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Civil and Environmental Engineering

The School of Civil, Environmental, and Infrastructure Engineering offers a Master of Science (M.S.) degree in Civil Engineering and a Master of Engineering degree (M.E.) in Civil and Environmental Engineering.

Master of Science (M.S.) in Civil Engineering

Graduate work leading to the Master of Science degree in Civil Engineering is offered by the School of Civil, Environmental, and Infrastructure Engineering. The program provides advanced study in the areas of structural engineering, environmental engineering, geotechnical engineering, and hydraulic and water resources engineering.

Admission

The School requires that applicants to the M.S. in Civil Engineering program hold a bachelor's degree in civil or environmental engineering (or equivalent), or have completed all undergraduate degree requirements prior to registration, with minimum grade point average (GPA) of 3.0 (A = 4.0) on the entire last undergraduate GPA earned at the time of application. Students having a GPA between 2.7 and 3.0 will be considered on a case-by-case basis. A student whose undergraduate training is deficient may be required to take additional coursework without graduate credit. All applicants are required to submit GRE scores in support of their applications for admission (minimum scores: 146 Verbal, 152 Quantitative, 3.5 Analytical Writing). The GRE scores must be less than five years old at the time of registration. Minimum requirements for GRE verbal and analytical writing may be waived if the student's TOEFL score is greater than 570 (test center), 230 (computer based) or 82 (Internet based), or IELTS score of 7.0 or higher, and he/she possesses good communication skills.

Students apply on-line at <u>gradschool.siu.edu/apply</u>. A nonrefundable \$65 application fee is required and must be paid by credit card. Applications cannot be processed until the fee is paid.

Requirements

A graduate student in the School is required to develop a program of study with a graduate adviser and establish a graduate committee of at least three members before the end of his/her first semester in the graduate program. Each student majoring in civil engineering may, with the approval of the graduate committee, also take graduate level courses in other branches of engineering or in areas of science and business, such as physics, geology, chemistry, mathematics, life science, administrative sciences, or computer science.

A minimum of 30 hours of acceptable graduate credit is required, including a minimum of three credit hours of CE 599, Thesis. Of this total, eighteen credit hours must be earned in the School. Furthermore, at least 50% of all credit hours must be 500-level and completed at Southern Illinois University Carbondale. Each candidate is also required to pass a comprehensive oral examination covering all of the student's graduate work, including a thesis.

Each student will select a minimum of three engineering graduate faculty members to serve as a graduate committee, subject to the approval of the School Director. The committee will:

- 1. approve the student's program of study;
- 2. approve the student's thesis topic;

- 3. approve the completed thesis;
- 4. administer and approve the comprehensive oral examination.

Teaching or research assistantships and fellowships are available for qualified applicants. Additional information about the program, courses, assistantships, and fellowships may be obtained from the School or the College of Engineering, Computing, Technology, and Mathematics.

Master of Engineering (M.E.) in Civil and Environmental Engineering

The Master of Engineering degree (M.E.) in Civil and Environmental Engineering is a non-thesis, course only, professional degree designed to provide advanced technical knowledge for professional practice. The program provides advanced study in the areas of structural engineering, environmental engineering, geotechnical engineering, and hydraulic and water resources engineering.

Admission

The School requires that applicants to the M.E. in Civil and Environmental Engineering program hold a bachelor's degree in civil or environmental engineering (or equivalent), or have completed all undergraduate degree requirements prior to registration, with minimum grade point average (GPA) of 3.0 or better (A = 4.0) on the entire last undergraduate GPA earned at the time of application. Students having a GPA between 2.7 and 3.0 will be considered on a case-by-case basis. The GRE is not required for students applying to the M.E. in Civil and Environmental Engineering degree program.

Students apply on-line at <u>gradschool.siu.edu/apply</u>. A nonrefundable \$65 application fee is required and must be paid by credit card. Applications cannot be processed until the fee is paid.

Requirements

For graduation, the M.E. in Civil and Environmental Engineering student is required to complete 30 credit hours of graduate level courses. Of this, at least 18 credit hours must be earned in the School. Furthermore, at least 15 credit hours must be 500-level and completed at Southern Illinois University Carbondale. Students are required to take CE 593, Civil Engineering Project. However, this requirement is waived if a student takes an additional 500-level course, i.e., at least 18 credit hours of 500-level courses. Students may, with the approval of the School Director, also take graduate level courses in other branches of engineering or in areas of science and business, such as physics, geology, chemistry, mathematics, life science, administrative sciences, or computer science.

The M.E. in Civil and Environmental Engineering program permits students to complete an advanced degree in three semesters (12 credit hours in Fall, 12 credit hours in Spring, six credit hours in Summer). This is a non-research degree; teaching or research assistantships are not available for students pursuing this degree, nor would this be a suitable track to pursue a Ph.D.

Doctor of Philosophy (Ph.D.) in Civil and Environmental Engineering

The School of Civil, Environmental, and Infrastructure Engineering within the College of Engineering, Computing, Technology, and Mathematics at SIUC offers a Doctor of Philosophy degree in Civil and Environmental Engineering. It is designed for students who desire positions requiring advanced preparation at the highest level with emphasis on theories of curriculum and instruction and in-depth preparation in research.

The Ph.D. program is supported by cutting-edge research projects conducted by nationally and internationally recognized Civil, Environmental and Infrastructure Engineering faculty members. The School has well equipped laboratories and computer facilities that are housed in a modern Engineering Complex that houses research laboratories, including facilities for civil engineering materials, a lab that includes concrete, steel, timber and asphalt, soil testing lab including cyclic triaxial and resilient modulus test and SWCC device, fluid mechanics lab, environmental engineering lab, etc.

The Doctor of Philosophy degree in Civil and Environmental Engineering is available for four fields of study that correlate with the School's core expertise. The areas of concentration are as follows:

- 1. Environmental Engineering
- 2. Geotechnical Engineering
- 3. Structural Engineering
- 4. Water Resources Engineering

Admission

Apply online to SIU. There is a \$65 application fee.

Admission to the program requires a Master of Science degree in Civil and Environmental Engineering or a related field with a GPA of 3.25/4.0 or higher. Applications for admission must include the following:

M.S. thesis abstract, a statement of interest, Bachelor and Master degree transcripts, GRE scores, and three letters of recommendation. International applicants should also include a photocopy of the page(s) of your passport showing your name, date of birth, and country of citizenship and a TOEFL score of 550 (paper score) or an IBT score of 80 or an IELTS score of 6.5. Admission to the program is made by the Civil and Environmental Engineering Graduate Committee.

For accelerated entry into the Ph.D. program, a student must complete at least two semesters in residence in an engineering M.S. program and complete a minimum of 18 hours of approved coursework with a minimum GPA of 3.75. Such entry is permitted only to superior students who have exhibited evidence that they are prepared to begin the research activities of doctoral-level study. In addition, the student must have GRE scores that are at or above the 50th percentile for both verbal component and analytical essay component and 80th percentile for the quantitative component or a combined total percentile score of 180 or higher. In case of a domestic student, an undergraduate GPA of 3.5 or higher is also a requirement. For an international student, a TOEFL score of 550 (paper score) or an IBT score of 80 or an IELTS score of 6.5 is an additional requirement. In exceptional cases, to substitute for the abovementioned GRE and TOEFL score requirements, the student's current faculty advisor, with the approval of the department chair, may submit a letter of recommendation for his/her student's accelerated entry into the Ph.D. program. The student, having an accelerated entry into the Ph.D. program, may not write a M.S. Thesis. In addition, 6 credit hours of course work of 500 level completed prior to his/her entry into the Ph.D. program may be counted toward the Ph.D. course requirement. In the rare event that the student getting an accelerated entry into the Ph.D. program fails to pass the Ph.D. qualifying exam in two attempts, he/she will be allowed to complete a MS degree in his/her respective discipline. Admission to the program is made by the Civil and Environmental Engineering Graduate Committee.

Admission to the doctoral program also requires the identification of an initial graduate adviser for each student. This advisor will be responsible with the student for planning the student's course work according to the field of study within Civil and Environmental Engineering described later.

Retention

Any prospective doctoral candidate with a grade point average of less than 3.25 and 20 semester hours of doctoral work will not be allowed to continue in the program and will not be re-admitted at a later date. Students must accumulate an overall grade point average of 3.50 for all doctoral work to qualify to take the qualifying examination.

Prior to the completion of 26 semester hours of course work, students meet with their major professors to determine whether or not to continue as doctoral students. Such matters as grade point average, progress in the program, course completion, motivation, general academic scholarship, and skills in writing and research are considered. A report is then made to the graduate committee and the school director. Students who are not making satisfactory progress or who violate the regulations of the school, college, or university may be dropped from the program.

Curriculum

A minimum of 26 semester hours of course work, including 2 hours of seminar, and 24 semester hours of dissertation research is required. The course work must be completed in 2 areas: area of concentration and program core. A student must complete a minimum of 15 hours of course work relevant to an area of concentration. The course work in the area of concentration is intended to provide depth in the

student's area of research. The program core consists of 11 hours of course work. A dissertation must be completed in the student's area of research interest with the approval of the dissertation committee.

Program Core

The program core consists of 11 hours of course work: 6 hours in math, 3 hours in engineering or science and 2 hours of seminar. The math courses to choose from are: all 500 level except MATH 511. The engineering courses to choose from are: ENGR 530— Engineering Data Acquisition: Theory and Practice, ENGR 540— Design of Engineering Experiments, ENGR 545—Advanced Numerical Methods in Engineering, ENGR 521—Probability and Stochastic Processes for Engineers. The science course could be any 500-level course in Computer Science, Physics, Chemistry or Geology, as approved by the student's advisor. The seminar course, ENGR 580, must be taken in two separate semesters, each time as a one-hour course. It is recommended that the seminar classes be taken after the initiation of doctoral research or after candidacy is granted.

Qualifying Examination

Upon completion of the concentration and core courses, the student may take the qualifying examination which has two components: written exam and oral exam. The examination in the area of concentration is organized and administered by at least three Engineering faculty members (examining committee) including the student's advisor. The oral exam, conducted by the examining committee, is held within two weeks of the student receiving the grades from the written exam. If not successful, the committee may allow the student to repeat the whole or part of the examination one more time. The qualifying examination, in whole or in part, cannot be taken more than two times.

Candidacy

A Ph.D. student must satisfy all Graduate School requirements to become a candidate. Admission to candidacy requires: (a) successful completion of the qualifying examination (which satisfies the research tool requirement of the Graduate School) and (b) successful completion of twenty-four hours of credit (which satisfies the residency requirement of the Graduate School).

Acceptance to Ph.D. candidacy is contingent upon the completion of all courses with A or B grades and successful completion of a written and an oral test in the student's field of study. One of the one-hour seminars can be taken after the candidacy.

After the completion of the qualifying examination, copies of the graded tests, along with signoff sheets for both the written and oral examinations are submitted to the director of the Ph.D. program, who is also the Director of the School.

Dissertation

A dissertation must be written under the direction or co-direction of an engineering faculty member and approved by a dissertation committee consisting of at least five members (one outside the College of Engineering, Computing, Technology, and Mathematics). The dissertation adviser must be chosen by the end of the student's first academic year. The dissertation committee should be formed after successful completion of the candidacy examination. The members of this committee need not be the same as the members of the candidacy examination committee. A dissertation research proposal must be approved by the dissertation committee. Candidates will be required to present an acceptable dissertation describing original research performed with minimal supervision. Dissertation approval is based on a successful oral defense of the dissertation research and approval of the dissertation. This requires approval of at least 80 percent of the dissertation committee.

Following the admission to candidacy and upon completion of all the coursework, the candidate will prepare and submit a formal written dissertation proposal, defining the proposed research and the proposed line of inquiry. The candidate subsequently must make an oral presentation of the dissertation proposal to the members of the dissertation committee in an open forum. A public announcement of this event must be made at least five days in advance.

In the framework of the oral presentation of the dissertation proposal, the candidate is expected to address and respond to any question (by the members of the committee) related to material covered by all the courses taken during his doctoral studies or to the background necessary for the specific area of

the proposed research. In addition, the candidate is expected to defend the research methodology and the proposed line of inquiry.

The Dissertation must be prepared in accordance to the "Guidelines for Dissertations, Theses and Research Papers" of the SIUC Graduate School. Dissertation approval is based on successful defense of the research performed in terms of originality, relevance and presentation (written and oral). This requires approval by at least 80% of the members of the dissertation committee.

Upon completion of the dissertation, which must demonstrate the ability of the candidate to conduct independent research, the committee will administer the final oral examination. The objective of the final oral examination, conducted in an open forum, will be the defense of the dissertation. Upon satisfactory completion of the dissertation and the final oral examination the committee will recommend the candidate for the doctoral degree.

Graduation Timeline

Although the time to completion of the doctoral program changes from individual to individual, the average completion time is about four years. The following outline shows the steps for completing the program, with links to various forms needed to show completion of the various stages of the program. Forms shown in italics are required by the Graduate School. The other forms are required by the College of Engineering, Computing, Technology, and Mathematics.

- 1. Admission to the program.
- 2. Students complete the core and concentration.
- 3. A candidacy (qualifying) exam committee, comprised of at least three faculty members and chaired by the advisor, is formed (*Candidacy Committee Form*).
- 4. Student takes the candidacy (qualifying) exam: first the written exam and within two weeks the oral. Advisor reports the exam results to the Director (*Candidacy Exam Results Form*). The advisor sends the form to the Director along with copies of the graded written exam papers. A candidacy request form is then sent to the Graduate School to request candidacy status for the student. The advisor, the student, and the Director sign this form (*Admit to Candidacy Form*).
- 5. A D. Committee, comprised of at least five faculty members (one of whom is from outside of CEIE), and chaired by the advisor, is formed to guide the student in his/her dissertation research. (*Graduate Faculty Committee Approval Form*).
- 6. Student defends dissertation. The advisor sends the form to the Director along with a copy of the proposal (Dissertation Proposal Approval Form).
- 7. Student defends dissertation (*Oral Defense Form*). The Dissertation Approval Form is to be completed and deposited at the Graduate School (*Dissertation Approval Form*, to be printed on 25 % cotton paper). A copy of this form must be filed at the School. The dissertation is to be submitted to the Graduate School electronically in pdf format. For spring, summer, and winter graduation dates and deadlines, check the Graduate School website.

Suggested Coursework for the Different Fields of Study

The Doctor of Philosophy degree in Civil and Environmental Engineering is available for four fields of study that correlate with the School's core expertise. The fields of study are as follows:

- 1. Environmental Engineering
- 2. Geotechnical Engineering
- 3. Structural Engineering
- 4. Water Resources Engineering

The selection of field of study courses is listed below.

Environmental Engineering

Recommended Courses

- CE 510-3 Hazardous Waste Engineering
- CE 511-3 Nanotechnology and Subsurface Remediation
- CE 512-3 Contaminant Fate, Transport and Remediation in Groundwater

- CE 514-3 Environmental Engineering Chemistry
- CE 516-3 Surface Water Quality Modeling
- CE 517-3 Industrial Waste Treatment
- CE 518-3 Advanced Biological Treatment Processes
- CE 519-3 Triple E Sustainability Environment Energy and Economy
- CE 592C 1 to 5 Special Investigations in Civil Engineering

This is only a partial list and students may take classes fromother departments to meet graduation requirements with the approval of their advisor and the CEIE Director.

Geotechnical Engineering

Recommended Courses

- CE 520-3 Advanced Soil Mechanics
- CE 521-3 Soil Improvement
- CE 522-3 Advanced Foundation Engineering
- CE 523-3 Soil Dynamics
- CE 524-3 Advanced Soil Testing
- CE 525-3 Foundations for Dynamic Loads
- CE 526-3 Seepage and Slope Stability Analysis

This is only a partial list and students may take classes from other departments to meet graduation requirements with the approval of their advisor and the CEIE Director.

Structural Engineering

Recommended Courses

- CE 530-3 Advances in Materials and Testing
- CE 540-3 Structural Dynamics
- CE 542-3 Nonlinear Structural Analysis
- CE 544-3 Advanced Design of Reinforced Concrete
- CE 545-3 Advanced Steel Design
- CE 551-3 Introduction to Finite Elements in Engineering Applications (Same as Mechanical Engineering 565).
- CE 552-3 Theory of Elasticity
- CE 553-3 Theory of Plasticity (Same as Mechanical Engineering 513)
- CE 554-3 Experimental Mechanics
- CE 556-3 Theory of Laminate Composite Structures
- CE 557-3 Advanced Mechanics of Materials (Same as Mechanical Engineering 566)
- CE 558-3 Reliability in Engineering Applications.
- Review of linear algebra, SVD, eigenvalue problems. Review of probability theory and statistics

This is only a partial list and students may take classes from other departments to meet graduation requirements with the approval of their advisor and the CEIE Director.

Water Resources Engineering

Recommended Courses

- CE 566-3 GIS in Civil, Environmental and Infrastructure Engineering
- CE 570-3 Sedimentation Engineering
- CE 571-3 Water Resources Systems Engineering and Management
- CE 572-3 Advanced Hydraulic Design
- CE 573-3 Modeling of Hydrosystems
- CE 592B-1 to 5 Special Investigations in Civil Engineering

This is only a partial list and students may take classes from other departments to meet graduation requirements with the approval of their advisor and the CEIE Director.

Civil and Environmental Engineering Courses

CE410 - Hazardous Waste Engineering Analysis of hazardous waste generation, storage, shipping, treatment, and disposal. Source reduction methods. Government regulations. Remedial action. Prerequisite: CE 310. Credit Hours: 3

CE413 - Collection Systems Design Design of waste water and storm water collection systems including installation of buried pipes. Determination of design loads and flows, system layout and pipe size. Prerequisite: CE 310 and ENGR 370A or ENGR 370C. Credit Hours: 3

CE418 - Water and Wastewater Treatment A study of the theory and design of water and wastewater treatment systems, including physical, chemical, and biological processes. Topics include sedimentation, biological treatment, hardness removal, filtration, chlorination and residuals management. Prerequisite: CE 310, ENGR 370A or ENGR 370C, and completion of or concurrent enrollment in ENGR 351. Credit Hours: 3

CE419 - Advanced Water and Wastewater Treatment Advanced concepts in the analysis and design of water and wastewater treatment plants. Topics include advanced physical, chemical, and biological processes. Emphasis is on the treatment and disposal of sludges, design of facilities, advanced treatment principles, and toxics removal. Prerequisite: CE 418 and ENGR 351. Credit Hours: 3

CE421 - Foundation Design Application of soil mechanics to the design of the foundations of structures; subsurface exploration; bearing capacity and settlement analysis of shallow foundations; lateral earth pressures and design of retaining walls; capacity and settlement of pile foundations for vertical axial loads. Prerequisite: CE 320. Credit Hours: 3

CE422 - Environmental Geotechnology Geotechnical aspects of land disposal of solid waste and remediation, solute transport in saturated soils, waste characterization and soil-waste interaction, engineering properties of municipal wastes, construction quality control of liners, slope stability and settlement considerations, use of geosynthetics and geotextiles, cap design, gas generation, migration and management. Prerequisite: CE 310 and CE 320. Credit Hours: 3

CE423 - Geotechnical Engineering in Professional Practice Application of principles of geotechnical engineering in a real-world setting; planning, managing and executing geotechnical projects; developing proposals and geotechnical project reports; interpreting and using recommendations developed by geotechnical engineers; total quality management, professional liability and risk management. Prerequisite: CE 320, completion of or concurrent enrollment in CE 421 or consent of instructor for graduate students. Credit Hours: 3

CE426 - Seepage and Slope Stability Analysis Seepage through soils; numerical and physical modeling of two-dimensional flow; basic mechanism of slope stability analysis; analytical methods in analyzing slopes; slope stabilization. Prerequisite: CE 320. Credit Hours: 3

CE431 - Pavement Design Design of highway pavements including subgrades, subbases, and bases; soil stabilization; stresses in pavements; design of flexible and rigid pavements; cost analysis and pavement selection; and pavement evaluation and rehabilitation. Prerequisite: CE 320 and CE 330. Credit Hours: 3

CE432 - Computer Aided Design and Drawing (CADD) for Civil Engineers A study of civil engineering drawings and their relationship to engineering design in the CADD environment. Emphasis is on the skills associated with developing and understanding technical drawings, including construction plans and related documents, for engineering design. Computer based design and drawing techniques and related software. Includes 3 hours lab per week. Prerequisite: Completion of or concurrent enrollment in CE 263. Credit Hours: 3

CE440 - Statically Indeterminate Structures Analysis of trusses, beams, and frames. Approximate methods. Method of consistent deformations. Three-moment theorem. Slope deflection. Moment distribution. Column analogy. Plastic analysis. Matrix methods. Prerequisite: CE 340. Credit Hours: 3

CE441 - Matrix Methods of Structural Analysis Flexibility method and stiffness method applied to framed structures. Introduction to finite elements. Prerequisite: CE 340. Credit Hours: 3

CE442 - Structural Steel Design An introduction to structural steel design with an emphasis on buildings. Design of structural members and typical welded and bolted connections in accordance with the specifications of the Steel Construction Manual of the American Institute of Steel Construction (AISC). Design project and report required. Prerequisite: CE 340. Credit Hours: 3

CE444 - Reinforced Concrete Design Behavior and strength design of reinforced concrete beams, slabs, compression members, and footings. Prerequisite: CE 340. Credit Hours: 3

CE445 - Fundamental Theory of Earthquake Engineering The nature and mechanics of earthquakes. Plate tectonics, types of faulting, recording and measuring ground motion. Analysis of free and forced vibration of a single degree of freedom system. Steady state and transient response. Impulse response function. Dynamic amplification and resonance. Response to ground motion. Response spectrum analysis. Prerequisite: CE 320 and CE 340, or consent of instructor for graduate students. Credit Hours: 3

CE446 - Prestressed Concrete Design Fundamental concepts of analysis and design. Materials. Flexure, shear, and torsions. Deflections. Prestress losses. Composite beams. Indeterminate structures. Slabs. Bridges. Prerequisite: Completion of or concurrent enrollment in CE 444 or consent of the instructor for graduate students. Credit Hours: 3

CE447 - Seismic Design of Structures Basic seismology, earthquake characteristics and effects of earthquakes on structures, vibration and diaphragm theories, seismic provisions of the International Building Code, general structural design and seismic resistant concrete and steel structures. Prerequisite: CE 442 or CE 444, or consent of instructor for graduate students. Credit Hours: 3

CE448 - Structural Design of Highway Bridges Structural design of highway bridges in accordance with the specifications of the American Association of State Highway and Transportation Officials (AASHTO); superstructure includes concrete decks, steel girders, prestressed and post-tensioned concrete girders; substructure includes abutments, wingwalls, piers, and footings. Prerequisite: CE 442 or CE 444, or consent of instructor for graduate students. Credit Hours: 3

CE471 - Groundwater Hydrology Analysis of groundwater flow and the transport of pollution by subsurface flow; applications to the design of production wells and remediation of polluted areas; finite difference methods for subsurface analyses. Prerequisite: ENGR 370A or ENGR 370C or consent of instructor for graduate students. Credit Hours: 3

CE472 - Open Channel Hydraulics Open channel flow, energy and momentum, design of channels, gradually varied flow computations, practical problems, spatially varied flow, rapidly varied flow, unsteady flow, flood routing, method of characteristics. Prerequisite: CE 474 or consent of instructor for graduate students. Credit Hours: 3

CE473 - Hydrologic Analysis and Design Hydrological cycle, stream-flow analysis, hydrograph generation, frequency analysis, flood routing, watershed analysis, urban hydrology, flood plain analysis. Application of hydrology to the design of small dams, spillways, drainage systems. Prerequisite: ENGR 370A or ENGR 370C or consent of instructor for graduate students. Credit Hours: 3

CE474 - Water Resources Engineering Hydrological Cycle, Flow Estimation, Study of pipe flow, network systems, pump selection, open channel flow, uniform flow, critical flow, gradually varied flow, rapidly varied flow, Introduction to HEC-RAS, design of transitions, water surface profiles. Prerequisite: ENGR 370A or ENGR 370C or consent of instructor for graduate students. Credit Hours: 3

CE486 - Nondestructive Evaluation of Engineering Materials (Same as ME 486) Overview of common nondestructive evaluation (NDE) techniques, such as visual inspection, eddy current, X-ray, and ultrasonics, to measure physical characteristics of and to detect defects in engineering materials. Laboratory experiments include contact ultrasonic, magnetic particle, liquid penetrant, and infrared

thermography methods of testing. Prerequisites: CE 320 and CE 330 with grades of C or better. Credit Hours: 3

CE500 - Seminar Collective and/or individual study of selected issues and problems relating to various areas of civil engineering. Restricted to graduate standing. Credit Hours: 1-4

CE510 - Hazardous Waste Engineering Analysis of hazardous waste generation, storage, shipping, treatment, and disposal. Source reduction methods. Government regulations. Remedial action. Design projects and presentation required. Students who have taken CE 410 are ineligible to enroll. Prerequisite: Graduate standing in the program or consent of instructor. Credit Hours: 3

CE511 - Nanotechnology and Subsurface Remediation Conventional and emerging nanotechnologybased remediation technologies for subsurface environment; review of current soil and groundwater remediation technologies; sediment remediation, nano-synthesis, characterization and nanotechnologydriven remediation technologies and materials. Special approval needed from the instructor. Credit Hours: 3

CE512 - Contaminant Fate, Transport and Remediation in Groundwater Mathematics of flow and mass transport in the saturated and vadose zones; retardation and attenuation of dissolved solutes; flow of nonaqueous phase liquids; review of groundwater remediation technologies; review of flow and transport models; modeling project. Students who have taken CE 412 are ineligible to enroll. Special approval needed from the instructor. Credit Hours: 3

CE514 - Environmental Engineering Chemistry Fundamentals as well as frontiers in aquatic chemistry, environmental organic chemistry, and environmental biochemistry. Topics include thermodynamics and kinetics of redox reactions, linear free energy relations, abiotic organic compound transformations, stoichiometry, energetics and kinetics of microbial reactions, biochemical basis of the transformation of key organic and inorganic pollutants in the environment. Prerequisite: CE 418 or consent of instructor. Credit Hours: 3

CE516 - Surface Water Quality Modeling Quantification of physical, biological, and chemical processes occurring in natural freshwater ecosystems. Mathematical analysis of the effects due to conservative and non-conservative pollutant loadings to lakes and rivers. Detailed study of dissolved oxygen mass balance modeling and eutrophication. Design projects and presentation required. Students who have taken CE 416 are ineligible to enroll. Restricted to graduate standing in the program or consent of instructor. Credit Hours: 3

CE517 - Industrial Waste Treatment Theories and methods of treating industrial wastes. Case studies of major industrial waste problems and their solutions. Prerequisite: CE 418. Credit Hours: 3

CE518 - Advanced Biological Treatment Processes The biochemical and microbial aspects of converting substrate to bacterial cell mass or products and its use in various phases of industry (both fermentation and wastewater treatment). Design of activated sludge and trickling filter plants from lab data obtained on explicit wastes from both industry and municipalities. Prerequisite: CE 418. Credit Hours: 3

CE519 - Triple E Sustainability - Environment Energy and Economy Principles, goals, and practical applications of sustainable development; major theories and issues related to sustainability in the areas of environmental resource use, energy production, and process life cycle analysis; identify and design sustainable approaches on common areas of interest to the society, such as buildings, transportation, food, industry processes, and ecology. Special approval needed from the instructor. Credit Hours: 3

CE520 - Advanced Soil Mechanics Advanced theories in soil mechanics, stress distribution in soils, seepage, consolidation, shear strength, settlement analysis and stability of slopes. Prerequisite: CE 320, ENGR 350A,B, CE 421 or concurrent enrollment. Credit Hours: 3

CE521 - Soil Improvement Methods of soil stabilization, compaction, dynamic compaction, chemical treatment, compaction piling, stone columns, dewatering, soil reinforcement with stirrups, geomembranes and geogrids, ground freezing, stabilization of industrial wastes. Prerequisite: CE 320, CE 421. Credit Hours: 3

CE522 - Advanced Foundation Engineering Case histories of foundation failure, bearing capacity theories, shallow foundations, deep foundations, piles under vertical and horizontal loads, pier

foundations, foundations for difficult soil conditions, soil improvement. Prerequisite: CE 421. Credit Hours: 3

CE523 - Soil Dynamics Problems in dynamic loading of soils, dynamic soil properties, liquefaction, dynamic earth pressure, foundations for earthquake and other dynamic loads. Prerequisite: CE 320 and CE 421. Credit Hours: 3

CE524 - Advanced Soil Testing Review of basic laboratory tests on soils, hands-on training for performing advanced laboratory tests on soils such as: triaxial compression, flexible wall permeability, one-dimensional consolidation, and California bearing ratio, understanding ASTM standards, sample preparation, data reduction and interpretation, and development of detailed laboratory test reports. Prerequisite: CE 421, or consent of instructor. Credit Hours: 3

CE525 - Foundations for Dynamic Loads Dynamic loads due to natural and man-made phenomena, damage to humans and the environment, property loss, analytical models for response analysis of foundation-soil systems for steady state, seismic and impact loads, design criteria, determination of soil properties, stiffness and damping of foundation-soil systems, design of shallow and deep foundations for various types of dynamic loads, computer applications, case histories of damage. Prerequisite: CE 421 and CE 445 or consent of instructor. Credit Hours: 3

CE526 - Seepage and Slope Stability Analysis Seepage through soils; numerical and physical modeling of two-dimensional flow; basic mechanism of slope stability analysis; analytical methods in analyzing slopes; slope stabilization. Additional project and presentation required for students taking this course instead of CE 426. Students who have taken CE 426 are ineligible to enroll. Prerequisite: CE 320 or consent of instructor. Credit Hours: 3

CE530 - Advances in Materials and Testing An introduction to advances in concrete technology; High strength concrete; Light-weight concrete; Cement and polymer composites; and Non-destructive testing. Fundamental concepts, manufacture, performance, testing, design methodology and applications. Prerequisite: CE 330 or equivalent or consent of instructor. Credit Hours: 3

CE540 - Structural Dynamics Analysis of the dynamic response of multidegree-of-freedom framed structures. Structural idealizations. Matrix formulation. Lagrange's equations. Response calculation by mode-superposition and direct integration methods. Analysis for earthquakes. Prerequisite: CE 340 or consent of instructor. Credit Hours: 3

CE542 - Nonlinear Structural Analysis Analysis of the nonlinear response of framed structures subjected to static and dynamic loads. Structural idealizations. Response calculation by incremental and iterative techniques. Instability phenomena of snap-through and bifurcation. Post-buckling behavior. Approximate formulations. Detection of instability under dynamic loads. Prerequisite: CE 441 or CE 551 or consent of instructor. Credit Hours: 3

CE544 - Advanced Design of Reinforced Concrete Deep beams, shear friction. Slab, beam, girder systems. Monolithic joints. Retaining walls. Deflections. Length effects on columns. Two-way floor systems. Yield line theory. Torsion. Seismic design. Prerequisite: CE 444. Credit Hours: 3

CE545 - Advanced Steel Design Economical use of high strength steel; behavior and design bolted and welded building connections, plate girders and composite steel-concrete beams; brittle fracture and fatigue; and low-rise and industrial-type buildings. Prerequisite: CE 442. Credit Hours: 3

CE551 - Introduction to Finite Elements in Engineering Applications (Same as ME 565) An introduction to finite element techniques and computer methods in finite element applications. Theory and structure of algorithms for one-dimensional and multi-dimensional problems. Applications in solid mechanics, structural analysis, groundwater and fluid flow, and heat transfer, projects and presentations. Students who have taken CE 451 are ineligible to enroll. Prerequisite: ENGR 351 or consent of instructor. Credit Hours: 3

CE552 - Theory of Elasticity Stress and strain equations of elasticity; equilibrium equations; compatibility equations; stress functions; applications of elasticity in solving engineering problems in two and three dimensions. Prerequisite: ENGR 350A,B and MATH 305. Credit Hours: 3

CE553 - Theory of Plasticity (Same as ME 513) Criteria for onset of yielding, isotropic and kinematic strain hardening; flow rules for plastic strains; elastic plastic bending and torsion, slip line field theory; plane stress problems; limit analysis. Prerequisite: ENGR 350A,B and MATH 305 or consent of instructor. Credit Hours: 3

CE554 - Experimental Mechanics An introduction of various experimental techniques that are commonly used to determine properties such as deformation, straining, surface contour, etc. The topics to be covered include the principles of strain gage technology, theory of photoelasticity, piezoelectric accelerometer, laser based interferometry, image processing and analysis, and reverse mechanics. The specific areas of practical application for each type of experimentation will be discussed. Prerequisite: ENGR 350A,B. Credit Hours: 3

CE556 - Theory of Laminate Composite Structures Orthotropic and Anisotropic Materials, Laminated Plate Theory, Ritz Method, Galerkin's Method, bending, buckling and vibration of laminated structures. Prerequisite: ENGR 350A,B and MATH 251. Credit Hours: 3

CE557 - Advanced Mechanics of Materials (Same as ME 566) Advanced topics in mechanics of materials including: elasticity equations; torsion of non-circular sections; generalized bending including curved beams and elastic foundations; shear centers; failure criteria including yielding, fracture and fatigue; axisymmetric problems including both thick and thin walled bodies; contact stresses; and stress concentration. Prerequisite: ENGR 350A,B. Credit Hours: 3

CE558 - Reliability in Engineering Applications An overview of principles and methods for quantifying the uncertainty in planning, design, testing and operation of engineering systems. Topics include probability theory, random variables, multivariate distributions, regression and correlation analyses, Monte Carlo simulations, and Bayesian approaches. Concepts are illustrated with examples from various areas of engineering, with particular emphasis on civil engineering applications. Prerequisite: ENGR 351 or consent of instructor. Credit Hours: 3

CE566 - GIS in Civil, Environmental and Infrastructure Engineering An introduction to fundamental principles of geographic information systems (GIS) as they apply to Civil, Environmental and Infrastructure Engineering. Spatial data acquisition, mapping of civil and land features, terrain analysis, map projections, and visualization of spatial data. Application of a leading GIS software in the creation of GIS spatial data bases to address problems in hydrology, environmental control, landfill site selection, land development and transportation with an emphasis on engineering design. Methods of spatial interpolation, develop spatial patterns for environmental data and estimate the values at an unsampled location. Project to perform spatial analysis. Prerequisite: ENGR 351 or consent of the instructor. Credit Hours: 3

CE570 - Sedimentation Engineering Introduction to the transport of granular sediment by moving fluids; analysis of regional degradation, aggradation and local scour in alluvial channels; investigation of sediment sources, yield and control. Prerequisite: CE 474 or consent of instructor. Credit Hours: 3

CE571 - Water Resources Systems Engineering and Management Philosophy of water resources planning; economic, social and engineering interactions related to water quantity; quantitative optimal planning methodologies for the design and operation of hydrosystems; guest lecturers; projects/case studies. Prerequisite: CE 474 or consent of instructor. Credit Hours: 3

CE572 - Advanced Hydraulic Design Design and analysis of stormwater control and conveyance systems, dams, spillways, outlet works, stilling basins, culverts and other complex hydraulic systems. Prerequisite: CE 474 or consent of instructor. Credit Hours: 3

CE573 - Modeling of Hydrosystems Hydraulic and hydrologic modeling; theory and application of common surface and subsurface flow models such as HEC-RAS, HEC-6, FLDWAV, DAMBRK, MODFLOW and MODPATH. Prerequisite: CE 474 or consent of instructor. Credit Hours: 3

CE592A - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Structural Engineering. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592B - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Hydraulic Engineering. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592C - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Environmental Engineering. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592D - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Geotechnical Engineering. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592E - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Fluid Flow Analysis. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592F - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Computational Mechanics. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592G - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/or problems in Composite Materials. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE592H - Special Investigations in Civil Engineering Advanced Civil Engineering Topics and/ or problems in Stress Analysis. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 1-5

CE593 - Civil Engineering Project Advanced project on topics such as case studies, engineering design, testing and analysis methods, computer modeling, or any other topic focusing on engineering practice. Detailed project report is required. Restricted to graduate standing. Special approval needed from the instructor. Credit Hours: 3

CE599 - Thesis Credit Hours: 1-6

CE601 - Continuing Enrollment For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only. Credit Hours: 1

Civil and Environmental Engineering Faculty

Delanka-Pedige, Himali, Assistant Professor, Civil Engineering, Ph.D., New Mexico State University, 2021; 2024, Environmental Engineering, water and wastewater treatment, organic micropollutant, biological treatment, algae-based wastewater treatment, water quality characterization, resources recovery, sustainability assessment, process modeling.

Fakhraei, Habibollah, Assistant Professor, Civil Engineering, Ph.D., Syracuse University, 2016; 2019. Environmental engineering, environmental modeling, biogeochemistry, aquatic chemistry, water quality modeling, air pollution effects, GIS, geostatistical analysis, hydrology, numerical optimization.

Kalra, Ajay, Associate Professor, Civil Engineering, Ph.D., University of Nevada, 2011; 2015. Hydraulics and water resources engineering, hydro-climatology, urban sustainability, water-energy-climate nexus, probabilistic forecasting and downscaling, surface water and groundwater interactions.

Kolay, Prabir, Professor and Director, Civil Engineering, Ph.D., Indian Institute of Technology, IIT Bombay, 2001; 2010. Geotechnical engineering, soil stabilization, utilization of recycled concrete aggregate (RCA) and coal ash, unsaturated soil, thermal properties of soil, and numerical modeling.

Liu, Jia, Associate Professor, Civil Engineering, Ph.D., University of Houston, 2014; 2015. Environmental engineering, renewable energy production, microbial fuel cell, water/wastewater treatment and

groundwater/soil remediation, material development for energy safety and environmental pollution detection.

Sen, Debarshi, Assistant Professor, Civil Engineering, Ph.D., Rice University, 2018; 2022. Structural dynamic systems, infrastructure monitoring and resilience, applications of statistical and machine learning in monitoring, regional fragility assessment, seismic response control.

Shin, Sangmin, Assistant Professor, Civil Engineering, Ph.D., Korea Advanced Institute of Science and Technology (KAIST), 2015; 2021. Integrated water resources engineering, cyber-physical systems, hydroinformatics, socio-environmental hydrology, system resilience and sustainability, water-energy-food nexus, systems thinking and optimization.

Tezcan, Jale, Professor, Civil Engineering, Ph.D., Rice University, 2005; 2005. Non-linear structural behavior, neural networks in system identification and structural control, rehabilitation, and retrofitting of structures damaged by earthquakes.

Tiwari, Nitin, Assistant Professor, Civil Engineering, Ph.D., Indian Institute of Technology (IIT) Indore, 2021; 2024. Sustainable and resilient infrastructure, impact of climate change on geoinfra, problematic soils, biogeotechnics, Al-driven, twin IoT-enabled real time monitoring, data-driven decision making (DDDM), application of 3D Printing, numerical methods in geotechnical engineering, underground structures.

Emeriti Faculty

Bravo, Rolando, Associate Professor, Emeritus, Civil Engineering, Ph.D., University of Houston, 1990; 1991.

Butson, Gary J., Associate Professor, Emeritus, Civil Engineering, Ph.D., University of Illinois at Urbana-Champaign, 1981; 1992.

Chevalier, Lizette R., Professor, Emerita, Civil Engineering, Ph.D., Michigan State University, 1994; 1995.

Cook, Echol E., Professor, Emeritus, Civil Engineering, Ph.D., Oklahoma State University, 1970; 1971.

DeVantier, Bruce A., Associate Professor, Emeritus, Civil Engineering, Ph.D., University of California-Davis, 1983; 1983.

Evers, James L., Associate Professor, Emeritus, Civil Engineering, Ph.D., University of Alabama, 1969; 1969.

Frank, Roy R., Jr., Assistant Professor, Emeritus, Civil Engineering, M.S., Southern Illinois University Carbondale, 1983; 1984.

Hsiao, J. Kent, Professor, Emeritus, Civil Engineering, Ph.D., University of Utah — Salt Lake City, 2000; 2001.

Kassimali, Aslam, Professor and Distinguished Teacher, Emeritus, Civil Engineering, Ph.D., University of Missouri, 1976; 1980.

Kumar, Sanjeev, Professor and Distinguished Teacher, Emeritus, Civil Engineering, Ph.D., University of Missouri Rolla, 1996; 1998.

Puri, Vijay K., Professor, Emeritus, Civil Engineering, Ph.D., University of Missouri-Rolla, 1984; 1986.

Ray, Bill T., Associate Professor, Emeritus, Civil Engineering, Ph.D., University of Missouri-Rolla, 1984; 1985.

Rubayi, Najim, Professor, Emeritus, Civil Engineering, Ph.D., University of Wisconsin, 1966; 1966.

Sami, Sedat, Professor, Emeritus, Civil Engineering, Ph.D., University of Iowa, 1966; 1966.

Warwick, John J., Professor, Emeritus, Civil Engineering, Ph.D., The Pennsylvania State University, 1983; 2011.

Yen, Max Shing-Chung, Professor, Emeritus, Civil Engineering, Ph.D., Virginia Polytechnic Institute, 1984; 1984.

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