriate topic with approval from advisor and do a presentation.

ITHM 520 Introduction of Hazardous Materials Management. (3 Hours) (For Non-hazardous Materials Management Majors). An introduction to contemporary national problems of air and water pollution, environmental monitoring, toxicology, hazardous waste; general problems of environmental contamination; legal and political aspects of current regulations; general scientific principles applied to the evaluation and control of specific problems.

I**THM 521 System Modeling.** (3 Hours) Practical application of simulation to diverse environmental systems including air, land, surface, sub-surface, water systems and also, the hazardous materials management models.

ITHM 522 Chemistry of Hazardous Materials. (3 Hours) This course shows how chemistry can be applied to hazardous materials. The course is designed to introduce and train students' awareness of the unique requirements involved in handling hazardous materials when they are encountered in different situations, thus reducing the loss of lives and property. Prerequisite: Chemistry 135 & 235.

ITHM 523 Statistics/Data Analysis. (3 Hours) This course is designed for the development and maintenance of proficiency in statistical interface. It contains a

comprehensive overview of how statistics work in actual cases and how it can be applied in hazardous materials management. Prerequisite: Math 111, CSC 115, & 203.

ITHM 524 Public Issues In Hazardous Materials/Waste. (3 Hours) This course is an overview of the strategies, tactics and techniques regarding environmental affairs, both public and private.

ITHM 525 Natural Resources and Conservation. (3 Hours) This course is designed to give students pertinent information of our natural resources with emphasis on their origin, properties, use, misuse and conservation practices.

ITHM 526 Environmental Regulations. (3 Hours) A study of Federal Laws and Regulations concerning hazardous materials and wastes. This course will introduce students to laws and regulations in Mississippi and the nation. The course emphasizes how to implement and comply with laws.

ITHM 527 Water and Wastewater Treatment. (3 Hours) Students will be given an overview on waste/wastewater treatment through discussions of various selected topics. The primary focus of these topics will be to introduce students to treatment methods. Prerequisite: BIO 115 and CHEM 142.

ITHM 527 Water and Wastewater Laboratory. (1 hour) This course is the supplementary course of ITHM 527; laboratory activities which develop techniques for testing water and wastewater. This will involve tests for COD, BOD, Alkalinity, Nitrogen, Colonial Count, TCLP and several other tests. Prerequisite: Bio 101, CHEM 135 & 235, and ITHM 401.

ITHM 528 Waste Minimization. (3 Hours) This course is designed to make students aware of the vast number of problems encountered as a result of disposing waste. Also, students will be given lectures on methods of recycling, reuse and reducing our waste.

ITHM 529 Environmental Toxicology and Risk Assessment. (3 Hours) This course will involve studying chemicals and harmful actions of chemicals on biological issues. This will include understanding chemical reactions and interactions of biological organisms. Students will also be introduced to scientific data and methods currently used to access human risk to environmental chemicals.

ITHM 530 Industrial Waste Treatment and Technology. (3 Hours) This course is an advanced course for hazardous waste treatment technology. It includes training in pretreatment of hazardous materials, chemical/physical process, stabilization, recovery processes, final disposal of, and secured landfill stabilization. EPA requirements for each process will be addressed in this class. Prerequisite: ITHM 302.

Technology

TE 500 Seminar/Workshop. (3 Hours) Designed for offering courses on subjects which are current and important to industrial education.

TE 501 Current Literature, Issues and Research. (3 Hours) Identification, analysis, and discussion of the periodicals, topical books, major issues, and research in the field of industrial education.

TE 504 Laboratory Planning and Management. (3 Hours) Designing various industrial education laboratories and facilities. Includes attention to purpose, recommended sizes and other specifications.

TE 505 History and Philosophy of Technology Education. (3 Hours) Factors involved in developing the trends and leaders in industrial and vocational education. Analysis of objectives, current concepts, practices and anticipated policies in industrial education.

TE 511 Technical Education. (3 Hours) Emphasis on trends, community surveys, curricula, definitions, and needs of post-secondary technical education programs.

TE 512 Administration and Funding. (3 Hours) Identifying current legislation and funding practices concerning industrial education. Function and relationship of directors, supervisors and instructors in all fields of industrial education.

TE 513 Instructional Aids. (3 Hours) Studying the many instructional aids available for teaching industrial subjects. The course includes instruction in the common audio-visual aids but also making models, cutaways and other industrial teaching aids.

TE 515 Career Education. (3 Hours) Current career education programs and their relationship to industrial education. Emphasis on integrating career education goals in industrial education with attention to the goals of each field.

TE 516 Curriculum Development. (3 Hours) Principles and techniques of designing and writing industrial education curricula. Attention will be given to goals, behavioral objectives, designing programs to meet objectives and evaluating results.

TE 521 Problems in Electricity/Electronics (3 Hours) Opportunity to study problems related to the area of electricity/electronics. Problems based on needs of students with approval of the advisor and the Dean of the School.

TE 522 Problems in Drafting. (3 Hours) Opportunity to study problems related to the area of drafting. Problems based on needs of students with approval of the Dean of the School and his advisor.

TE 523 Problems in Metals. (3 Hours) Opportunity to study problems related to the area of metals. Problems based on needs of students with approval of the Dean of the School and his adviser.

TE 524 Problems in Woodworking. (3 Hours) Opportunity to study problems related to the area of woodworking. Problems based on needs of students with approval of the Dean of the School and his adviser.

TE 581W Residential Plumbing. (3 Hours) Residential Plumbing is designed to acquaint the student with the fundamentals of basic residential and commercial plumbing. Much of the class time will be given to hands-on activities. Graduate students in residual plumbing are

required to do a research project in air-conditioning and refrigeration.

TE 590 Thesis. (3 Hours) The candidate selects an appropriate topic with approval of adviser and his committee.

TE 599 Independent Research. (1-3 Hours) Opportunities for studying special problems and doing research in the major area. Developed and defined in consultation with the professor.

TE 600 Seminar in Industrial Education. (3 Hours) Seminar in the various fields of industrial and technical education.

TE 601 Selection and Organization of Subject Matter. (3 Hours) Analysis and selection of materials for junior and senior high school, and also, adult industrial technical education.

TE 602 Evaluation of Programs of Industrial and Technical Education. (3 Hours) Evaluation principles and practices in the specialized areas of industrial arts, technical and industrial education.

TE 603 Research in Industrial Education. (3 Hours) Rationale for and methods of research in education. Emphasis is given to the identification of researchable problems and interpretation of research studies in industrial education.

TE 621 Coordination in Occupational Training and Placement Program. (3 Hours) Analysis of objectives and scope of trade and industrial cooperative education program, apprenticeship, and general education work experiences.

TE 622 Developing Occupational Curricula in Two-Year Colleges. (3 Hours) Approaches to occupational curriculum development and course construction in junior colleges. For prospective teachers and administrative personnel.

TE 688 Internship. (variable credit) Supervised graduate internship and externship in various areas of industrial education.

TE 699 Reading and Independent Study. (variable credit) Study on an individual or group basis in industrial education.