DATA ANALYTICS FOR WATER RESOURCES

https://www.uvm.edu/cems/cee

OVERVIEW

The aim of the Certificate of Graduate Study (CGS) in Data Analytics for Water Resources program is to educate students on understanding and developing advanced methods (e.g., physics- and process-based modeling, statistical, machine learning, deep learning and data visualization methods) to address critical water resources challenges such as: Drinking water treatment and access, Recovery and treatment of wastewater, Surface and groundwater management, and Adaptation to climate change and other hazards.

DEGREES

Data Analytics for Water Resources CGS

FACULTY

Badireddy, Appala Raju; Assistant Professor, Department of Civil and Environmental Engineering; PHD, University of Houston
Garcia, Luis; Professor, Department of Civil and Environmental Engineering; PHD, University of Colorado
Hamshaw, Scott; Research Assistant Professor, Department of Civil and Environmental Engineering; PHD, University of Vermont
Rizzo, Donna Marie; Professor, Department of Civil and Environmental Engineering; PHD, University of Vermont
Underwood, Kristen L.; Research Assistant Professor, Department of Civil and Environmental Engineering; PHD, University of Vermont

Courses

CEE 5440. Transport Plan Demand Modeling. 3 Credits.
Study of transportation planning theory and policy; methods used to collect and evaluate household travel behavior; design of household travel surveys; methods used to forecast household travel demand, destination choice; travel mode choice, and transportation network flows; mathematical methods common to travel modeling. Applications to both transportation planning practice and research. Credit not awarded for both CEE 5440 and CEE 4440.

CEE 5450. Spatial Analy Sustainbl Transp. 3 Credits.
Students will learn to use spatial analysis methods to support sustainable transportation and land use planning. Topics include spatial data types, mapping and data visualization, spatial operations and analysis, and network analysis. In-class examples and exercises will include applications related to transportation, land use, sustainability, planning, and equity. Credit not awarded for both CEE 5450 and CEE 4450. Prerequisite: Graduate student or Instructor permission.

CEE 5550. Phys/Chem Proc Water/Wstwater. 0 or 3 Credits.
Theory of physical/chemical processes for treating waters and wastewaters; reactor dynamics, mass transfer, adsorption, ion exchange, precipitation; project-based. Prerequisite: Graduate student or Instructor permission; content knowledge of water and wastewater engineering (such as CEE 3510 or CEE 3515) assumed.

CEE 5600. Principles of Hydrology. 3 Credits.
Understanding and applying theory of precipitation, run-off, infiltration, and ground water; precipitation and run-off data; application of data for use in development of water resources; review and synthesis of relevant scientific literature. Credit not awarded for both CEE 5600 and CEE 4600. Prerequisites: Content knowledge of hydraulics/fluid mechanics assumed.

CEE 5620. Advanced Hydrology. 3 Credits.
Introduces computer modeling of hydrological systems. Project-based. Simple overland flow, flood routing, water quality, and groundwater models are developed using finite difference techniques. Stochastic hydrology and hydrologic time series analysis are also introduced. Prerequisite: Graduate student or Instructor permission; content knowledge of hydrology (such as CEE 4600) assumed.

CEE 5630. Applied River Engineering. 3 Credits.
Application of fundamental principles of fluid dynamics and open channel flow to the design and retrofit of river-connected infrastructure, including road embankments, road drainage systems, berms, culverts, bridges and impoundments. Project-based. Prerequisites: Graduate student or Instructor permission; content knowledge of hydraulics/fluid mechanics (such as CEE 3600, CEE 3615, or ME 2230) assumed.

CEE 5650. Groundwater Hydrolo & Modeling. 3 Credits.
Principles of ground water hydraulics, well characteristics, aquifers, and use of numerical methods to solve ground water flow problems. Modeling of groundwater and contamination remediation design. Credit not awarded for both CEE 5650 and CEE 4650. Prerequisites: Content knowledge hydraulics/fluid mechanics is assumed.

CEE 5660. Climate Change Impacts. 3 Credits.
Introduces the physical basis of climate change and explores a number of climate change impacts, particularly those that affect the built environment; primary focus on hydro-climate impacts, specifically flood risk, water resources, coastal flooding, and stormwater infrastructure; various modeling techniques are introduced and applied to engineering problems. Prerequisite: Graduate student or Instructor permission; programming skills (such as in Python or Matlab) and content knowledge of hydraulics/fluid mechanics (such as CEE 3600, CEE 3615, or ME 2230) assumed.

CEE 5700. Advanced Structural Analysis. 3 Credits.
Virtual work and strain energy theorems, matrix analysis of three-dimensional statically indeterminate frame and truss structures by the flexibility and stiffness method, stability and collapse mechanisms in structural systems. Project-based. Prerequisite: Graduate student or Instructor permission; content knowledge of structural analysis (such as CEE 3700) assumed.

CEE 5720. Structural Dynamics. 3 Credits.
Time-domain and frequency-domain analysis of linear single degree of freedom (SDOF) systems subjected to initial conditions and(or) arbitrary loading. Multi-degree of freedom (MDOF) systems. The eigenvalue problem in structural dynamics. Analysis of linear multi-degree of freedom systems using modal analysis. Numerical methods for dynamic analysis of MDOF systems, wave propagation. Project-based. Prerequisites: Graduate student or Instructor permission; content knowledge of calculus through differential equations (such as MATH 3201) and Physics (such as PHYS 1500) assumed.

CEE 5730. Structural Design - Wood. 3 Credits.
Analysis and design of solid and glue laminated timber members and structural systems including tension members, beams, columns, beam-columns, diaphragms, shear walls, and connections; LRFD and ASD design methods; application of IBC for timber systems; current developments in wood design/construction; project-based. Prerequisite: Graduate student or Instructor permission; content knowledge of structural analysis (such as CEE 3700) assumed.

CEE 5850. Geo-energy Systems. 3 Credits.
An introduction to Geoenergy technologies for subsurface energy extraction (shallow and deep geothermal systems, enhanced oil recovery, shale gas extraction) and secure storage of byproducts of energy production (carbon dioxide and nuclear wastes); project-based. Prerequisite: Graduate student or Instructor permission; content knowledge of soil mechanics (such as CEE 3800 or CEE 3815) assumed.

CEE 5870. Design of Earth Structures. 3 Credits.
Soil and rock properties using laboratory, field and in-situ testing; analysis and design of slopes, embankments and retaining structures. Prerequisites: Graduate Student or Instructor permission; content knowledge of soil mechanics (such as CEE 3800 or CEE 3815) assumed.

CEE 5980. Numerical Methods for Engineer. 3 Credits.
Foundational concepts of numerical integration, numerical differentiation, and numerical approximation and solution of differential and partial differential equations of the type encountered in the analysis of engineering problems and data processing; project-based. Prerequisite: Graduate student or Instructor permission; content knowledge of calculus through differential equations (such as MATH 3201) and linear algebra (such as MATH 2522 or MATH 2544) assumed. Cross-listed with: ME 5980.

CEE 5990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CEE 5993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CEE 6391. Master's Thesis Research. 1-18 Credits.
Research for the Master's Thesis.

CEE 6392. Master's Project Research. 1-6 Credits.
Independent project related to Civil & Environmental Engineering under the supervision of a Civil & Environmental Engineering faculty member, concluding with a written technical report and an oral presentation to a committee of two Civil & Environmental Engineering faculty members. Prerequisite: Permission of Civil & Environmental Engineering Graduate Coordinator or Civil & Environmental Engineering Department Chair.

CEE 6550. Environmental Chemodynamics. 3 Credits.
Understanding the behavior of chemicals in the environment. Emphasis on human-made chemicals; their movement through water, air, and soil; and their eventual fate. Physical transport, and chemical and biological sources and sinks, are discussed. Case studies and models are used to illustrate how quantitative predictions of chemical dynamics and behavior in environmental systems can be made. Linkages to health effects, sources and control, and policy aspects are discussed and debated. Prerequisites: Content knowledge of chemistry and water and wastewater engineering is assumed; Graduate student.

CEE 6610. Data Analytics Water Resources. 3 Credits.
Understanding and application of computational tools to the analysis of water resources data including: 1) autocorrelation or semivariograms to examine data structure; 2) kriging methods for data interpolation; 3) clustering and classification techniques for data exploration; and 4) Bayesian analyses to quantify uncertainty. Data analysis techniques are presented as a systems approach to site characterization, monitoring, remediation or restoration applications in groundwater or surface water settings recognized as components of the complex Earth system. Prerequisites: Content knowledge of statistics assumed; Graduate student.

CEE 6840. Site Characterization. 3 Credits.
A comprehensive approach to subsurface site characterization for geotechnical and environmental designs and a systems approach for integrating the two. Prerequisites: Graduate Student or Instructor permission; content knowledge of hydraulics/fluid mechanics (such as CEE 3600, CEE 3615, or ME 2230) and soil mechanics (such as CEE 3800 or CEE 3815) assumed.

CEE 6930. CEE Graduate Seminar. 0 Credits.
Presentation and discussion of advanced problems, research, and current topics in Civil & Environmental Engineering by faculty, Graduate students, and outside guest speakers. Prerequisite: Civil & Environmental Engineering Graduate student.

CEE 6990. Special Topics. 1-18 Credits.
Advanced topics in recently developed technical areas.

CEE 6991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CEE 6993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CEE 6995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CEE 7491. Doctoral Dissertation Research. 1-18 Credits.
Research for the Doctoral Dissertation.

CEE 7900. Uncertainty & Risk in Eng Sys. 3 Credits.
Modeling uncertainty and risk, random variables, modeling and simulation of functions of random variables and random processes, propagation of uncertainties in computational models, analytical and computational methods for computing failure probability of engineering systems, Bayesian updating of risk measures, communicating uncertainty and risk. Prerequisite: Content knowledge of probability and statistics (such as STAT 2430 or STAT 2510) is assumed.

CEE 7920. Appld Artificial Neural Ntwrks. 1-3 Credits.
Introduction to artificial neural networks. A broad range of example algorithms are implemented in MATLAB. Research applications to real data are emphasized. Prerequisites: Programming skills (such as in Python or Matlab) and content knowledge of multivariate statistics (such as STAT 5230) are assumed. Cross-listed with: CSYS 7920.

CEE 7980. Applied Geostatistics. 3 Credits.
Introduction to the theory of regionalized variables, geostatistics (kriging techniques): special topics in multivariate analysis; Applications to real data subject to spatial variation are emphasized. Prerequisites: Programming skills (such as in Python or Matlab) and content knowledge of multivariate statistics (such as STAT 5230) are assumed. Cross-listed with: CSYS 7980, STAT 7980.

CEE 7990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CEE 7991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CEE 7993. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CEE 7995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.