312 Soil Mechanics
Fall, Spring. 4(3-3) P: ME 222 and (CE 273 or concurrently) and (CE 274 or concurrently) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering and open to juniors or seniors in the Biosystems Engineering major.


321 Introduction to Fluid Mechanics
Fall, Spring. 4(3-2) P: MTH 235 and CE 221 and Completion of Tier I Writing Requirement R: Open to juniors or seniors in the Department of Civil and Environmental Engineering or in the Biosystems Engineering Major. Not open to students with credit in ME 332.


337 Civil Engineering Materials
Fall, Spring. 4(3-3) P: (ME 222 or concurrently) and (CE 273 or concurrently) and (CE 274 or concurrently) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering. Common civil engineering construction and paving materials: aggregates, inorganic cements, asphalts, concretes, wood, and steel. Composition, structure, physical and mechanical properties, tests, and production mix design.

341 Transportation Engineering
Fall, Spring. 3(3-2) P: (MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently) and (CE 274 or concurrently) and (CE 273 or concurrently) and (CE 274 or concurrently) and completion of Tier I writing requirement) and ((CE 372 or concurrently) or (STT 200 or concurrently) or (STT 201 or concurrently)) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering or in the Urban and Regional Planning Major. SA: CE 346

Fundamentals of transportation planning, traffic flow and level-of-service, traffic signal design, geometric design of highways, and highway safety.

371 Sustainable Civil and Environmental Engineering Systems
Fall, Spring. 3(3-0) P: Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: (MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently) R: Open to juniors or seniors in the Applied Engineering Sciences Major or in the Civil Engineering Major or in the Environmental Engineering Major. SA: CE 272 Principles and tools of sustainable design and engineering economics in Civil and Environmental Engineering.
Pavement rehabilitation, design procedures. Performance measurements. Failure mechanisms. Popu-
lar thickness design procedures. Design consideration for surface friction, pavement joints, and drain-
age.

432 Applied Hydraulics
Spring, 3(2-2) Interdepartmental with Environ-
mental Engineering. Administered by Environ-
mental Engineering. P: CE 321 or ME 332. R: Open to juniors or seniors or graduate students in the College of Engi-
neering.


431 Pavement Design and Analysis
Spring, 3(3-0) R: Open to juniors or seniors or graduate students in the College of Engineering.

Highway and airfield pavement structural design. Performance measurements. Failure mechanisms. Popu-
lar thickness design procedures. Design considera-
tions for surface friction, pavement joints, and drain-
age.

430 Pavement Rehabilitation
Spring of odd years. 3(3-0) P: CE 337 RB: CE 431 R: Open to seniors or graduate stu-
dents in the College of Engineering.

Engineering concepts and information needed to re-
habilitate pavements. Network and project survey and evaluation: design of rigid and flexible overlays, other methods of rehabilitation, selection of rehabili-
tation alternatives. Initial and life cycle cost analysis of various rehabilitation alternatives.

444 Principles of Traffic Engineering
Spring, 3(3-0) P: CE 341 R: Open to juniors or seniors or graduate students in the Civil Engineering Major.

Driver and vehicle characteristics affecting traffic flow and safety. Speed, density, capacity relations-
ships. Signal control in street networks. Freeway management systems. Risk management and liabil-
ity.

448 Transportation Planning
Spring, 3(3-0) P: CE 341

Transportation planning process and procedures. Estimation of travel demand using traditional models of trip generation, trip distribution, modal split, and traffic assignment. Use of "quick-response" proce-
dures. Traffic impact of new facilities.

449 Highway Design
Spring, 3(3-0) P: CE 341 R: Open to juniors or seniors or graduate students in the College of Engineering.

Geometric design of highways. Operation, capacity, safety, and geometric features. Alignment, drainage and pavement design. Use of CAD systems in pre-
paring contract plans.

461 Computational Methods in Civil Engineering
Spring, 3(3-2) P: EGR 102 and CE 221 and (MTH 235 or MTH 340 or MTH 347H) R: Open to juniors or seniors or graduate students in the Civil Engineering Major. SA: CA 390 Not open to students with credit in ME 361. Theoretical, numerical, and computational methods for civil engineering problems. Physical modeling, numerical techniques, and programming methods. Focus on civil engineering dynamics, solving sys-
tems of differential equations, and visualizing the re-
sults.

471 Construction Engineering - Equipment, Methods and Planning
Spring, 3(3-0) P: CE 305 and CE 312 and CE 337 or (CMP 305 and CMP 322) R: Open to juniors or seniors or graduate stu-
dents in the College of Engineering or in the Department of Management or in the Construction Management major.

Engineering and construction fundamentals of earth-
work operations, moving of materials, concrete con-
struction, formwork, false work, and other temporary structures. Relationship to a construction project's constructability, cost, and schedule.

472 Life Cycle Assessment of Energy Technologies
Spring, 3(2-2) Interdepartmental with Environ-
mental Engineering. Administered by Environ-
mental Engineering. P: CE 371 or approval of department R: Open to students in the College of Engineering.

Use of life-cycle assessment (LCA) for energy tech-
ologies to evaluate trade-offs between various en-
ergy options and guide energy choices.

473 Smart and Sustainable Building Design and Operations
Spring of odd years. 3(3-0) Interdepart-
mental with Environmental Engineering. Ad-
mistered by Civil Engineering. P: CE 371 or approval of department R: Open to students in the College of Engineering.

Elements of the design and operation of smart and sustainable buildings. Current and future energy-re-
lated challenges of existing buildings.

480 Environmental Measurements Laboratory
Spring, 2(1-3) Interdepartmental with Envi-
ronmental Engineering. Administered by Environ-
mental Engineering. P: (CEM 161 or CEM 185H or LB 171L) and ENE 280 and (CEM 142 or CEM 152 or CEM 182H or LB 172) and ((ENE 481 or concurrently) or (ENE 483 or concurrently)) or 480 and (CEM 152 or concurrently)) and Completion of Tier I Writing Requirement R: Open to juniors or seniors or graduate students in the College of Engineering.

Basic chemical and microbiological methods used in the analysis of environmental media. Laboratory safety, quality assurance, quality control, and statis-
tics used in laboratory analysis.

481 Environmental Chemistry: Equilibrium Concepts
Spring, 3(0-0) Interdepartmental with Envi-
ronmental Engineering. Administered by Environ-
mental Engineering. P: (CEM 141 and CEM 142) or (CEM 151 and CEM 152) or (CEM 181H and CEM 182H) or (LB 171 and LB 172) and (ENE 280 or BE 230 or GLG 201 or GLG 301 or approval of depart-
ment) and ((CHE 201 or concurrently) or (CHE 251 or concurrently)) R: Open to sophomores or juniors or seniors or gradu-
ate students in the Department of Biosys-
tems and Agricultural Engineering or in the Department of Chemical Engineering and Materials Science or in the Department of Civil and Environmental Engineering or in the Department of Earth and Environmental Sciences.

Chemistry of environmental systems and air, water, and soil pollutants as applied to environmental engi-
neering.

483 Water and Wastewater Engineering
Spring, 4(3-2) Interdepartmental with Envi-
ronmental Engineering. Administered by Environ-
mental Engineering. P: (ENE 280 or BE 230) and (CE 321 or CHE 311) R: Open to juniors or seniors or graduate students in the College of Engineering.

Engineering and scientific basis and design of physi-
cal, chemical and biological methods for the treat-
ment of drinking water and wastewater. Operation process selection and design. Field trips required.

485 Landfill Design
Spring, 3(3-0) Interdepartmental with Envi-
ronmental Engineering. Administered by Civil Engineering. P: ENE 280 and CE 321 R: CE 312

Geotechnical and environmental design of solid waste landfills.

487 Microbiology for Environmental Science and Engineering
Spring, 3(3-0) Interdepartmental with Environ-
mental Engineering. Administered by Environ-
mental Engineering. P: ENE 280

Fundamentals of microbiology. Application of these concepts to environmental processes such as wastewaster treatment, human health and bioremedi-
ation.

489 Air Pollution: Science and Engineering
Spring, 3(3-0) Interdepartmental with Envi-
ronmental Engineering. Administered by Environ-
mental Engineering. P: (CEM 141 or CEM 151 or LB 171) and (MTH 133 or MTH 153H or MTH 153H or LB 119) and (ENE 280 or BE 230) and (CE 321 or CHE 311) and (CE 372 or CHE 316) and (ME 201 or concurrently) or (BE 351 or concurrently) or (CHE 321 or concurrently) R: Open to juniors or seniors or graduate students in the College of Engi-
neering.

Basic physical and chemical principles governing indoor and atmospheric air pollutant fate, transport and control technologies.

490 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A stu-
dent may earn a maximum of 6 credits in all enrollments for this course. R: Open to sen-
iors in the College of Engineering. Ap-
proval of department.

Civil engineering problem of specific interest to the student and a faculty member. May be analysis or design.
492 Selected Topics in Civil Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.
Selected topics related to construction engineering, fluid mechanics, geotechnical engineering, hydrology, pavements, structural engineering, or transportation engineering.

495 Senior Design in Civil and Environmental Engineering
Fall, Spring. 4(2-3) P: (CE 274 and CE 371 and CE 372) and (ENE 421 or ENE 422 or ENE 483 or ENE 489 or CE 418 or CE 431 or CE 405 or CE 406 or CE 444 or CE 449) and (ENE 421 or ENE 422 or ENE 483 or ENE 489 or CE 405 or CE 406 or CE 418 or CE 431 or CE 444 or CE 449) and (ENE 421 or ENE 422 or ENE 483 or ENE 489 or CE 405 or CE 406 or CE 418 or CE 431 or CE 444 or CE 449). R: Open to seniors in the Civil and Environmental Engineering Major.


805 Advanced Design of Steel Structures
Spring. 3(3-0) P: Flexural and torsional instability of columns and beams. Slender cross-sectional elements, design of beam-columns. Torsion, plastic design, plate girders, composite steel-concrete construction, connections.

806 Advanced Structural Concrete Design
Spring of even years. 3(3-0) SA: CE 808 Analysis and design of prestressed and conventionally reinforced concrete structures.

807 Seismic Structural Design
Spring of even years. 3(3-0) RB: CE 400 and CE 405 and CE 406 Theory and methods for the seismic design of buildings, bridges, and other structures. Emphasis on fundamental factors influencing and controlling structural response. Philosophies for ductile design, capacity design and performance-based design. Analysis of structural systems under seismic demands for design and assessment. Introduction to retrofit strategies.

808 Structural Fire Engineering
Spring of even years. 3(3-0) RB: CE 400 and CE 405 and CE 406 Fire safety, fire codes, and fire engineering design methods. High temperature material properties, and behavior of materials and structures exposed to fires. Fire resistance design of steel, concrete, composite and timber structures. Use of the computer program for thermal and structural analysis.

809 Advanced Composite Materials and Structures
Spring of even years. 3(3-0) RB: ME 222 and CE 490 and CSE 231 and MTH 235 and MTH 314 Mechanics and design of advanced composite materials and structures and their use for civil infrastructure. Elastic anisotropy and failure theories. Micro- and macro-mechanical analysis of fiber-reinforced polymer composites, particulate composites, and nanocomposites. Analysis and behavior of laminated plates and shells. Design applications to civil and mechanical structures.

812 Properties of Soils
Spring of odd years. 3(2-3) Saturated and unsaturated hydraulic properties, consolidation and shear strength properties, thermal properties, and numerical modeling. Laboratory determination of soil properties including, interpretation of experimental data.

815 Selected Topics in Geotechnical Engineering
Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. Selected topics related to soil stabilization, highway and airport soils, and frozen ground engineering.
838 Bituminous Materials
Spring of even years. 3(2-3) RB: CE 431 and CE 432 and CE 461
Superpave asphalt mix design, binder tests, hot mix asphalt performance tests, viscoelasticity, continuum damage models, image analysis methods.

841 Traffic Flow Theory
Spring. 3(3-0)
Microscopic and macroscopic traffic flow models, Queuing theory. Gap acceptance. Simulation models for network analysis. Intelligent vehicle highway systems.

844 Highway and Traffic Safety
Spring of odd years. 3(3-0)

847 Traffic Analysis and Control
Spring of odd years. 3(3-0) P: CE 444 RB: Graduate student in transportation engineering
Modern traffic control and traffic modeling using state-of-the-art algorithms and computer models. Practical implications.

849 Transportation Research Methods
Spring. 3(3-0)
Application and interpretation of quantitative methods and design of experiments for transportation research; ANOVA, non-parametric, discriminant analysis, factor analysis, multivariate regression, SPSS.

850 Intelligent Transportation Systems (ITS)
Spring of odd years. 3(3-0) RB: Traffic and Transportation engineering
Technical and policy aspects emerging from the application of advanced technologies to transportation problems. Intelligent Transportation Systems (ITS) user services requirements, available and emerging technologies, case studies of ongoing operational tests, legal institutional and planning issues related to ITS development and deployment.

851 Transportation and the Environment
Spring of even years. 3(3-0) RB: B.S. in Civil Engineering with emphasis on transportation or environmental engineering R: Open only to graduate students in the College of Engineering. The impact of transportation systems on the environment. Elements of Environmental Impact Statements. Policy options and their consequences. Alternatives for reducing environmental impact.

872 Finite Element Method
Fall, Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Mechanical Engineering. SA: AE 809, MSM 809
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.

878 Autonomous Futures: Self-driving Vehicles, Domotics, and Artificial Intelligence in Smart Cities

880 Civil Engineering Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. RB: Graduate student or undergraduate at senior level with a GPA of 3.0 or higher
Current research in civil engineering.

890 Independent Study in Civil Engineering
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Civil and Environmental Engineering. Approval of department.
Research problems of limited scope not pertaining to thesis accomplished under CE 899 or CE 999.

891 Selected Topics in Civil Engineering
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
Selected topics in new or developing areas of civil engineering.

892 Master's Research Project
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to master's students in the Civil Engineering major. Approval of department.
Master's degree Plan B individual student research project. Original research, research replication, or survey and reporting on a research topic.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course.
Master's thesis research.

900 Research Strategies and Methods in Civil Engineering
Spring. 1(1-0) R: Open to graduate students in the Department of Civil and Environmental Engineering. Not open to students with credit in ENE 900.
Criteria for quality research, scientific method, scientific arguments, statistical testing, critical thinking skills, reviewing journal articles, literature synthesis, writing proposals and papers, giving presentations, responsible conduct of research.

910 Independent Study in Civil Engineering
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students in the Civil Engineering major.
Research problems of limited scope not pertaining to thesis accomplished under CE 999.

990 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Doctoral dissertation research.