GRADUATE ENGINEERING PROGRAM

The Graduate Engineering Program includes both M.S. and Ph.D. degrees in engineering. Enrolled students may specialize in one or more of the eight areas of emphasis including:

- Civil Engineering,
- Environmental Engineering,
- Geological Engineering,
- Coastal Engineering,
- Computer Engineering,
- Computational Engineering,
- Electrical Engineering, or
- Telecommunications Engineering.

Department of Civil & Environmental Engineering and Industrial Systems & Technology

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Faculty

Dr. D. Leszczynska, Professor
Dr. Y. Li, Professor
Dr. R. W. Whalin, Professor
Dr. W. Zheng, Professor
Dr. M. Khan, Associate Professor
Dr. K. Wen, Assistant Professor
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Dr. H. Liu, Assistant Professor

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Dr. K. Ali, Professor
Dr. S. Aliabadi, Professor
Dr. F. C. Dancer, Assistant Professor
Dr. L. Gong, Assistant Professor
Dr. S. Hong, Associate Professor
Dr. J. Jackson, Associate Professor
Dr. M. Manzoul, Professor
Dr. N. Meghanathan, Professor
Dr. V. Melapu, Assistant Professor
Dr. L. Moore, Professor
Dr. T. Pei, Professor
Dr. A. Tanner, Associate Professor
Dr. S. Tu, Professor

Masters

- Engineering (M.S.) (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms/)
- Engineering (M.S.) Civil Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-civil-engineering-emphasis/)
- Engineering (M.S.) Coastal Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-coastal-engineering-emphasis/)
- Engineering (M.S.) Computational Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-computational-engineering-emphasis/)
- Engineering (M.S.) Computer Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-computer-engineering/)
- Engineering (M.S.) Electrical Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-electrical-engineering/)
- Engineering (M.S.) Environmental Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-ms-enivornmental-engineering-emphasis/)
- Engineering (M.S.) Telecommunications Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/telecommunications-engineering-emphasis/)

Doctoral

- Engineering (Ph.D.) (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-phd/)
- Engineering (Ph.D.) Civil Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-phd-civil-engineering-emphasis/)
- Engineering (Ph.D.) Coastal Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-phd-coastal-engineering-emphasis/)
- Engineering (Ph.D.) Environmental Engineering Emphasis (https://jsums-public.courseleaf.com/graduate/college-science-engineering-technology/graduate-engineering-program/engineering-phd-environmental-engineering/)

Course Descriptions

CIV 520 ADVANCED ENGINEERING ANAYLS 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 ADVD ENGINEERING ANALYSIS II (3 Hours)
A comprehensive course to familiarize engineering professions with advanced applied mathematics as it relates to solving practical engineering problems. The course of intensive study blends the theoretical use 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; Numberical Methods; Optimization; Graphs, and Probability and Statistics.

CIV 531 TRAFFIC ENGINEERING (3 Hours)
Prerequisite: CIV 390 or permission of Department.
Study of fundamentals of traffic engineering; analysis of traffic stream characteristics; capacity of urban and rural highways; design and analysis of traffic signals and intersection; traffic control; traffic impact studies; and traffic accidents.

CIV 535 PAVEMENT DESIGN (3 Hours)
Aggregate, binder systems. Theory and design of pavement structures, rigid and flexible pavement designs, subgrade materials, pavement management, nondestructive testing, pavement maintenance, design constraints, infrastructure maintenance, major design project.

CIV 536 HIGHWAY ENGINEERING (3 Hours)
Analysis of factors in developing highway transportation facilities; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; and highway maintenance planning.

CIV 538 COASTAL STRUCTURES (3 Hours)
The types and functions of coastal structures studied include, seawalls, groins, revetments, bulkheads, dikes, detached breakwaters, reef breakwaters, storm surge barriers and others. A coastal structure will be designed to each student to provide the class a lecture and to prepare a term paper on the coastal structure assigned. Determination of the design wave climate for coastal structures is investigated as it pertains to the functional types of coastal structures. Invited guest lecturers will appear as available.

CIV 539 ADVANCED COASTAL ENGNRG DESIGN (3 Hours)
This course provides a comprehensive advanced investigation of the coastal engineering design process. It includes the Planning and Design Process, Site Characterization, Shore Protection Projects, Beach Fill Design, Navigation Projects, Sediment Management at Inlets and Environmental Enhancement. A design project will be assigned to each student to provide the class a power point presentation and to prepare a term paper on the design project assigned. Invited guest design professionals will appear and present lectures as available.

CIV 542 ADVND DESIGN OF CONCRETE STRUC (3 Hours)
Prerequisite: CIV 420.
Theory and design of reinforced concrete continuous beams, slender columns, two-way-slabs, footings, retaining walls, shear walls and multistory buildings. Design for torsion and design constraints. Framing systems and loads for buildings and bridges, design constraints and a major design project. (Cross reference: CIV 477)

CIV 544 ADVD DESIGN OF STEEL STRUCTURE (3 Hours)
Prerequisite: CIV 360.
Behavior and design of members subjected to fatigue, dynamic, combined loading. Methods of allowable design stress, and load resistance factor design. Design of continuous beams, plate girders, composite beams, open-web joists, connections, torsion and plastic analysis and design. Framing systems and loads for industrial buildings and bridges, design constraints and a major design project. (Cross reference: CIV 476)

CIV 550 ENGINEERING HYDROLOGY (3 Hours)
Prerequisite: CIV 370 or permission of Department.
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,

CIV 560 ENVIRONMENTAL ENGINEERING II (3 Hours)
Prerequisite: permission of Department.
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.

CIV 561 CHEMISTRY FOR ENVIRNL ENGINEER (3 Hours)
Prerequisite: CIV 340, or CIV 560, or permission of Department.
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.

CIV 562 HAZARDOUS WASTE ENGINEERING (3 Hours)
Prerequisite: CHEM 241, CHML 241, CIV 340, CIVL 340, or permission of Department.
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. (Cross reference: CIV 468)

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

CIV 566 AIR POLLUTION (3 Hours)
Prerequisite: permission of Department.
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.

CIV 567 ENVIRONMENTAL REMEDIATION (3 Hours)
Prerequisite: permission of Department.
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 bioremediaton, oxidation, soil vapor extraction, soil washing, surfactant-enhanced remedy, thermal treatment, air stripping, solidification/stabilizations, electro kinetic 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 emphasized. Examples of successful applications of the remediation technologies are discussed.

CIV 568 LAND DISPOSAL OF WASTE (3 Hours)
Prerequisite: permission of Department.
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. 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.

CIV 569 ADVD TPCS IN WATER RESOU ENGNE (1 Hour)
Prerequisite: permission of Department.
Mathematical modeling of environmental systems, including rivers, lakes, estuaries, and air.

CIV 573 ENVRNMNTL GEOLOGY FOR ENGNS (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.

CIV 574 HYDROGEOLOGY (3 Hours)
Prerequisite: permission of Department.
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.

CIV 580 Advanced Construction Engineering & Management (3 Hours)
Prerequisite: CIV 452 or permission of the department
Skills and knowledge required for sound project management in a variety of management settings, discussion of corporation structures, risk management concepts, labor, safety, and finance. Elements of sound project management. Advanced knowledge of planning, scheduling, and monitoring of construction projects. Contracting issues facing project managers in the engineering world are discussed.

CIV 581 Construction Scheduling (3 Hours)
Prerequisite: Department permission.
This course aims to increase and improve the working knowledge of students in project scheduling and to train them as professional construction managers as stated in the program mission. Students will be provided an understanding of planning, scheduling, and monitoring of construction projects including development of critical path networks, Gantt bar charts and construction cost control and reporting practices. The students will also learn how to use the software tools to accurately prepare and analyze the project schedule and to effectively communicate the schedule to the management team. (Cross-referenced: CIV 454)

CIV 582 Construction Estimating, Cost Analysis & Control (3 Hours)
Prerequisite: CIV 453 or department permission.
This course presents a broad study of estimating methodology, including detailed unit pricing, labor, equipment, materials, subcontracts, job conditions, preconstruction costs, indirect costs, and profit. Detailed Work Breakdown Structure in the estimating process and preparation of a sound bid estimate are presented. Methods for cost control are discussed.

CIV 583 Construction Engineering Equipment & Methods (3 Hours)
Prerequiste: Permission of the department. This course provides an understanding of the various construction methods and equipment employed in the construction industry. The International Building Code, as well as fundamental principles of green building and sustainable design are presented. This course presents a detailed study of typical building materials, design details, and various construction methods, and materials including soil, steel, concrete, wood, and composites. Deployment of equipment, materials, personnel, and subcontracts using a variety of building material and system types are presented.

CIV 584 Construction Contracts, Laws, & Claims (3 Hours)
Prerequisite: Departmental permission.
This course provides an overview of the fundamental aspects of the laws that affect construction and engineering companies, subcontractors as well as the project owners. Construction contracts including contract forms, provisions related to the liability for engineering design and construction, contract language negotiations, as well as key contract terms and how to apply them when managing an active construction project will be discussed. In addition, the course will focus on understanding how to manage claims and disputes, such as claims related to schedule delays and productivity losses.

CIV 585 Building Information Modeling and Integrated Project Delivery (3 Hours)
Prerequisite: Permission of the department
This course covers the Building Information Modeling (BIM) and Integrated Project Delivery (IPD) approaches that address and resolve the perceived inefficiencies in the construction industry. BIM covers geometry, spatial relationships, geographic information, quantities, and properties of building components and can be used to demonstrate the entire building lifecycle including the processes of construction and facility operation. IPD deals with the integration of people, systems, business structures and practices into a single process and collaboratively harness the talents and insights of all participants on a particular construction project in order to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. (Cross reference: CIV 455);

CIV 586 Construction Economic Analysis (3 Hours)
Prerequisite: CIV 355 or permission of the department.
Foundation in Life Cycle Cost Analysis computation within the context of current issues in environmental sustainability and evidence-based thinking; lean construction as a strategy to overcome the hurdle of first cost. Topics covered include the time value of money, and the importance of Cash Flow Diagrams.

CIV 587 Computer Integrated Construction Engineering (3 Hours)
Prerequisite: Permission of the department.
This course educates the emerging design and construction engineering, related work processes, and the contractual relationships for a successful project to the student. The Building Information modeling (BIM), virtual design & construction (VDC), and reality capture will be presented to the students, and various software will be taught.

CIV 588 Decision & Risk Analysis in Construction Engineering (3 Hours)
Prerequisite: Permission of the department
This course provides an overview of the concept of risk analysis including probability, and uncertainty, including probabilistic theories and models, data sampling, hypothesis testing, and the basics of Bayesian Decision Theory. Components of a risk event such as source and impact, and risk reward structure, in construction engineering projects are presented. Decision making process based on risks analysis in construction industry is presented. Sound approaches to support "go" or "no go" decision-making, project financing choices, and project risk mitigation are discussed.

CIV 589 Productivity in Construction Engineering (3 Hours)
Prerequisite: Permission of the department
This course provides an overview of the construction productivity and methods to reduce waste. Lean history concepts and methods, optimization, deduction of basic training modules in lean project delivery, and application of lean management in construction projects are presented. Applications of methods improvement techniques such as time-lapse photography, flow charts, process charts and time standards to improvement of construction productivity are discussed.

CIV 590 Sustainable Construction (3 Hours)
Prerequisite: CIV 453 or departmental permission
Sustainable development includes reducing the impacts of human activities on natural ecosystems and understanding the role these ecosystems have in the economy and on human welfare. The course covers the environmental ethics and environmental justice; ecological/environmental economics including Life Cycle Costing; building assessment (frameworks) and ecolabels. The course develops basic knowledge about energy systems, exergy, entropy, energy conservation and renewable energy; Life Cycle Assessment, embodied energy, energy, and materials.

CIV 631 LINEAR THEORY OF OCEAN WAVES (3 Hours)
Governing equations in free surface flow, deterministic and probabilistic wave theories, wave transformation, wave-induced coastal currents. The formulation and solution of the governing boundary value problem for small amplitude waves are developed and kinematic and pressure fields for short and long waves are explored.

CIV 632 TIDES AND LONG WAVES (3 Hours)
Prerequisite: permission of the Department.
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 636 SPECTRAL WAVE ANALSIS (3 Hours)
Prerequisite: CIV 330, CIV 631 or permission of the Department.
Measurement techniques of ocean waves. Introduction and basic concept of wave spectrum. Harmonic analysis and mathematical formulation of wave spectrum. Maximum entropy and maximum likelyhood methods. Idealized wave spectral models. Wave energy balance equation and its application. Nonlinear wave-wave interaction and diffraction. Wave hindcast and forecast modeling in coastal waters.

CIV 637 ADVD DESIGN FOR BRKWATER REHAB (3 Hours)
Advanced analysis and design considerations for breakwaters are investigated for the most complex challenges. These challenges are associated with rehabilitation and/or reconstruction of damaged breakwaters. Design considerations are explored from an analysis of breakwater failures at Sines, Nawilliwilli, Kahului and others. Toe design, crest elevation, crown design, core alternatives, runup, overtopping, design waves, head design, constructability and functionality are explored.

CIV 640 FINITE ELEMENT METHODS (3 Hours)
Prerequisite: CIV 540 or permission of Department.
Theory and application of the finite element method; stiffness matrices for triangular, quadrilateral, and isoparametric elements; two- and three-dimensional elements; algorithms necessary for the assembly and solutions; direct stress and plate bending problems for static, nonlinear buckling and dynamic load conditions; displacement, hybrid, and mixed models together with their origin in variational methods.

CIV 642 PRESTRESSED CONCRETE DESIGN (3 Hours)
Study of strength, behavior, and design of prestressed reinforced concrete members and structures, with primary emphasis on precast, prestressed construction; emphasis on the necessary coordination between design and construction techniques in prestressing.

CIV 650 SMALL WATERSHED HYDROLOGY (3 Hours)
Prerequisite: CIV 550 or permission of Department.
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.

CIV 653 ADVD DESIGN OF HYDRAULIC STRUC (3 Hours)
Prerequisite: CIV 370 or permission of Department.
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. (Cross-Reference: CIV 466)

CIV 659 ADVD TPS IN WATER RESOURCE ENG (1-4 Hours)

CIV 660 PHYCML PROCESSES IN WATER & WT (3 Hours)
Prerequisite: CIV 561 or permission of Department.
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.

CIV 661 BIOL PROCESS IN WASTEWATER ENG (3 Hours)
Prerequisite: CIV 660.
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.

CIV 666 ADVND WASTE TRTMNT PROC IN ENV (3 Hours)
Prerequisite: CIV 661 or permission of Department.
An in-depth study of the biological processes used to treat wastewater, with an emphasis on recently published information.

CIV 669 ADVND TPC IN ENVRNML ENGINEERG (3 Hours)
Prerequisite: permission of Department.
Course will focus on a variety of topics in the field of environmental engineering. May be repeated for credit.

CIV 670 ROCK MECHANICS (3 Hours)
Prerequisite: permission of Department.
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.

CIV 672 ADVANCED GEOMECHANICS (3 Hours)
Prerequisite: CIV 380 or permission of Department.
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.

CIV 673 ADVD FOUNDATION ENGINEERING (3 Hours)
Prerequisite: CIV 430 or permission of Department.
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.

CIV 675 EARTH DAMS AND SLOPES (3 Hours)
Prerequisite: CIV 380 or permission from the Department.
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.

CIV 680 UNSATURATED SOIL MECHANICS (3 Hours)
Introduction of unsaturated soil, stress-state variables, soil water suction and soil water characteristics curves, hydraulic function curves, flow in unsaturated soil, shear strength and slope stability analysis, lateral earth pressure and retaining structures, design, and compressibility and volumne change analysis for unsaturated soils.

CIV 681 EXCAVATION SUPPORT SYSMS & R S (3 Hours)
Earth pressure theory used in the design of temporary and permanent earth retaining structures, guidelines for the selection of retention method, retaining wall design and associated construction issues of gravity walls, concrete retaining walls,MSE wall, sheet pile wall, soldier pile and diaphragm walls, braced and tie back excavation support systems.

CIV 682 COMPUTATIONAL GEOTECHNICS (3 Hours)
Introduction to numerical and finite element modeling, analyses of embackments, earth dams, slopes, excavation support systems including soldier pile and diaphragm walls, shallow and deep foundation systems, and other geo-structures using advanced geotechnical software.

CIV 683 SOIL STRUCTURE INTERACTION (3 Hours)
Introduction to geotechnical earthquake engineering and fundamental understanding of soil behavior under dynamic loading, finite element analysis of soil structure interaction due to dynamic loading and structural response, seismic slope stability analysis, seismic design of retaining wall and buried structures, case studies.

CIV 684 ADVND SITE CHARACTER & INSTRUM (3 Hours)
In situ test methods, advantages and limitations,SPT, CPT, DCPT, CPTU or piezoncone, DMT, pressure meter, shear vane and other field testvmethods, non-destructive seismic, resistivity, electromagnetic methods, soil property interpretation procedures, geotechnical instrumentation types, monitoring and applications.

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

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

CIV 698 INDEPENDENT STUDY (1-4 Hours)
Prerequisite: permission of Department.
Intensive study of a special engineering project including research and literature review selected in accordance with student interests and arranged in consultation with the adviser. Topics will vary. Student will make periodic reports, and will prepare a scholarly paper at the end of semester.

CIV 699 THESIS RESEARCH (1-3 Hours)
Prerequisite: permission of adviser.
Master's thesis representing an independent and original research.

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